Imperial College London

Analysis of Risk Mitigation Measures in Agricultural Trade

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Declaration of Originality

I declare that this thesis "Analysis of Risk Mitigation Measures in Agricultural Trade" is entirely my own work. Where any material could be interpreted as the work of others, it is fully cited and referenced with appropriate acknowledgement given.

Copyright Declaration

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Abstract

International trade has brought tremendous choice to consumers and expanded markets for producers. Cross-border exchange also brings import risks such as food contaminants and invasive species. Balancing legitimate concerns to protect health and the environment with avoiding protectionist use of risk-based measures is highly important to the integrity of the multilateral trading system. This research studies three aspects of the relation between domestic regulations and international trade.

Firstly, this thesis provides evidence addressing an ongoing international policy debate. This thesis is the first to show that the 8,487 new risk-based regulations under the Sanitary Phytosanitary (SPS) Agreement and 4,745 regulations under Technical Barriers to Trade (TBT) Agreement notified from 1996-2010 are driven in part by loss of tariff protection and country-level environmental governance factors. Declining tariffs, however, do not make the implementation of "suspect" SPS (i.e. measures later subject to a trade concern) more likely. This suggests policymakers may be systematically choosing to work on products that have lost tariff protection, but not systemically putting in illegitimate, non-tariff barriers to compensate.

Secondly, this thesis investigates the patterns of Specific Trade Concerns (STCs) raised against 292 suspect SPS policies and 282 suspect TBT policies by members of the WTO from 1996-2010. It was found that developing countries struggle to resolve concerns they raise against developed economies. From work on 79 plant health concerns, it was clear that countries raise STCs using science-based and economics-based arguments of illegitimacy.

Lastly, SPS measures are implemented to reduce risks transmitted via trade, but the effectiveness of risk reduction depends as well on actions of supply chain actors before export. A case study on coffee pests and diseases from a survey of 119 growers and 89 traders in Uganda is presented to scrutinize the decision-making process of growers in a high pest/disease prevalence environment.

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Glossary of Terms

Term	Full Name	First Page of Use
AD	Anti-Dumping (measures)	36
BND	Bound (Tariff)	41
BO	(Tariff) Binding Overhang	41
BTB	Black Twig Borer	218
CBB	Coffee Berry Borer	218
CBD	Coffee Berry Disease	218
CRRA	Constant Relative Risk Aversion	224
CTB	Coffee Twig Borer (alternative name for BTB)	218
CWD	Coffee Wilt Disease	151
DSB	(WTO) Dispute Settlement Body	80
EPI	Environmental Performance Index (Emerson, Esty, Levy, et al., 2010)	42
ESI	Environmental Sustainability Index (Esty, Levy, Srebotnjak, et al., 2005)	42
FAQ	Fair Average Quality (coffee)	160
GAP(s)	Good Agricultural Practices	158
GATT	General Agreement on Trade and Treaties	31
GDPPC	Gross Domestic Product Per Capita	130
HH	Household (survey)	155
HL	Holt & Laury (2002) (a MPL design)	211
HS	Harmonized System (of codes for internationally traded goods)	38
IMF	International Monetary Fund	41
IPM	Integrated Pest Management	176
IPPC	International Plant Protection Convention	31
IQR	Inter-Quartile Range	143
ISPM	International Standards for Phytosanitary Measures	126
LIFFE	London International Financial Futures and Options Exchange	184
MPL	Multiple Price List (design for measuring risk-aversion)	224
NAADS	National Agricultural Advisory Services (extension agency of Uganda)	159
NB	Negative Binomial (count data regression method)	58
NGO	Non-Governmental Organization	156
NRC	Number of Risky Choices (metric of risk-aversion in MPL design)	260
NTB	Non-Tariff Barrier	36

Term	Full Name	First Page of Use
NTM	Non-Tariff Measure	33
NUCAFE	National Union of Coffee Agribusinesses and Farm Enterprises	159
OIE	World Organization for Animal Health	31
PRA	Pest Risk Assessment/Analysis	117
RASD	Rural Agency for Sustainable Development (partner NGO for fieldwork)	156
RBD	Red Blister Disease	218
RMB	Root Mealybug	218
RPPO	Regional Plant Protection Organization	119
SPS	Sanitary Phytosanitary	24
SPS-IMS	SPS Information Management System	39
STC	Specific Trade Concern	27
STDF	Standards and Trade Development Facility	22
TBT	Technical Barriers to Trade	24
TBT-IMS	TBT Information Management System	39
TPP	Trans-Pacific Partnership	322
TRAINS	Trade Analysis and Information System (database of UNCTAD)	41
UCDA	Uganda Coffee Development Authority	153
UNCTAD	United Nations Conference on Trade and Development	34
USh	Uganda Shillings	165
WB	World Bank	41
WDI	World Development Indicators (database of WB)	41
WEO	World Economic Outlook (database of IMF)	41
WGI	World Governance Indicators (database of WB)	56
WITS	World Integrated Trade System (database of WB/UN)	41
WTO	World Trade Organization	24
ZIP	Zero-Inflated Poisson (count data regression method)	57

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Chapter 1. Introduction

The topic of Trade and Environment is wide research area. This PhD focuses on challenges that occur from import risks. The first half the work is devoted to study of regulations used to mitigate these risks before the border of the importing nation. The second half examines, via a case study in Uganda, how stakeholders respond to plant pests and diseases that have established behind the border. While the work is by nature interdisciplinary, this chapter introduces the overarching research area (section 1.1) with specific literature introduced at the beginning of each chapter. The aims and objectives of the thesis are in section 1.2, which is followed by a chapter-level overview in section 1.3 and the original contributions of the thesis (section 1.4).

1.1. BACKGROUND TO THE RESEARCH AREA

Around half of employment in developing countries is in the agricultural sector (Bussolo, De Hoyos & Medvedev, 2011), and for the least developed countries, around 75% of people are engaged in agriculture as their primary activity (Cheong, Jansen & Peters, 2013). While most food is produced for local consumption, export markets have become an increasing share of total agricultural output growing at 4% annually (by volume) from 1950-2010 compared to 2% annual growth for overall agricultural output (Cheong, Jansen & Peters, 2013).[1] The growth in agricultural exports for developing countries though has primarily been to markets of other developing countries (Aksoy & Ng, 2010). Developed country markets are more difficult to penetrate due to quality and safety standards (Henson & Loader, 2001), which some evidence suggests can be overcome with technical assistance like that provided by the Standards and Trade Development Facility (STDF) (Henson, Masakure & Cranfield, 2011). However, agricultural trade policy is not an important topic just for developing countries. Several developed nations like Canada are major agricultural exporters; as a result, the agricultural sector generates significant revenue and jobs making it politically important. Other developed nations like South Korea and Japan depend tremendously on food and other agricultural

[1] To be clear, while agricultural exports are becoming a more significant use of agricultural production, the share of agriculture as a percentage of global GDP (1/13th in 2005 vs. 1/10 in 1960) or global merchandise trade (9% in 2005 vs. 22% in 1975) is actually declining (Anderson & Martin, 2005).

products imported into their market.[2] As a result, agricultural trade policies are important for developed nations as well.

The intersection of agriculture and trade policy is important, but fraught with complication. Agriculture both historically and currently is the most difficult sector of international trade to achieve policy consensus. The Uruguay Round of multilateral trade negotiation from 1986 to 1995 was delayed due to the US and EU disagreeing over agricultural trade (Anderson & Martin, 2005). The current impasse of the 2001 Doha Round of trade agreements of the WTO largely results from disagreements on agricultural policy; in August 2014, the only sub-agreement (the Bali agreement) to emerge from over a decade of mired Doha Round talks collapsed as well over agriculture issues (BBC News Business, 2014). The swing towards bilateral (and plurilateral) trade agreements and the tenuous state of the institutional legitimacy of the multilateral system in the 21st century is driven in part by challenges from agricultural trade policy.[3] The main points of disagreement for the breakdown of the Bali agreement were about agricultural subsidies and stockpiles[4], however, regulations meant to mitigate risks of invasive species and food contaminants have another set of policy challenges. These risk-based measures are particularly interesting because of the scientific and economic motivations for their use—and potential abuse.

Import risks are defined here as potential hazards for the importing nation from taking a foreign product into a domestic market.[5] International legal protections allow countries to protect against these risks. There are obvious reasons that make import requirements necessary. As one example of an import risk, invasive species cause immense economic damage to agricultural (and natural) land and the costs of control are often tremendous (Waage, Fraser, Mumford, et al., 2005). The widely cited study by Pimentel, Zuniga & Morrison (2005)

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[2] See Appendix A.11 for net agricultural exports by country in 2011 using data from FAOSTAT (2014).
[3] This point is returned to at the end of the thesis (Chapter 8) in the context of the Trans-Pacific Partnership.
[4] The main holdout nation was India, refusing to back down from many of their agricultural support programs. Reading the modelling results of Bussolo, De Hoyos & Medvedev (2011) it is clear that South Asia would experience drastic increases in poverty due to the removal of agricultural distortions, while most other regions of the world would experience declines in poverty.
[5] The other side of the trade equation are export risks. These are defined here as risks that arise to human, economic, and environmental capital for the exporter from resource use in a home market for consumption in a foreign nation. The literature here includes topics like the impacts of labelling (Staffin, 1996) (Loureiro & Lotade, 2005) and science of footprinting (e.g. water (Chapagain & Hoekstra, 2004), land (Würtenberger, Koellner & Binder, 2006), fertilizers (MacDonald, Bennett & Carpenter, 2012)). These are beyond the scope of the research and not discussed further.

estimated the cost of environmental damage, agricultural losses, and control of invasives at almost $120 billion USD per annum in the United States alone—the global figure is certainly higher. The growing need to study invasion events is recognized by many scientists.[6]

In the international context of the World Trade Organization (WTO), regulations against import risks primarily fall under the Technical Barriers to Trade (TBT) Agreement and the Sanitary and Phytosanitary (SPS) Agreement. WTO members have sovereignty to decide what they will allow and what they will not allow into their markets—subject to their commitments under these international agreements. It is difficult to regulate global trade in a way that minimizes environmental/health risk and maximizes the welfare benefits for both parties involved in the exchange. The best policies are never straightforward: (1) future environmental conditions are difficult to predict, (2) stakeholders have divergent values, and (3) interactions between species are complex (Schlaepfer, Sax & Olden, 2011).

Given the scientific uncertainties and potential clash of stakeholder values, it is not surprising the difficulty policymakers face in legislating effective and non-controversial regulations on imported products to protect human, animal, and/or environmental health. Regulatory measures one country views as legitimate protection of their territory, another claims are unfair use of regulations to obfuscate economic motivations. Most of the economic argument centres on the political economy drivers to protect domestic industries (Kono, 2006), especially when the public supports aiding domestic agriculture (Jensen & Shin, 2014). However, illegitimate policies under the banner of risk mitigation can also be used with the intention to harm a rival's market. At the end of July 2014, Russia was accused of using phytosanitary measures on apple imports from Ukraine (and threating wider EU fruit and vegetable bans) in a tit-for-tat response to embargos for Russia's actions in destabilizing Ukraine (Devitt & Szary, 2014). The various uses (and potential abuses) make the study of risk mitigation measures on agricultural trade a complex, but interesting area. It is important as well. The recent analysis of the "leverage points" to achieve global food security by West, Gerber, Engstrom, et al. (2014) in *Science* shows the need to close yield gaps and produce crops in economically and environmentally optimal areas. Therefore, effective, fair, and safe agricultural trade regulations are needed to achieve a sustainable future for global food supplies while protecting nations from import risks.

[6] See Simberloff, Martin, Genovesi, et al. (2012) for the most recent review of the literature.

1.2. AIMS AND OBJECTIVES

This thesis has two major aims:

1. To investigate the use of risk-mitigation measures and the complications that have arisen from them in the WTO.
2. To explore how people respond to pests and disease risk on their farms once sanitary or phytosanitary policy has failed to mitigate the harm before the border.

To make progress towards the first aim there were five objectives:

1. Synthesize the theoretical literature and empirical evidence for non-tariff barriers to trade compensating for lost tariff protection.
2. Test claims of policy substitution for lost tariff protection with risk-based trade measures.
3. Identify the conflicts that currently arise between countries on SPS and TBT measures as well as to distinguish the factors that give rise to dispute.
4. Test claims of bias against developing countries in the resolution of trade concerns in the SPS system.
5. Examine the motivations given by countries in the concerns they raise against others' SPS policies.

To develop the second aim there were seven objectives in a case study of Ugandan coffee:

1. Conduct interviews with key stakeholders in the supply chain and a run a targeted household survey of coffee growers and traders.
2. Assess the impact of certifications and cooperative institutional arrangements on coffee production and pest risk-reduction behaviours like weeding and pruning.
3. Examine whether stakeholders at different levels of the supply chain agree on the risk of different pests and diseases of Robusta coffee.
4. Determine the risk-aversion of growers and if risk-aversion has an impact on coffee plot decisions.

5. Elucidate the opinions of farmers and traders about fair prices for coffee and their ideal supply chain to see if that has an impact on coffee investment choices.

6. Use a novel market simulation game to elicit growers' willingness to accept a stable priced contract for coffee.

7. Examine other income-sources that coffee growers have and what factors influence some to abandon coffee production after heavy pest damage

1.3. OVERVIEW AND CONTRIBUTIONS OF THESIS

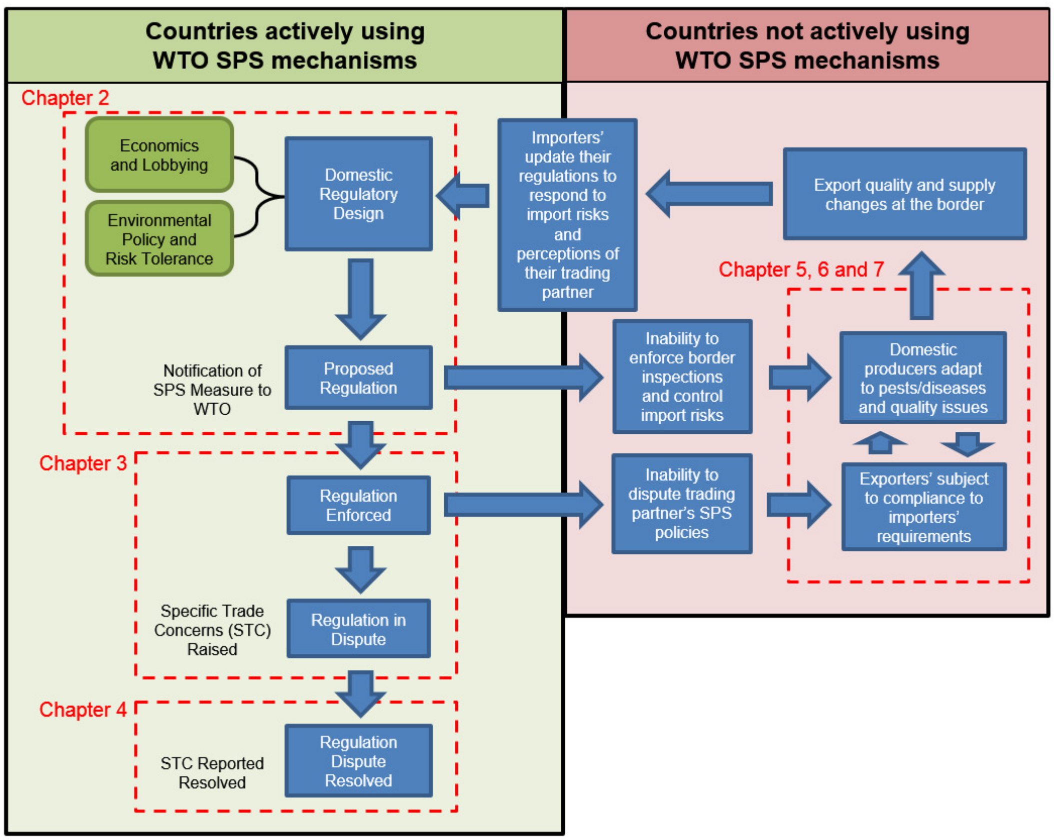

Figure 1: Schematic overview of SPS regulatory pathway for WTO members and the chapters that address issues in each area highlighted

As shown conceptually in Figure 1, this PhD addresses topics at the country-level for SPS/TBT notifications and concerns in Chapters 2 through 4, and at the producer-level for SPS issues in a specific commodity-country case study in Chapters 5 to 7. The advantage of a case study in a particular context is to highlight the consequences from inadequate SPS policy participation at the national level.

As presented in Chapter 2 and Chapter 3, the regulatory setting of policies to mitigate import risks are meant to address the poor quality of some imported products, but can result in disagreements about the severity of measures required (e.g. ppb concentration levels to protect human health from mycotoxins). The risks at the border stem from the decisions of stakeholders within an exporting country's supply chain. As shown in Chapters 5 to 7, a country that does not have rigorous SPS institutional structures is hurt both by the spread of pests and diseases within their production areas, as well as, the limited ability to negotiate compliance limits with importers. In the case study discussed (Uganda's coffee production system), the lack of robust SPS policies led to low prices from quality issues and low production from yield losses as supply chain actors adapted to introduced pests. Producers' and traders' responses then shape how the country as a whole is perceived by their trading partners (see Figure 1).

The thesis is presented in eight chapters; brief summaries of the contributions are given below:

Chapter 2: Environmental Protection or Protectionism?

Econometric methods are utilized to rigorously test questions of what determines countries' use of SPS and TBT policy. The contributions of this chapter to the literature are twofold: (1) it is the first robust empirical test of the policy substitution argument for SPS and TBT use, and despite the persistence of the belief in the policy sphere, one of few empirical tests for NTM substitution after liberalisation. Secondly, (2) it empirically tests other important country-level drivers (e.g. environmental governance)—which have not previously been examined—to explain countries' use of risk-based trade measures.

Chapter 3: Patterns of Trade Concerns in SPS/TBT Use

Econometric methods are used to test for tariff binding as a driver of SPS measures that are later questioned as illegitimate by other WTO members. Major assumptions on the concordance between SPS measures and Specific Trade Concerns (STCs) are made, however despite these limitations, this is the first empirical test of tariff binding constraints as a driver for issuing potentially illegitimate SPS policies. It also provides evidence against the suggestion in the literature that the use of SPS measures on obscure products are likely illegitimate. Only one peer-reviewed work has utilized the STC data, hence another set of contributions are detailed summary statistics on the patterns of STC use.

Chapter 4: STC Resolution and Plant Health Cases

As the leader on analysis of GATT and WTO dispute, Bown (2004a, 2004b, 2004c, 2005) shows rigorously that the development status of the country has an impact on (1) its ability to participate and (2) the outcome of the dispute. This chapter is the first to test this relationship for STC disputes in the SPS system. An additional contribution is to demonstrate a methodology on plant health concerns for categorizing the reason for raising the STC.

Chapter 5: A Case Study of Responses to SPS Issues

Survey data collected by the author on 119 farmers are compared to production data from two cooperatives (with over 4,000 growers combined) that collaborated in the research. Qualitative analysis of the challenges to cooperative coffee farming in Uganda are discussed. New data collected by the author at a workshop in Nkokonjeru of around 100 growers' views about the coffee supply chain structure is presented.

Chapter 6: Risk-aversion of Coffee Farmers and Traders

Empirical contributions are made in three areas of risk-aversion of coffee growers in the case study regions of Uganda. (1) Coffee growers' and traders' risk aversion are measured using a classic Holt & Laury (2002) design based on Tanaka & Munro (2014). The chapter presents the first comparison of coffee growers to a large random sample of the Ugandan population from Tanaka & Munro (2014). (2) A pest survey developed by the author is used to understand the priority pests of Uganda Robusta coffee and the extent to which stakeholders at different levels of the supply chain communicate and agree on the risks of each. (3) A coffee market game developed by the author is piloted at the workshop in Nkokonjeru. The novel methodology, with future improvements, has wider potential for understanding farmers' decision-making under uncertain market prices and crop investment opportunities.

Chapter 7: Income Diversification and Decision-making

Results from the survey of 119 coffee growers and 89 traders are used to examine the social networks of growers and who they consult when making decisions on pest treatment and investments on the coffee plot. A logistic model is created to predict the likelihood of abandoning coffee production based on a farmer's beliefs and characteristics of the household. Contributions to the empirical literature are made demonstrating the importance of growers' views on fair price for their products and the number of social connections a grower consults for advice.

Chapter 8: Conclusion and Future Work

Conclusions are drawn at the end of each chapter, but some overarching points are briefly discussed. Future research, including some preliminary work that was not included in the PhD on risks present at the EU border, is discussed, and included in the Appendix (A.28).[7]

1.4. EXTERNAL PRESENTATION OF WORK

The work that became part of Chapter 2 began while the author was a Fulbright Scholar at the College of Business and Economics at The Australian National University and was advised by Dr. Emma Aisbett. An earlier version of just the SPS work was written in a working paper for the Crawford School of Public Policy.[8] Earlier versions of the work with Dr. Emma Aisbett under the title "Environmental and Health Protections, or new Protectionism? Determinants of SPS Notifications by WTO Members" were accepted and presented by the author at three major international conferences:

- Empirical Investigations in Trade and Investment (EITI), Keio University, Tokyo, Japan, 16 March, 2012.
- International Conference on Econometrics, Operations Research and Statistics (ICEOS), Eastern Mediterranean University, Famagusta, North Cyprus, 25th May, 2012.
- European Trade Study Group, KU Leuven, Brussels, Belgium, 15th September, 2012.

The econometric estimation models that the author used in his PhD were substantially improved by Dr. Emma Aisbett in subsequent work. Our current paper together (not included

[7] With permission from DG Sanco (see Appendix A.29), EU border notifications (over 20,000 in the past decade) of rejected imports were scraped using automated computer scripts coded by the author from two online websites maintained by the European Commission: the RASFF database for food products and RAPEX online websites for non-food products.

[8] Crawford School Research Paper No. 12-13

in the PhD) is substantially different, with the addition of a political economy model of standard setting which incorporates producer loss aversion. As of this publication date, this paper has been submitted to a peer-reviewed international trade journal with the title "Trade liberalization and product standards for health and environmental protection".

The work of Chapter 3 on the patterns of trade concerns in the SPS agreement and the work on the causes of dispute for plant health concerns (Chapter 4) was presented at the American Phytopathological Society (APS) annual meeting in 2012. The reference is given below:

- Pearson, L. (2012) "From Boom to Busted: Trade Concerns under the WTO's SPS Agreement" Special Session 'Right of the Boom: Deciding to Act, React, or Let Go in a Fluid Data Environment' American Phytopathological Society (APS) annual meeting, Providence, Rhode Island, 8th August.

Selected results from the fieldwork in Uganda (Chapter 5 to Chapter 7) were presented at a research booth of the Imperial Festival (May 9-10, 2014). Initial results from Chapter 7 were presented by the author and Mr. Ignitius Bwoogi at a lunchtime seminar in the Centre for Environmental Policy (CEP) on January 22nd, 2014.

The author taught two lectures on trade and environment to MSc students of CEP at Imperial College in March of 2013 and 2014. As well, other presentations are listed below:

- Pearson, L. (2013). "Trade Policy from a Sustainability Paradigm" Global Sustainability Institute (GSI) annual conference. Anglia Ruskin University, Cambridge, England, 14th May.
- Pearson, L. (2012) "Achieving Sustainable Agriculture Trade in the Global Food System" Global Environmental Change and Human Security, 3rd international conference. North-South Research Center for Social Sciences (Morocco) and GIZ (Germany). Marrakesh, Morocco, 22-24th November.
- Pearson, L. 2011. "Always use protection? SPS measures as green protectionism" poster presented at ETNA Summer School on *Food Security – how can science and policy contribute*. Lucerne, Switzerland, 10 September, 2011.

Chapter 2. Environmental Protection or Protectionism?

Protecting the geographical borders and integrity of the country is one of the fundamental purposes of a sovereign state. No country wants to unnecessarily cause environment damage due to an invasive species, put its citizens at risk from a clearly dangerous product, or allow disease vectors freely into the country. Therefore, policy must exist in order to mitigate the risks that come from allowing commerce and travel across borders; this fact has long been recognized in the multilateral trade system through the World Trade Organization (WTO) and its predecessor the General Agreement on Trade and Treaties (GATT). Under the GATT, Article XX codified the exceptions to liberalisation rules when it came to reasons of environmental and human health protection. With the inception of the WTO in 1995, these exceptions have been codified into two agreements: the Sanitary and Phytosanitary (SPS) Agreement and a major update to the Technical Barriers to Trade (TBT) Agreement.

2.1. BRIEF INTRODUCTION TO THE SPS AND TBT AGREEMENTS

The SPS agreement covers import regulations and standards dealing with food safety, animal health, and plant health. While they usually apply to agricultural products, they are not restricted just to these products. The agreement is meant to protect from risks that arise from the import of foreign products, ensuring that imported products meet the standards for domestic industries in areas like food safety. Countries are encouraged to follow international standards suggested by three international standard-setting organizations with different product focuses: the (1) FAO/WHO Codex Alimentarius Commission suggests international standards for food, the (2) International Animal Health Organization (OIE based in Paris) for animal health, and finally, the (3) FAO's Secretariat of the International Plant Protection Convention (IPPC) for plant health. These agencies existed long before the SPS agreement and were formed based on the need to codify standards in response to various outbreaks.[9] Countries are free to differ from international standards to provide the level of protection they deem appropriate, but can only do so to protect against a scientifically justified risk. Countries are also obliged to implement

[9] For instance, the OIE was formed in 1924 largely in response to rinderpest (cattle plague) establishing in Belgium while in transit from India to Brazil. See the OIE website for more of the history of the organization: http://www.oie.int/about-us/history/

regulations in the least trade restrictive way possible and to avoid unjustified barriers to trade.[10] If countries follow international standards, they are very unlikely to be challenged. A good review covering the history of the SPS agreement can be found in Isaac (2004), and a thorough explanation of the application of the agreement is available via the SPS training module produced by the WTO (WTO, 2014).

Complementing the SPS agreement is the Technical Barriers to Trade (TBT) agreement. The TBT agreement was previously the Standards Code adopted at the end of the Tokyo Round of multilateral trade agreements in 1979. The agreement covered technical regulations, standards, and conformity assessment procedures. Technical regulations are any characteristic of the product—such as size and strength—as well as the packaging and labelling of a good.[11] The Standards Code was further extended at the adoption of the TBT agreement in 1995 with the creation of the WTO. The extensions included coverage of processing and production methods, a wider conformity assessment provision, along with other changes. Technical standards are important for consumer information and ensuring that products meet the requirements for which the buyer intends them.

Technical standards on products can form very effective barriers to trade if implemented for the purpose of protecting domestic producers (Beghin & Melatos, 2011; Schlueter, Wieck & Heckelei, 2009; Chen, Yang & Findlay, 2008; Swann, 2010). The purpose of the TBT Agreement is to make sure technical regulations and product standards (excluding those concerning health, which are covered by the SPS agreement) are not set arbitrarily. Differing from the SPS agreement, the TBT agreement suggests a code of practice that encourages industry groups to adopt sets of voluntary standards, which countries could recognize when assessing if a product should be permitted in the market. There are parallel institutional bodies for the TBT agreement like the SPS agreement, which meet to discuss transparency and issues that arise from implementation of the agreement.

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[10] The examination of SPS Specific Trade Concerns in Chapter 4 will examine in more detail the challenges that arise from countries disputing the legitimacy of SPS measures implemented by other WTO members.
[11] See exact definitions on the WTO's technical description of the TBT agreement: http://www.wto.org/english/tratop_e/tbt_e/tbt_info_e.htm

2.2. DIFFICULTY OF PROTECTION

Despite the recognized legitimate need for protection against risks that arise from the import pathway, difficulty comes in operationalizing the SPS and TBT agreements for a variety of reasons. There are two main strands of difficulty. The first (1) is the challenge of establishing scientific agreement on the risk protected against by a given measure with a high enough degree of certainty for consensus. To address this issue there has been an extensive research agenda centred on improved models of pest entry, establishment, and spread under various assumptions of landscape heterogeneity, human movement, and climate conditions.[12] The second (2) major type of issue—and the focus of this research—is dealing with regulations created under the guise of biologically-based protection which obfuscate true economic motivations for protectionism. In relation to the WTO, the second issue is of prime importance as there is a growing recognition of the need to better understand domestic policy impacts on trade with the success of the institution in lowering tariff-based protectionism among members (WTO, 2012).

On the economics side of the research work on SPS measures and other Non-Tariff Measures (NTM) generally, one of the most pervasive assumptions is that a major driver of the increased use of measures has been to substitute for the loss of tariff protection. The SPS Agreement Training Module available from the WTO expresses this claim quite succinctly:

> All governments accept the fact that trade restrictions may be necessary to ensure food safety and animal and plant health protection. However, governments are sometimes pressured to go beyond what is necessary for health protection and to use SPS measures to shield domestic producers from economic competition. Such pressure is likely to increase as other trade barriers are reduced as a result of the Uruguay Round agreements. An SPS measure which is not actually required for health reasons can be a very effective protectionist device, and because of its technical complexity, a particularly deceptive and difficult barrier to challenge. (WTO, 2014)

This belief that the decline of tariffs from trade agreements, like the Uruguay Round, lead to additional SPS measures is maintained commonly in the academic literature as well (discussed

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[12] See Waage & Mumford (2008) for an overview of biosecurity research related to SPS issues.

below). Despite the ubiquitous nature of this statement, there is a lack of rigorous empirical evidence to test it.

SPS and TBT measures are particularly interesting because ostensibly their objectives of protecting human, plant and animal health are laudable and serve legitimate policy objectives. Concerns about protectionist abuse of SPS and TBT measures are common both in the academic literature (Runge, 1990; Mahé, 1997; Baldwin, McLaren & Panagariya, 2000; Charlier & Rainelli, 2002; Kastner & Pawsey, 2002a; Peterson & Orden, 2008; Götz, Heckelei & Rudloff, 2010) and the broader media. Recent SPS controversies include: the market access implications of the EU limits on aflatoxin levels for African cereal and nut growers (Otsuki, Wilson & Sewadeh, 2001); the barriers to emerging economy exporters to US markets posed by drug residue standards (Tran, Wilson & Anders, 2012) and processing standards (Anders & Caswell, 2009) on seafood; the long-running contention between the US and the EU over scientific uncertainty both in the assessment of health risk from hormone-treated beef (Charlier & Rainelli, 2002; Kastner & Pawsey, 2002b) and genetically modified foods (Hanrahan, 2010); and Australia's refusal from 1921 to 2012 to allow the import of apples from New Zealand due to the potential introduction of the contagious disease fire blight to its orchards.[13]

2.3. OVERVIEW AND AIMS OF RESEARCH

The goal of this chapter is not to measure the trade impact of SPS and TBT measures, but to analyse if the use of SPS/TBT measures has risen commensurate with the decline of tariffs. Recent analysis on the latest data through 2013 from the UN Conference on Trade and Development (UNCTAD), which collects data on SPS and TBT measures along with other NTMs noted:

> The presence of correlation between the use of NTMs and traditional forms of trade policy [i.e. tariffs]… may indicate that NTMs have been used, at least to some degree, as substitutes to tariffs in order to continue protecting key economic sectors in spite of tariff liberalisation of the last 10 years. (Nicita & Gourdon, 2013)

[13] see Dispute 367 on WTO website: http://www.wto.org/english/tratop_e/dispu_e/dispu_status_e.htm

This chapter builds upon very basic correlation tests like those conducted by those authors at UNCTAD to rigorously analyse relationships between domestic policy and tariff liberalisation for a subset of NTMs. Complementing previous approaches discussed in the literature review (section 2.4 below), the research in this chapter examines evidence of protectionist intent by connecting the decline in bound tariffs on a product with the issuance of new SPS and TBT regulations on that same product. The two basic research questions driving the analysis are:

1. Does the loss of tariff protection lead to compensating use of SPS and TBT policy?
2. What are the other determinants of SPS/TBT policy changes?

Analysis is conducted in both a cross-section[14] for total notifications from countries on products in the 15-year sample period (1996 to 2010) and several time-series[15] specifications for country-product-year observations. Beyond the main examination of the bound tariff as a determinant of notifications, the role of other trade variables—exports, imports, exchange rate and current account deficits—are also examined in determining the probability of new/changed SPS or TBT regulations.

In contrast to the previous literature (section 2.4), serious consideration to other potential drivers of SPS measures is given. Knowing that health and environmental quality are normal goods[16], their proliferation may be related to rising incomes and demographic changes. The research setup of both the cross-section and the time-series models control for population and income levels and changes. In the cross-section, the regressions also analyse the relationship between SPS/TBT notifications and measures of domestic environmental and health governance.

The various sources of all the data on SPS/TBT policy, economic factors, and demographic factors are described in the Data and Variables section (2.5, page 38). Some summary information and trends in SPS/TBT use, which motivate the modelling, are presented in section 2.6. The theoretical predictions on how these variables are expected to influence the regression models are discussed in the respective model setup sections. The predictions for the cross-

[14] Cross-section methodology and predictions are in section 2.7, and the results of regressions are in section 2.8
[15] Time-series methodology and predictions are discussed in section 2.9 and the results are found in section 2.10
[16] Meaning that the demand for the good increases (decreases) with the rise (fall) of income

section are discussed in section 2.6 and the time-series expectations are discussed in section 2.9. Section 2.11 discusses future research and concludes.

2.4. LITERATURE REVIEW

Through successive rounds of trade negotiations, bound tariffs have fallen and limitations have been placed on traditional trade barriers among WTO members. From very early in the evolution of the GATT, however, there have been concerns that negotiated reductions in tariffs may lead to a rise in NTMs that serve as barriers to trade (Wilson, 1969).[17]

2.4.1. NTM concerns from Tokyo to Uruguay Round

Page (1987) reviews much of the early work on measuring NTMs following the Tokyo Round of GATT negotiations which concluded in 1980, as well as general trends in protection (tariff and non-tariff) from 1960s to 1980s (Page, 1987). Similarly, Green (1981) writes of the "new protectionism" of the 1980s with the use of "fair trade" (defined in his study as countervailing duties and anti-dumping laws), "orderly marketing", and "voluntary restraints". Laird & Yeats (1990) look at the growth of NTBs[17] comparing 1966 to 1986 using NTB frequency indices. They found significant increases in NTB frequency ratios for the major economies of the developed world. Food products had the highest increase (53% greater). Overall coverage rose from 5% in 1966 to 51% in 1986. They conclude "while a major effort was made in multilateral trade negotiations to reduce tariffs, protectionism in the form of NTBs greatly expanded, and may have even offset or exceeded the effects of liberalized import duties" (Laird & Yeats, 1990). This concern led to the inclusion of agreements intended to curtail non-tariff protectionism in the Uruguay Round of trade negotiations.

Although the NTB concerns in the early years of GATT were predominately centred on quotas and voluntary export restraints (VERs), today technical standards and anti-dumping (AD) measures are of increasing importance. For example, in the 2012 WTO World Trade Report both Pascal Lamy, director WTO, and Patrick Low, WTO Chief Economist, highlighted the critical importance of better understanding the drivers and impacts of domestic environmental

[17] NTMs are also called Non-Tariff Barriers (NTB) in the literature when they are clear "barriers" to trade and not just policy measures that have the potential to affect trade patterns.

and health policies—such as sanitary and phytosanitary (SPS) measures—on international trade (WTO, 2012). In the policy arena and grey literature, these environmental/health measures are often framed as "protectionism in disguise" or green protectionism (Wilson, 2010).

2.4.2. The political economy of protectionism

The incentives for governments to raise NTMs in response to negotiated decreases in bound tariffs have been illustrated in numerous political economy models. Some refer to the political advantages of NTMs' complexity and/or financial benefits from lobbying contributions (Yu, 2000; Kono, 2006), while others focus on specific substitution of one type of NTM for another (Rosendorff, 1996). Mansfield & Busch (1995) have an extensive discussion of the various incentive structures that have been modelled. The intuition of all these models is that trade agreements lower the rate of protection, but do not reduce the underlying domestic political economy pressure for protectionism. Bhagwati (1988) labelled this phenomenon the "Law of Constant Protection".

2.4.3. Empirical studies

In contrast to the theoretical literature, the empirical literature is relatively undeveloped in testing the relation between liberalisation and countries' NTM use. Earlier studies looked only over a few years and used broad NTB coverage ratios (Laird & Yeats, 1990). The connection at a more detailed level on specific NTMs has been investigated almost solely for AD measures (Moore & Zanardi, 2011; Vandenbussche & Zanardi, 2010; Anderson & Schmitt, 2003a). Feinberg & Reynolds (2007) for example, find that tariff reductions increased the likelihood and the number of AD petitions. However, the correlation found in this and similar studies have generally been between *levels* of tariffs and *changes* in NTBs. The current chapter attempts to test the relationship between NTMs and tariffs in properly specified time-series models.

A growing number of studies seek to quantify the trade impacts of SPS. Chen, Yang & Findlay (2008) find a trade depressing effect from food safety standards can be more significant than that of import tariffs. A survey of developing country exporters also found that SPS measures are thought to form some of the strongest barriers to trade (Henson & Loader, 2001). Other studies of SPS measures focus on developing techniques to find tariff equivalents (J.C. &

Bureau, 2001; Maskus, Wilson & Otsuki, 2000). These methods have been applied mainly in studies of specific countries and/or specific products to capture the trade effects of SPS measures, usually using product-line SPS coverage ratios in a gravity model setup. These studies also tend to conclude that SPS regulations have a trade depressing effect (Calvin, Krissoff & Foster, 2008; Liu & Yue, 2009; Otsuki, Wilson & Sewadeh, 2001; Chen, Yang & Findlay, 2008; Jongwanich, 2009). While these findings are important, they do not address the issue of protectionism per se. Though reduced trade is a protectionist *effect*, it does not necessarily imply protectionist *intent*.

Protectionism has been variously defined throughout the literature with regards to NTBs. Broad definitions such as Walter (1971) define any measure which impacts the direction, composition, or volume of trade as a protectionist barrier. Others have taken a narrower view and considered the data from trade concerns: when there is a high ratio of trade concerns to new trade policy notifications at the product level, this could indicate protectionist intent by a country (Disdier & van Tongeren, 2010). Disdier, Fontagné & Mimouni (2008) look for protectionism in the frequency of standards on products across countries; when only a few countries have issued a regulation on a specific Harmonized System (HS) [18] code, the regulation may be potentially protectionist. In the following analysis, the relationship with the bound tariff will be used as evidence of a potentially protectionist bias to SPS/TBT policy changes.

2.5. DATA AND VARIABLES

The main set of data comes from SPS and TBT notifications of WTO member states. The empirical analyses utilize panel data of all countries (98) that have reported SPS notifications (Regular and Emergency) in 69 product types (at 2-digit, chapter level HS codes) to the WTO over the period from 1996 to 2010. For the TBT system, the empirical analysis utilizes a panel data set of the 68 countries that have notified Regular TBT measures on 95 different HS-2 lines

[18] HS refers to the Harmonized System or less commonly, the Harmonized Commodity Description and Coding System. All internationally traded codes are coded with standardized descriptions and codes that express increasing levels of disaggregation with more digits. As an example: "live animals" is the chapter description at the 2-digit level for HS01. At the 4-digit level, HS0102 is the section code for "live bovine animals". At the 6-digit level HS010210 is "Pure-bred breeding bovines". HS classification goes to 8-10 digits depending on the country, but 8-digits is the standard for tariff-line level classification. See further description on the World Customs Organization website:
http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs_convention.aspx

of products during the same period. The data on notifications from each country per product, per year were then merged with relevant economic factors, environmental metrics, and governance controls to form a panel.

The European Union (EU) created a dilemma. The EU reports some SPS/TBT notifications as community-wide policy, but also individual members are able to report new SPS/TBT policy as well. Two versions of the databases were created. One is an EU aggregate where EU notifications and member states notifications are compiled into a large, aggregate EU "country" (the methodology used by Fontagné, Mimouni & Pasteels (2005)). The second applies EU-wide notifications to each member state and drops the EU as an independent "country" in the data set. This disaggregated version will account for intra-EU trade and slight differences between the standards in each country. Results are reported for the EU-disaggregated version of the TBT/SPS data set unless otherwise specified.

The data for all analysis comes from a variety of common sources in the economics literature as well as some less-common sources for the environmental and SPS notification components. The sources are explained in the following sections (2.5.1 to 2.5.3). Summary statistics for all of the variables are reported in Table 63 in Appendix A.1 for SPS measures and in Appendix A.2, Table 64 for TBT measures.

2.5.1. SPS and TBT notifications

Each WTO member is required to have both a National Notification Authority and an official Enquiry Point for SPS regulations. A parallel body is required for TBT notifications that can be the same agency, which is often the case for developing countries. The transparency sections of the SPS and TBT agreements require that all WTO members report new or changed SPS/TBT measures to the WTO when the standard is different from international standards and will have a significant impact on trade. To increase transparency, these notifications are compiled by the WTO and available through the SPS Information Management System (SPS-IMS)[19] and TBT Information Management System (TBT-IMS)[20]. For both the SPS and the TBT agreement, member countries report both "Regular" notifications that reflect new or

[19] http://spsims.wto.org
[20] http://tbtims.wto.org/

changed permanent regulatory measures. Only for the SPS agreement, members report "Emergency" measures that should be temporary restrictions either due to an outbreak event or while gathering evidence to make a Regular notification.

Although these online databases represent a significant improvement in the compilation of SPS and TBT data, there is still likely to be some under-reporting by countries. For instance for the SPS system, not all WTO members have appointed a National Notification Authority and some have not issued any SPS notifications in the 1996 to 2010 period. Specifically, by 2010, there were 153 WTO members, yet only 64% notified at least one SPS notification and only 44% notified at least one TBT measure from 1996 to 2010.

The other major limitation of the SPS/TBT-IMS data is that most members do not report the specific products (i.e. by HS 4-digit or 6-digit codes) it applies to. For many SPS notifications, the product the measure affects is only given at the HS 2-digit level of detail by the notifying country. Given these data constraints, defining products at the HS 2-digit level was used in this analysis, as it was the most disaggregated level possible, while still utilizing the vast majority of observations from the database.[21] The full summary table of total TBT and SPS notifications by HS-2 code in the entire sample from 1996 to 2010 can be found in the Appendix (A.3 on page 348).

Given that the research question is on the drivers of reporting an SPS measure, the sample needs to include all country-HS-year observations where it was possible to report a changed regulation. As a result, an HS-2 code was included for all countries in the analysis if at least one country notified at least one SPS/TBT measure in the sample period. The database then includes observations for every combination of 98 countries and 69 HS codes over the period of 1996 to 2010. Notifications are then set to be zero if there are no reported SPS/TBT regulations for that country-HS-year observation. Both SPS and TBT notification data are then merged with other economic data as described below.

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[21] For example, in the SPS-IMS database there are around 2,000 notifications without HS categorization from 1996 to 2010 that will not be analysed in this work.

2.5.2. Trade and economic variables

Tariff data (reported for AHS/Applied, BND/Bound, and MFN/Most Favoured Nation rates) at the HS 2-digit level were downloaded from UN TRAINS via the World Integrated Trade System (WITS)[22] for all countries for the years 1996 to 2010 (World Bank, 2011). Both the trade-weighted average tariff and the simple average tariff were acquired. The trade-weighted average tariff accounts for the fact that many products that are not traded have extremely high tariffs and therefore artificially inflate the simple average tariffs for a country. Therefore, this trade-weighted tariff better reflects the tariffs observed by exporters looking to enter that market than the simple average tariff.

Tariff binding overhang (BO) was calculated by taking the difference between the bound and applied tariff for each country-HS-year observation. Bound tariffs are agreed by countries on various products to stipulate the maximum tariff the importing nation can levy on imports from any WTO member. The applied tariff is allowed to vary at will by the country and, as long as the tariff remains below the bound tariff rate, the country is complying with its international obligations. The tariff BO is then a measure of the flexibility a country has to raise the applied tariff up towards the bound rate. When the BO is large, a country has great flexibility to raise the applied rate to achieve trade policy objectives. When the applied rate approaches the bound rate and the BO is quite small, the country does not have much flexibility to raise tariffs without potentially violating WTO obligations. Summary trends between BO rate and SPS/TBT notification is presented in section 2.6.1 starting on page 46.

Trade data for imports and exports were downloaded from UN COMTRADE for each country as a reporter and the world as the partner (UN COMTRADE, 2012). Nominal values from the database were converted to constant (year 2000) baseline US dollars to match World Bank (WB) data. This was calculated based on the suggested method from WB.[23] Macro-economic indicators (GDP per capita, Current Account, and Exchange Rate) were taken from World Bank (2012) World Development Indicators (WDI). The same data for Taiwan was acquired from the World Economic Outlook (WEO) of the International Monetary Fund (IMF) (IMF, 2012). Conversions to constant year 2000 US dollars to match WB data were calculated as above.[23]

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[22] More information about the relationship between the UN TRAINS and World Bank's WITS databases is explained on the UN website: http://www.unctad.info/en/Trade-Analysis-Branch/Key-Areas/TRAINSWITS/
[23] WB method for conversion to constant USD found at: http://data.worldbank.org/about/faq/specific-data-series

2.5.3. Governance, environment and demographic variables

The most widely used source of environmental metrics and governance data comes from a joint project of Yale University and Columbia University through the Environmental Performance Index (EPI) (Emerson, Esty, Levy, et al., 2010) and their previous work on the Environmental Sustainability Index (ESI) (Esty, Levy, Srebotnjak, et al., 2005).[24] These indexes have been widely used in the environmental economics and policy literature (Whitford & Wong, 2009; Mukherjee & Chakraborty, 2010; Morse & Fraser, 2005; Fredriksson & Wollscheid, 2007). Each index produces an overall score for each country based on many metrics and sub-metrics. From the ESI, data was missing for 13 member countries who reported 686 Regular SPS notifications in the sample and 10 members who reported 131 TBT notifications. From the EPI, data was missing for three members (Taiwan, Macao, and Hong Kong) who only reported 119 Regular SPS notifications and three members (Taiwan, St. Vincent and the Grenadines, and Hong Kong) that reported 123 TBT notifications.

The EPI score has two components: "environmental health" and "ecosystem". The metric of environmental health as a whole and then relevant components of the ecosystem metric were used in the cross-section analysis (see Governance and Environment in section 2.7.3).[25]

Population for each WTO member as well as the portion of the population that is above age 65 was taken from the World Population Prospects 2010 revision provided by the UN Department of Economic and Social Affairs (DESA) Population Division (UN DESA, 2010). Governance indicators on Regulatory Quality are taken from World Bank (2010).[26] Data were missing for the years 1997, 1999, and 2001 and were linearly interpolated from adjacent years to fill in the missing values. Annual data for level of democracy was taken from the Polity IV project (Marshall & Gurr, 2011). The polity2 measure is widely used in the literature to analyse the impact of democracy and autocracy on environmental performance.[27] Data is available for most countries, but seven members were missing (accounting for 107 total SPS notifications).

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[24] The current EPI: <http://epi.yale.edu/> ; the 2005 (last year conducted) ESI: <http://www.yale.edu/esi/>

[25] The "ecosystem" component contained sub-metrics such as climate change that were not used as there was no clear relation a priori expected from these metrics. The sub-components used from the ecosystem metric were measures of agricultural pesticide regulation and biodiversity protection.

[26] The data release of September 2010.

[27] A selection of recent articles includes: (Asiedu & Lien, 2011; Bhattacharyya & Hodler, 2010; Farzin & Bond, 2006; Neumayer, 2002; Fredriksson & Wollscheid, 2007; Li & Reuveny, 2006; Pellegrini & Gerlagh, 2006)

In the EU-aggregated version of the dataset, the above indicators were created for the block by taking a simple average of the data for all 27 EU members. A simple average was used for all metrics for the EU-aggregate dataset for simplicity and to avoid unfairly weighting certain outcomes. For some of the metrics like polity2, a population-weighted average may have been more logical. For others like environmental health, a land-area-weighted metric might be the most valuable. For regulatory quality, perhaps a GDP-weighted metric would be most valid. While all different weighting schemes could be defended, a simple average is the easiest method without choosing what factor to prefer for weighting. The EU-aggregate version of the data is primarily used for robustness checking in section 2.10.2.

2.6. TRENDS IN SPS AND TBT NOTIFICATIONS

The top ten product categories on which SPS and TBT measures are applied are examined below. Table 1 contains the number of Emergency SPS and Regular SPS notifications for the top ten most notified products globally. In total, there are 8,487 SPS notifications in all HS categories from 1996 to 2010, but the number of notifications is heavily skewed towards a few product types. Meat and live animals (HS02 and HS01, respectively) account for nearly one third of all notifications (termed "Both" in the table) and well over half of the SPS Emergency notifications to the SPS secretariat in the sample period. The top ten HS codes account for over 75% of the total number of either type of SPS notification. SPS notifications are almost exclusively in agricultural products (as defined by the WTO Agreement on Agriculture), though the SPS agreement is not legally limited to these products.[28]

[28] Agriculture Products are defined by Annex 1 of the Agreement on Agriculture of the WTO, which defines HS codes 1-24 excluding fish and fish products (HS03) as agriculture. In addition, certain specific 4-6 digit codes from other chapters are considered agricultural products as well. In this analysis, only the 2-digit agricultural products were considered. Further details on the Agreement on Agriculture can be found on the WTO website: http://www.wto.org/english/docs_e/legal_e/14-ag_02_e.htm#annI

Table 1: Top 10 HS-2 codes with the most SPS notifications (1996 to 2010)

HS Code	Description	Agri. Prod.	Reg.	Emer.	Both
2	Meat and edible meat offal	Yes	712	699	1,411
1	Live animals	Yes	678	686	1,364
4	Dairy prod; birds' eggs; natural honey	Yes	520	369	889
5	Products of animal origin, NES[29]	Yes	255	290	545
8	Edible fruit and nuts; peel of citrus fruit or melon	Yes	501	41	542
23	Residues & waste from the food industry	Yes	240	205	445
7	Edible vegetables and certain roots and tubers	Yes	328	37	365
12	Oil seed, oleaginous fruits; misc. grain, seed	Yes	299	9	308
6	Live tree & other plant; bulb, root; cut flowers	Yes	271	26	297
3	Fish & crustacean, mollusc & other aquatic invert.		272	24	296
	TOP TEN TOTAL		**4,076**	**2,386**	**6,462**
	ALL TOTAL		5,928	2,559	8,487

Table 2: Top 10 HS-2 codes with the most TBT notifications from 1996 to 2010

HS Code	Description	Agri. Prod.	Reg.	% Total
85	Electrical, electronic equipment		595	12.5%
84	Nuclear reactors, boilers, mchy & mech appliance;		446	9.4%
87	Vehicles other than railway, tramway		375	7.9%
73	Articles of iron or steel.		167	3.5%
90	Optical, photo, technical, medical, etc apparatus		151	3.2%
27	Mineral fuels, oils & product of their distil.		134	2.8%
22	Beverages, spirits and vinegar.	Yes	122	2.6%
39	Plastics and articles thereof.		119	2.5%
4	Dairy prod; birds' eggs; natural honey	Yes	113	2.4%
30	Pharmaceutical products.		107	2.3%
	TOP TEN TOTAL		**2,329**	**49.1%**
	ALL TOTAL		4,745	100.0%

The summary of total TBT notifications by HS-2 code from 1996 to 2010 is shown in Table 2. Unlike SPS, the majority of notifications concern non-agricultural products. The notifications are also less skewed than SPS. The top ten products (HS-2 codes) account for just under half of the total number of notifications, but the top two categories (HS85 and HS84) still account for around 22% of all notifications. The top categories unsurprisingly correspond to products

[29] NES – not elsewhere specified (i.e. animal products not included in HS 01, HS 02, etc.)

that are used in industries with needs for rigid technical specifications (e.g. products of iron/steel in the construction industry) and safety requirements (e.g. nuclear reactors in the power industry and electronic equipment in the healthcare sector).

SPS use by country is presented in Table 3. Several developing countries are in the top ten users of SPS notifications (e.g. Peru accounting for 5.6% of all SPS notifications and Philippines accounting for 14% of all Emergency SPS notifications). Some countries use almost exclusively Regular SPS notifications (e.g. Japan), others nearly exclusively Emergency (e.g. Albania), others more balanced (e.g. European Union).[30] It might be interesting to explore the various political economy factors across countries that account for the divergent patterns of use between the two notification types, however, this is not explored at present.

Table 3: Top 10 countries with the most SPS notifications from 1996-2010

Country	Regular	% All Reg.	Emergency	% All Emer.	Both	% All Both
European Union	771	13.01%	311	12.15%	1,082	12.75%
Japan	530	8.94%	23	0.90%	553	6.52%
United States	446	7.52%	92	3.60%	538	6.34%
Peru	329	5.55%	149	5.82%	478	5.63%
Philippines	114	1.92%	362	14.15%	476	5.61%
Brazil	396	6.68%	12	0.47%	408	4.81%
Albania	13	0.22%	380	14.85%	393	4.63%
New Zealand	274	4.62%	86	3.36%	360	4.24%
China	286	4.82%	36	1.41%	322	3.79%
Chile	261	4.40%	35	1.37%	296	3.49%
TOP TEN TOTAL	**3,420**	**57.69%**	**1,486**	**58.07%**	**4,906**	**57.81%**

The top ten countries for TBT notifications are given in Table 4 below. The top ten countries have submitted a larger portion of the total number of TBT notifications than the parallel result for SPS policy (i.e. 72% of total TBT notifications vs. 58% for total SPS notifications). Additionally, only four of the top ten countries using TBT notifications are developed nations; many developing or newly industrialized countries including two from Africa (i.e. Kenya and South Africa) are in the top ten TBT users.

[30] The econometrics analysis in the cross-section (section 2.8) and time-series (section 2.10) tests the robustness of the results to using either regular notifications or both types of notifications as the metric for the use of SPS policy.

Table 4: Top 10 countries with the most TBT notifications from 1996-2010

Country	Regular	% Total
USA	650	13.70%
Israel	587	12.37%
China	505	10.64%
Thailand	389	8.20%
Japan	376	7.92%
Brazil	281	5.92%
South Africa	205	4.32%
Kenya	176	3.71%
European Union	129	2.72%
El Salvador	120	2.53%
TOP 10 TOTAL	**3,418**	**72.03%**

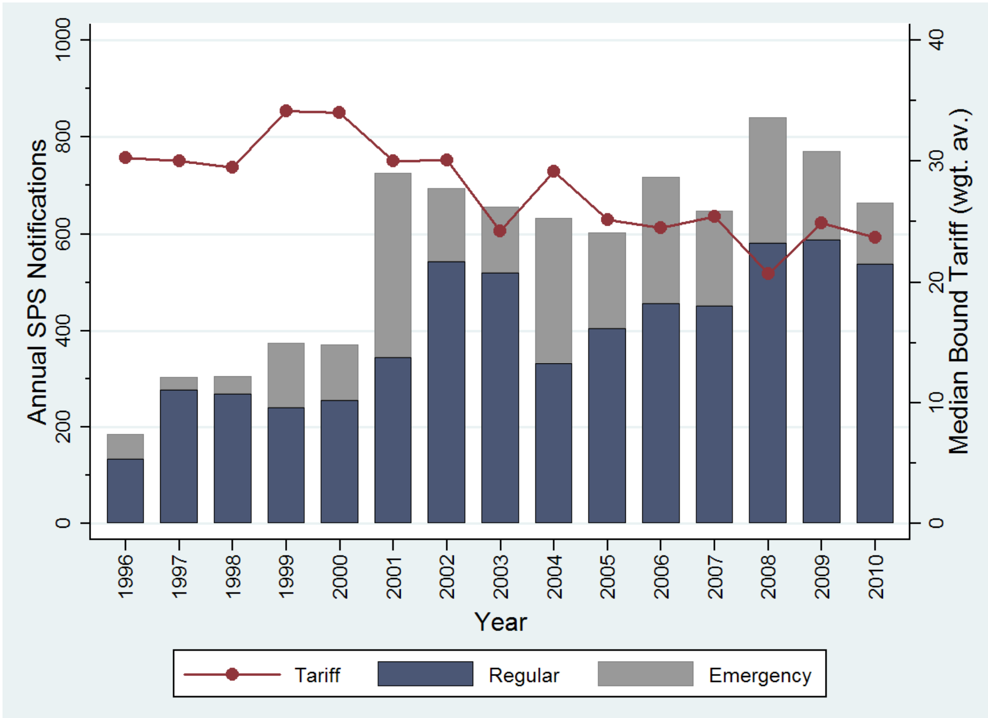
2.6.1. SPS/TBT notifications and bound tariffs

The trend between the increased use of SPS and TBT notifications with falling bound tariffs is shown in Figure 2. In panel (a), the total number of SPS notifications from every country are plotted in the columns by year, while the median bound tariff across all products[31] for all countries in the data set is plotted in the line. Similarly, for TBT measures, the information is plotted in panel (b). At this aggregated level in Figure 2, few definitive conclusions can be made. The transparency reporting system for the SPS and TBT agreement only started in 1995 and one would expect use to increase as countries became more familiar with the system. While there appears to be a correlation, it by no means suggests causality. This figure cannot show if on specific products, declines on tariffs were concurrent or related to issuing of new SPS or TBT measures.

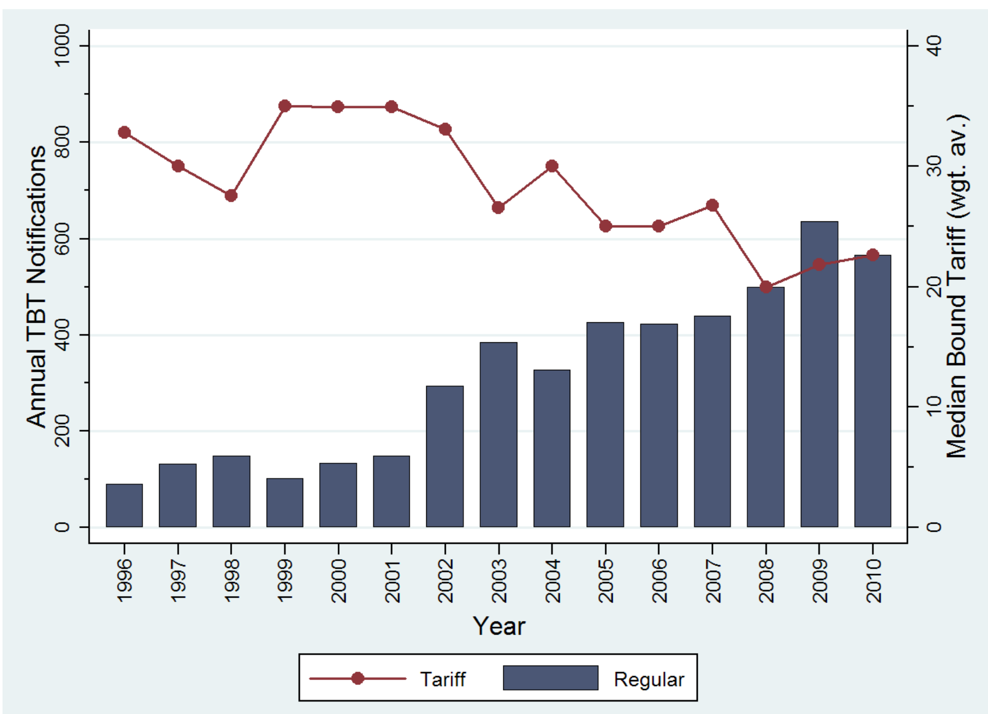
Figure 3 makes the relation more clear. The sum of SPS and TBT notifications for every country along with their mean tariff BO are calculated. This dataset is then divided up into four groups of countries based on the flexibility of the tariff BO. These categories were decided by the percentile on the applied trade-weighted binding overhang tariff. The smallest category of tariff BO has countries with below 25th percentile tariff BO, while the large BO category contains countries with above 75th percentile tariff BO. The group of countries that had the

[31] "All products" refers to the 69 HS codes where there was at least one SPS notification from 1996 to 2010 by any WTO member. If there was never an SPS notification, tariff data on that HS-line is not included.

smallest (<25th percentile) mean tariff BO, notify many more SPS notifications than the group of countries with among the highest average tariff BOs. The TBT system had more outliers, but it also appears that countries with tighter tariff binding across all their products notify more TBT measures.

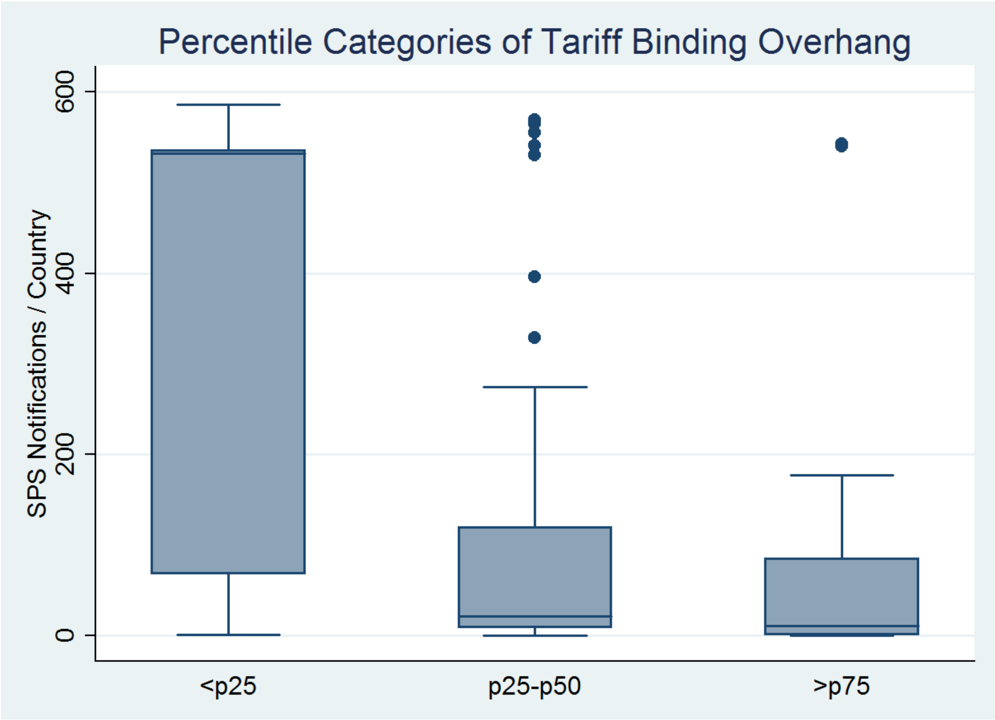


(a)



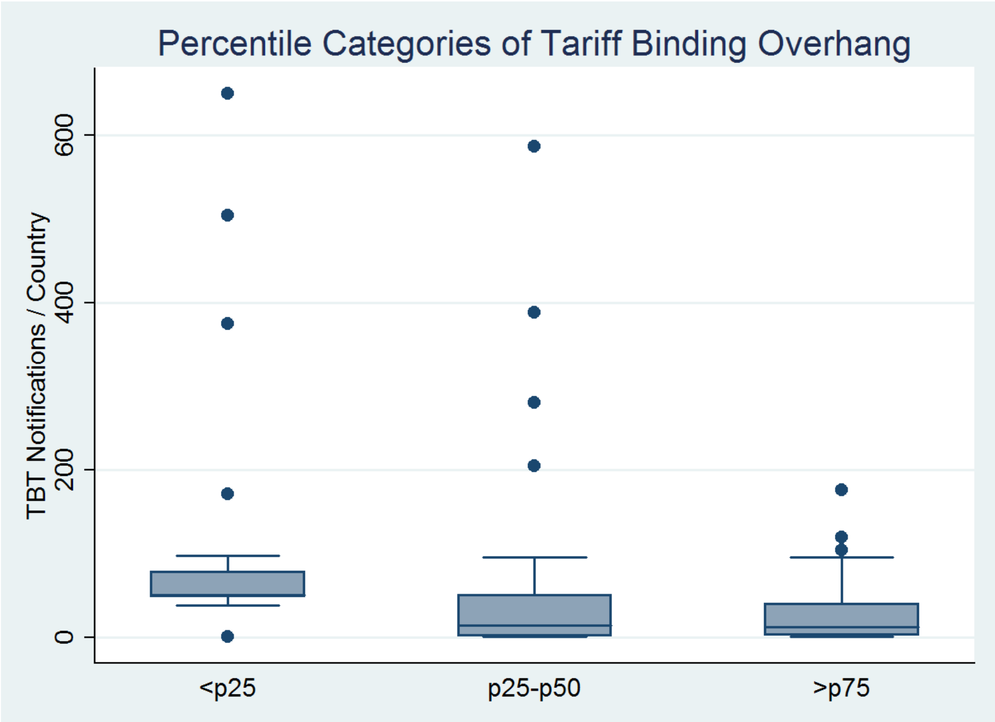
(b)

Figure 2: Trend between median bound tariff levels and (a) annual global SPS notifications, (b) annual global TBT notifications



Note: no countries had a mean BO between median (p50) and 75th percentile (p75)

(a)



Note: no countries had a mean BO between median (p50) and 75th percentile (p75)

(b)

Figure 3: Notifications of (a) Regular SPS and (b) TBT measures by category of percentile median BO at the country level

In Table 5 below, the differences between the small BO category and the large BO category from Figure 3 are confirmed using both a two-sample T-test[32] and a Wilcoxon rank-sum test (i.e. Mann-Whitney two sample test statistic) since a Shapiro-Wilk W-test suggested the data was non-normal for the majority of the notification types (Wilcoxon, 1945). The T-test results are still reported. For both SPS and TBT measures, the results show that countries in the bottom quartile of BO—and thus most restricted in raising applied tariffs—notify significantly more measures than countries in the top quartile of BO that are free to raise applied tariffs.

Table 5: Tests of means difference for SPS and TBT country-level notification rates comparing smallest (<p25) and largest (>p75) percentile tariff binding overhang categories

	(mean) Notifications / Country		Results		Significance	
	Small BO	**Large BO**	**T-test**	**Wilcoxon**	**T-test**	**Wilcoxon**
TBT Regular	124 ± 37 (n=21)	36 ± 11 (n=21)	t=2.2902 p=0.0314	z=3.138 p=0.0017	**	***
SPS Regular	344 ± 49 (n=24)	77 ± 31 (n=24)	t=4.6312 p<0.0000	z=3.581 p=0.0003	***	***
SPS Emergency	69 ± 15 (n=24)	23 ± 7 (n=24)	t=2.7862 p=0.0077	z=3.235 p=0.0012	***	***
SPS Both	413 ± 52 (n=24)	100 ± 36 (n=24)	t=4.9452 p<0.0000	z=3.764 p=0.0002	***	***

NOTE: * p < 0.1, ** p < 0.05, *** p < 0.01

The implication of Figure 3 and Table 5 is that SPS and TBT notification increases with declining ability to raise tariffs due to binding constraints. However, this could be driven by many other country-level factors that conflate with SPS/TBT policy use. A country's GDP is one example since, in general, developing countries have larger BO than developed countries and also likely lack institutional capacity to fully utilize the SPS/TBT notification system. The subsequent analysis controls for these factors and other sources of heterogeneity, however, these simplistic figures may demonstrate the source of the persistent perception of "green protectionism" in the political arena for the use of these risk-based trade measures (Costinot, 2008; Yu, 1994; Campbell & Coombes, 1999).

[32] Levene's test rejected the hypothesis of equal variances for the BO groups for TBT notifications, regular SPS, and both SPS, but equal variances could not be rejected for SPS Emergency notifications comparison.

2.6.2. SPS/TBT notifications and environmental governance

From the ESI data, the component "environmental governance" was used which measures each countries' institutional strength in environmental regulatory capacity.[33] The general trends between environmental governance and SPS/TBT notifications are shown below in Figure 4. Countries are grouped in four categories (analogous to Figure 3) based on the percentile of their environmental governance score. For SPS measures, low (below 25th percentile) environmental performance was a score of -0.175, median was 0.07, and high (above 75th percentile) was above 0.76.[34] For TBT measures, the low threshold environmental governance score was -0.18 (25th percentile), median was 0.19, and the high was 0.78 (75th percentile).

As might be expected for SPS policy used for legitimate purposes, the general trend emerges that countries with stronger environmental governance tend to issue more SPS notifications (see Table 6). Mean notification rates per country were tested using both a two-sample T-test[35] and a Wilcoxon rank-sum test, since a Shapiro-Wilk W-test suggested the data was very non-normal for all notification types. Given the lack of data coverage for the environmental governance score, several groups had a smaller sample size (around n=20). The T-test results are reported for completeness, but may not be reliable given the smaller sample size and non-normality of the notification data. The rank-sum test confirms for all types of notifications that the typical country in the high environmental governance group is a more active user of TBT and SPS policy than the typical country from the low environmental governance group.

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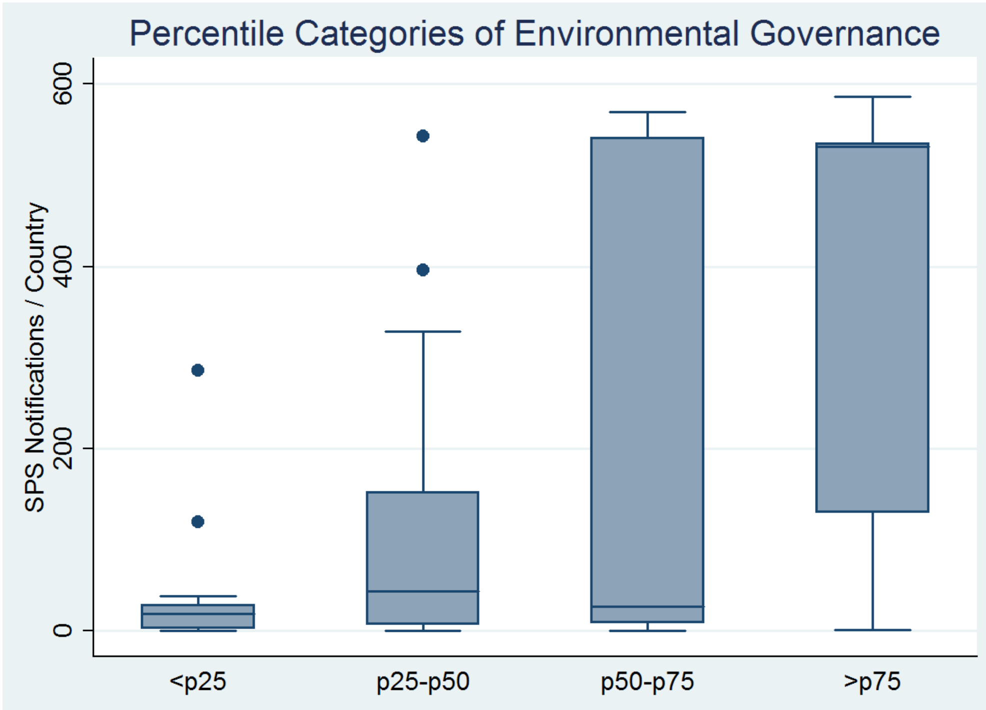
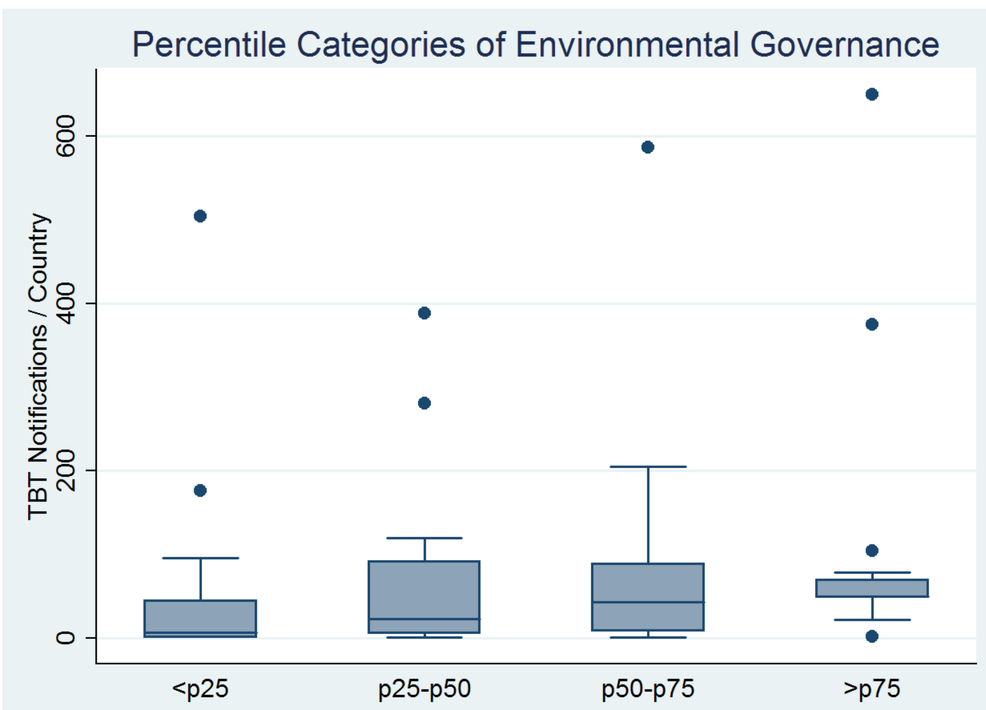
33 See section 2.5.3 for sources of environmental governance data.

34 See Esty, Levy, Srebotnjak, et al. (2005) for methodology of the scores calculation.

35 Levene's test rejected they hypothesis of equal variances for the Environmental Governance groups for Regular SPS and Both SPS, but equal variances could not be rejected and were used for SPS Emergency notifications as well as TBT notifications comparisons.



(a)



(b)

Figure 4: Notifications of (a) Regular SPS and (b) TBT measures by percentile environmental governance score for the country

Table 6: Tests of means difference for SPS and TBT country-level notification rates comparing lowest (<p25) and highest (>p75) percentile environmental governance score categories

	(mean) Notifications / Country		Results		Significance	
	Low Env.	**High Env.**	**T-test**	**Wilcoxon**	**T-test**	**Wilcoxon**
TBT Regular	53 ± 27 (n=19)	102 ± 37 (n=18)	t= -1.0666 p=0.2935	z= -3.151 p=0.0016		***
SPS Regular	34 ± 14 (n=21)	359 ± 51 (n=20)	t= -6.1976 p<0.0000	z= -4.046 p=0.0001	***	***
SPS Emergency	34 ± 18 (n=21)	54 ± 7 (n=20)	t= - 0.995 p=0.3259	z= -3.241 p= 0.0012		***
SPS Both	68 ± 23 (n=21)	413 ± 56 (n=20)	t= -5.8906 p<0.0000	z= -4.057 p< 0.0000	***	***

Note: * p < 0.1, ** p < 0.05, *** p < 0.01

2.7. CROSS-SECTION SETUP

Due to the lack of international time-series data for environmental governance and performance data, a cross-sectional investigation was conducted first to investigate the impact of these variables. SPS and TBT protections may be motivated by a combination of "protectionist" and "protective" desires on behalf of governments. "Protectionist" motivations would be related to protecting domestic producer interests in terms of raising the price of imports, or the government's interest in improving the terms of trade and keeping a positive current account (see variables described in section 2.5.2). "Protective" motivations would be related to responding to consumers and the environmental lobby desiring more stringent and effective environmental policy (see variables described in section 2.5.3).[36] Thus, explanatory variables in the cross-sectional analysis combine variables commonly used in the empirical literature on trade protectionism with those commonly used in empirical studies of environmental policy. The following sections briefly discuss each of the variables and their predicted relationship to both SPS and TBT notifications.

[36] The best measurement of the protective motivations of SPS/TBT policy would be some measure of what each regulation notified is stated to prevent or protect against. The current database does not facilitate this analysis easily and with the number of SPS and TBT notifications in the data, country-level proxies of environmental stringency and governance were necessary. In Chapter 3 and Chapter 4, more detail on what is in the content of a notification and a trade concern will be analysed at a notification-level basis.

2.7.1. Trade-related variables

The key variable to test whether negotiated tariff reductions are a driver for increased SPS notifications is the trade-weighted average bound tariff rate (see section 2.5.2 for a detailed explanation of the tariff variables). In line with the theoretical literature discussed in section 2.4, the expectation is that decreases in bound tariffs will be associated with increases in SPS/TBT use if protectionist motivations have an influence on the use of SPS/TBT policy. As a result, the cross-section includes the bound tariff rate (BND), varying by both HS-2 code and country. Alternative measures of tariffs by the BO (difference between the bound and applied tariff levels) are also tested to check the robustness of the tariff result.

The next most important trade-related variables are imports and exports (also varying by HS-2 code and country). Both are included in their logarithms levels to make the variables more approximately lognormal. Consistent with the substantial literature on modern uses of trade protectionism[37], it is expected that larger values of imports should be associated with greater numbers of SPS notifications. Quite simply the higher the import competition, the more the domestic producers are likely to lobby or otherwise influence government policy towards increasing alternative forms of protection—including SPS and TBT policy (Kono, 2006). It is worth noting, however, that a positive correlation between imports and SPS notifications in the data could also be an indicator of legitimate, protective use of SPS. Since *ceteris paribus* both the risk of a biosecurity incident and the likelihood of detection increase with higher import volumes, one would expect new SPS pest-risk evaluations and SPS notifications positively correlate with imports (Mumford, 2002; Waage & Mumford, 2008).

Compared to imports, the trade protectionism literature is more ambiguous about the expected relationship between exports and trade protectionism. One theory suggests that export industries should be more competitive than their non-exporting domestic peers (Melitz, 2003) and thus, in less need of protection (Gawande & Krishna, 2003). However, this theory ignores the impact of political bargaining by domestic industries. Another line of economic theory work would suggest export industries would have a larger political base that they can use to demand protection (Grossman & Helpman, 1992). For heterogeneous industries, when more competitive firms improve efficiencies and increase output, declining firms may push for

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[37] (Anderson & Schmitt, 2003b; Bechtel, Bernauer & Meyer, 2012; Kee, Neagu & Nicita, 2013; Baylis, Nogueira & Pace, 2012)

protection (Rodrik, 1995). On the other hand, particularly for SPS regulations, an additional reason to expect a positive correlation between exports and SPS notifications is not protectionist. Part of setting SPS policy is to consider the potential damage to a domestic industry from a biosecurity incursion, thus large exports proxy having a large agricultural industry, which would be more valuable and demand more careful consideration when setting the appropriate level of protection under the SPS measure by the policy-maker. As a result of these myriad drivers, the expected sign on exports coefficient in the regression is ambiguous.

2.7.2. GDP and population variables

GDP and population are standard components of cross-country economic analysis. In this case, "protective" motivations for SPS/TBT would predict a positive correlation between GDP and SPS/TBT use since environmental quality and health are both normal goods. One would also expect a positive relationship between GDP and SPS/TBT notifications, since these measures require institutional support, and institutional quality is generally increasing with country GDP. Protectionist motivated SPS/TBT measures, however, may show a negative correlation between GDP and SPS/TBT use, since protectionist use of the policy is economically inefficient at the macro-level just as a tariff would be.

The prediction for the coefficient on population size is unambiguously positive, since both protective and protectionist motivations for SPS suggest a positive relationship. The "protective" prediction is positive since there are fixed costs to funding the institutional capacity to build the risk-based case for the measure, preparing the measure, and notifying appropriately the SPS measures. The "protectionist" prediction follows from the standard terms of trade manipulation explanation for trade protectionism.

Also included in the regressions is a more novel demographic measure, namely, the proportion of the population over 65. The literature on food safety standards shows that older populations have substantially stronger preferences for high food safety standards (Taylor, Coveney, Ward, et al., 2011; Tobin, Thomson & LaBorde, 2012; Buchler, Smith & Lawrence, 2010; De Jonge, Van Trijp, Renes, et al., 2010). Thus, protective motivations predict that SPS/TBT use is increasing in the proportion of the population over 65 years old.

2.7.3. Governance and environment variables

If SPS and TBT standards a being used as a legitimate means of ensuring consumer safety and protecting human, plant and animal health, one would expect them to be determined by a combination of the social pressure for such protections and the government's willingness and ability to respond to this pressure. This combination of drivers is captured using a number of variables.

The base specification in the cross-section model includes the ESI environmental governance measure (Esty, Levy, Srebotnjak, et al., 2005). In a separate regression, governance and environment/health aspects are included separately. For governance, the “Regulatory Quality” measure from the WB World Governance Indicators (WGI) is included. For a measure of environmental quality, several components of the EPI are used (see data section 2.5.3 starting on page 42). The first is the “Environmental Health” sub-component, which aggregates scores for air and water quality and access, as well as, sanitation and disease burden. The second environmental proxy variable is the “Agricultural Pesticides” sub-component, which measures the stringency of safety measures on pesticide use in the country. Pesticide policies are a good proxy as many SPS measures are related to maximum residue levels (MRLs) of chemicals on agricultural products (Otsuki, Wilson & Sewadeh, 2001; Tran, Wilson & Anders, 2012). If domestic and foreign policy in a country are consistent, then countries with higher environmental health scores and more stringent pesticide regulations should have stricter SPS standards on imports.

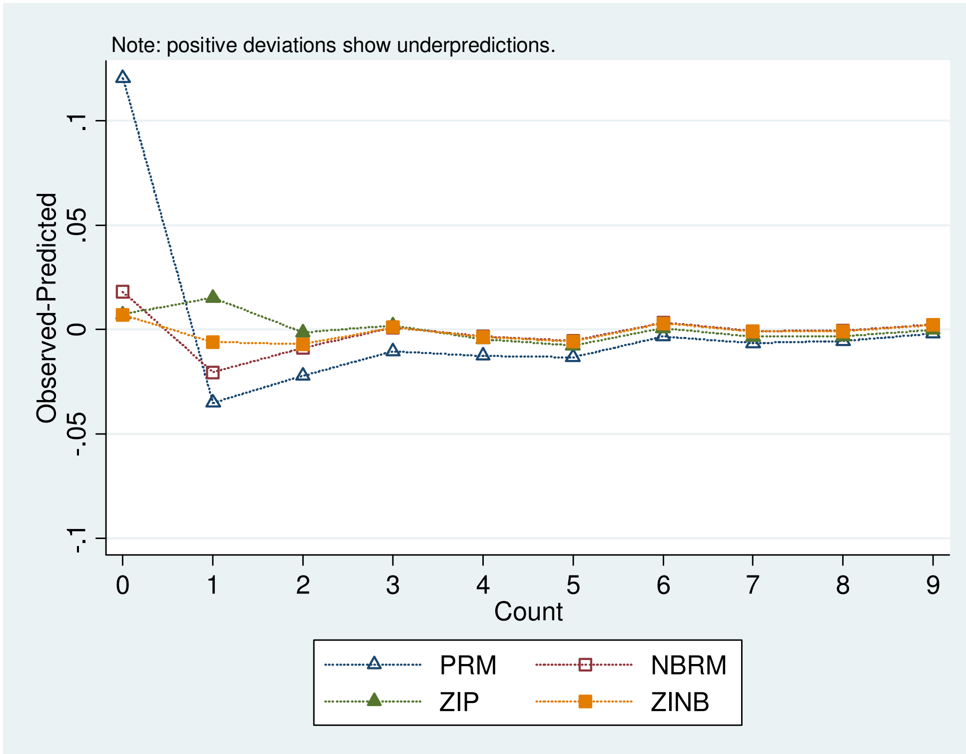
Finally, in all regressions the “polity2” measure of democracy from the Polity IV project is included. The impact of democracy on environmental policy is highly debated, but several papers find generally that more democratic countries tend to have higher environmental protection (Driesen, 2006; Fredriksson & Wollscheid, 2007; Midlarsky, 1998). In the political science literature, democracy is also predicted to increase government preferences for NTBs over tariffs because it allows policy makers to protect industries in ways that are less transparent to the public (Kono, 2006). Thus, both protective and protectionist motivations suggest a positive relationship between democracy and SPS/TBT use.

2.7.4. Model fitting for cross-section

For the cross-section part of the analysis, the dependent variable is the total number of notifications (by country and HS-2 code) from 1996 through 2010. On the right hand side, those variables for which time-series data are available are replaced by their means over the 15-year sample period. HS-2 code dummies are included in all regressions to control for product heterogeneity.

After testing the performance of a number of count data models, the Zero-inflated Poisson (ZIP) was selected for its robustness and ability to fit the SPS data, which included a large proportion of zeroes. Additionally, the ZIP was the best-fit model that biased towards under-predicting notified SPS measures as opposed to the next closest model (the Zero-Inflated Negative Binomial, ZINB) which over-predicted low counts. Following the informal method of Long & Freese (2001), the predicted probabilities of four count models (Poisson, ZIP, NB, ZINB) were compared against the observed probabilities of each count number in the data (see Figure 5).

As expected, the Poisson count model greatly under-estimated the number of zeroes because of the excess zeroes on HS-2 codes that rarely have a SPS notification (see Figure 5). The HS-2 code factor variable was used in the inflation model to predict the excess zeroes as a part of the ZIP model. Deviations from zero in Figure 5 that are positive reflect an underestimate of the model fitting as compared to the data, while negative deviations are over-estimates of the model as compared to the data.



Note: PRM is Poisson Regression Model; ZIP is Zero-inflated Poisson; NBRM is Negative Binomial Regression Model; and ZINB is Zero-inflated Negative Binomial.

Figure 5: Fit of model (2) from Table 9 for SPS measures using Long & Freese (2001)

Some of the zero-inflated models would not converge for TBT measures when run with equivalent covariates and HS-2 code dummies as the SPS models. As such, section 2.8.1 starts with some simplified regression models to compare TBT and SPS policies against a smaller set of covariates using a Negative Binomial (NB) regression to account for the over-dispersion in the data. More advanced models using a Zero-Inflated Poisson (ZIP) estimator just for SPS measures are discussed subsequently in section 2.8.2.

2.8. CROSS-SECTION RESULTS

2.8.1. SPS and TBT in simplified cross-section using NB estimator

To simplify the comparison between SPS and TBT policies in the cross-section, a limited number of variables that are expected to have influence on notification rates are first tested using a NB estimator. The total number of SPS/TBT notifications predicted by the decline in the bound tariff rate, along with trade variables, and country GDP are modelled in column (1) of both Table 7 and Table 8. In column (2) the ESI measure of environmental governance is added as a further covariate. In column (3) alternative measurements of environmental governance, including the polity2 measure of democracy, the WB WGI measure of regulatory quality, and the EPI measure of environmental health at the country level are included.

Table 7: Cross-sectional correlates of total (Regular + Emergency) SPS notifications by country and HS-2 code using NB estimator

	(1) SPS		(2) SPS		(3) SPS	
	Coeff.	ΔN	Coeff.	ΔN	Coeff.	ΔN
BND Tariff (wgt. av.)	-0.00475**	-0.0471	-0.00365**	-0.0379	-0.00263**	-0.0230
Log Imports	0.101**	0.0730	0.0251	0.0186	-0.0470	-0.0294
Log Exports	0.159**	0.179	0.146**	0.164	0.0969**	0.0907
Log GDP	0.0547	0.0278	0.0402	0.0207	0.101**	0.0447
Enviro. governance			0.727**	0.118		
Polity					0.0935**	0.122
Regulatory quality					0.312**	0.0520
Enviro. health					0.0201**	0.0793
ln(α)	1.003**		0.792**		0.663**	
Observations	6394		5592		5936	

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients and discrete change in predicted number of notifications (ΔN) for a change in the covariate from minus to plus 0.5 standard deviations. HS-2 code dummies included, but not reported.

The results show consistently that decreases in the bound tariff predict increased log counts of notifications of SPS or TBT measures in all models tested (see Table 7 and Table 8). For SPS measures in Table 7, the NB models predicted a one-unit decrease in the bound tariff rate results in a 0.00263 to 0.00475 increase in the log count of SPS notifications. Similarly, for TBT measures in Table 8, the models predicted a one-unit decrease in the bound tariff rate results in a 0.00240 to 0.00335 increase in the log count of SPS notifications. For all TBT and SPS models, the value of α confirmed significant over-dispersion in the data (i.e. $\alpha \neq 0$), hence the correct choice of the NB estimator instead of Poisson.

Additionally, for both SPS and TBT measures larger export values positively correlated with more notifications. While for TBT there was a positive relationship with imports as well, for SPS the result was not robust once environmental governance covariates were introduced in models (2) and (3). Similarly, richer countries (as measured by log GDP) were associated with more TBT notifications per HS-2 code product, but the result was inconclusive for SPS notifications where the coefficient was not significant in models (1) and (2).

Table 8: Cross-sectional correlates of total TBT notifications by country and HS-2 using NB estimator

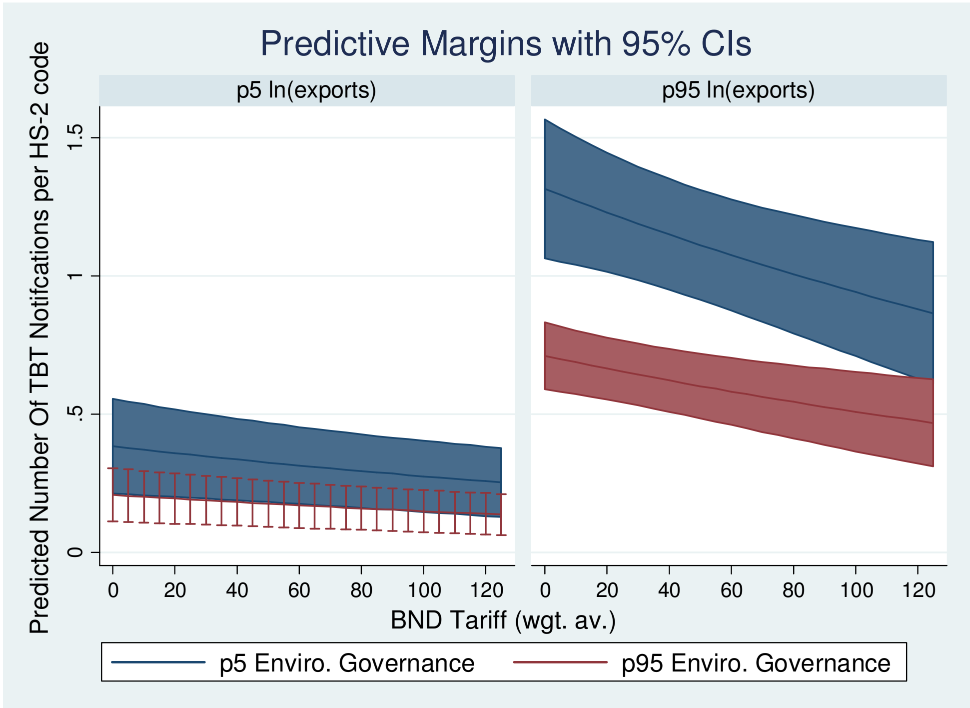
	(1) TBT		(2) TBT		(3) TBT	
	Coeff.	ΔN	Coeff.	ΔN	Coeff.	ΔN
BND Tariff (wgt. av.)	-0.00240*	-0.0150	-0.00335*	-0.0228	-0.00263*	-0.0170
Log Imports	0.0903**	0.0580	0.124**	0.0878	0.137**	0.0916
Log Exports	0.0831**	0.0839	0.0781**	0.0829	0.0715**	0.0727
Log GDP	0.114**	0.0535	0.0930**	0.0464	0.0992**	0.0468
Enviro. governance			-0.296**	-0.0478		
Polity					0.0235**	0.0335
Regulatory quality					-0.100	-0.0188
Enviro. health					-0.00798*	-0.0294
ln(α)	1.247**		1.198**		1.212**	
Observations	7707		6824		7146	

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients and discrete change in predicted number of notifications (ΔN) for a change in the covariate from minus to plus 0.5 standard deviations. HS-2 code dummies included, but not reported.

As expected for SPS measures, countries with higher environmental governance scores reported more SPS notifications by HS-2 code (see models (2) and (3)). For TBT measures, countries with lower environmental governance scores are shown to report more TBT notifications. There is less of a clear relation between TBT policy and environmental policy of a country (as compared to SPS policy). As shown in the data, a lot of TBT notifications apply to vehicles, nuclear reactors, and other products with discriminating technical standards, but little relation to environmental quality and human health. It could be that countries with more heavy, polluting industry use TBT measures more frequently and as a result, there is a correlation with poor environmental metrics.

It is difficult to interpret results in terms of the log counts. To aid understanding, the predicted number of notifications at the country-HS level for model (2) are plotted in Figure 6 for TBT and Figure 7 for SPS. The predictions are plotted over the range of the trade-weighted bound tariff from the 1st to 99th percentile. Separate plots are made for variations of high/low environmental governance scores and high/low export value at the HS-2 level. [38]

[38] "High" here is defined as 95th percentile in the data and "low" is 5th percentile in the data



Note: (left) p95 Enviro. Gov. confidence intervals shown in red bars due to overlap

Figure 6: Predicted TBT notifications from model (2) in Table 8 over bound tariff for high/low environmental governance and high/low exports in the HS-2 code

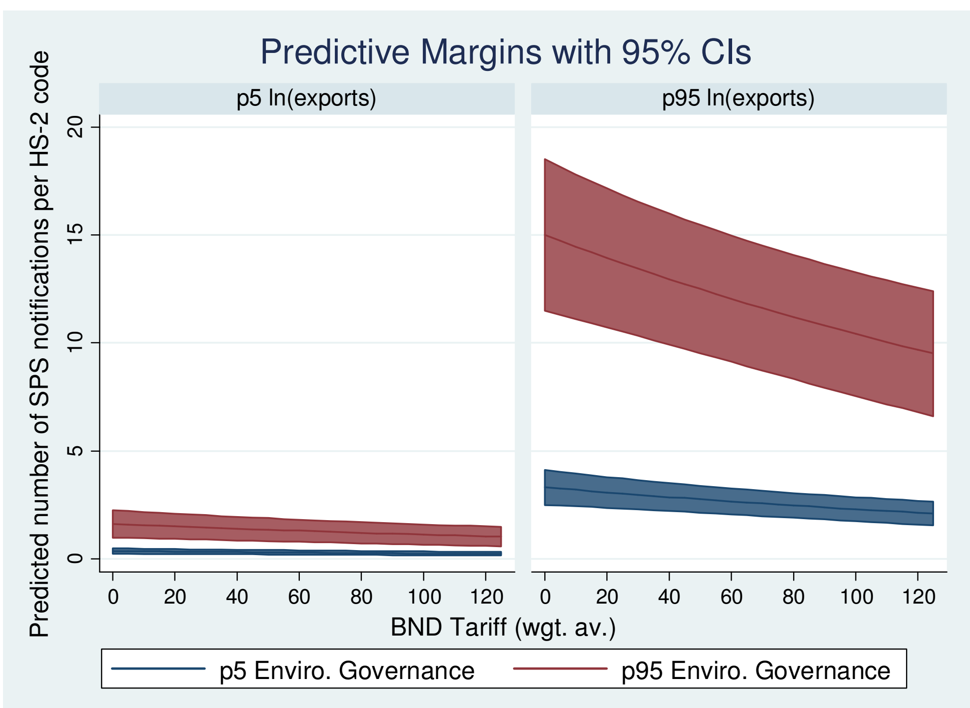


Figure 7: Predicted SPS notifications from model (2) in Table 7 over bound tariff for high/low environmental governance and high/low exports in the HS-2 code

The first thing to note in the figures (Figure 6 and Figure 7) is the impact that the value of the export industry (as measured by the log of HS-2 exports) has on the number of policy changes for either the SPS agreement or the TBT agreement. For SPS measures particularly, the countries with low export values are predicted to have very few notifications, whether the country has high or low environmental policy metrics and no matter how stringent or loose the tariff binding is. The impact of a declining bound tariff is most explicit for the high environmental governance country in a large export sector; there the largest possible move from a 100% tariff to a 0% tariff would be expected to double the number of SPS notifications from around 5 to around 10. Realistically however, such large movements in tariffs are very rare and for most trade policy scenarios, the predicted impact would be much smaller.

For TBT measures, the impact was similar for larger export product categories, but to a lesser degree than SPS measures. The biggest difference in notification rates between 95th and 5th percentile exports was around 3 times as many notifications as compared to around 6 times for SPS (see Figure 6 and Figure 7). In addition for TBT measures, environmental governance scores predicted the opposite effect compared to SPS, and also a smaller magnitude difference between notification rates of the top (i.e. 95th percentile) environmental performers and the lowest (i.e. 5th percentile) environmental performers (see Figure 6).

2.8.2. SPS using ZIP estimator with additional covariates

Using a wider set of the covariates discussed in section 2.5 (page 38), Table 9 presents the main regression results for the cross-sectional analysis of SPS measures. The discrete change in predicted number of notifications (ΔN) per HS-2 code per country for a change in the covariates from minus to plus 0.5 standard deviations (other covariates held at means) is shown in the second column for each model. The main variable of interest, the bound tariff rate, has a statistically significant negative correlation with the number of SPS notifications made by a country in the 15 years of the sample. Nevertheless, the predicted economic/policy impact is small. While the average number of notifications per country per HS-2 code is just under three (2.85) in the dataset, a one standard deviation decrease in bound tariff rate is predicted to increase notifications by only 0.03-0.08 notifications (a 1% to 3% increase above mean notification rate) depending on the specification.

Table 9: Cross-sectional correlates of total SPS notifications by country and HS-2 code using a ZIP estimator

	(1) SPS		(2) SPS		(3) SPS	
	Coeff.	ΔN	Coeff.	ΔN	Coeff.	ΔN
BND Tariff (wgt. av.)	-0.00190**	-0.0618	-0.00251**	-0.0808	-0.00115**	-0.0333
Log Imports	0.0475**	0.110	0.0436**	0.100	0.0229**	0.0472
Log Exports	0.0445**	0.154	0.0478**	0.162	0.0265**	0.0813
Log GDP per capita	0.0179	0.0205	-0.0248	-0.0280	-0.237**	-0.242
GDP per capita growth	14.89**	0.185	11.20**	0.140	10.88**	0.120
Log Population	0.0191*	0.0243	0.0604**	0.0713	0.0803**	0.0908
Population growth	0.140	0.00175	-19.42**	-0.195	-1.164	-0.0129
Percent aged over 65	6.757**	0.282	3.854**	0.158	5.961**	0.220
Polity	0.0847**	0.411	0.0775**	0.334	0.0622**	0.267
Enviro. governance			0.164**	0.0797		
Regulatory quality					0.393**	0.216
Enviro. health					0.0119**	0.154
Pesticide regulation					0.00477*	0.0253
Biodiversity protect.					0.00300**	0.0535
Observations	5936		5525		5936	

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients and discrete change in predicted number of SPS notifications (ΔN) for a discrete change (± sd/2) in the covariate reported. HS-2 code dummies included in main and inflation equation, but not reported.

Imports and exports are both positively correlated with SPS use. The economic significance of imports is similarly small to that of the bound tariff, but that of exports is about twice as large (in regressions 2 and 3 of Table 9). These findings could be consistent with either protective or protectionist drivers of SPS use, but certainly do not suggest a dominance of traditional import-protecting motivation. GDP per capita growth and population size both show robust positive correlations with SPS use. This indicates that SPS use is increasing in both countries with large populations and countries that are getting richer.

The most robust and economically significant correlates of SPS use are the measure of democracy (i.e. polity2), the percentage of the population aged over 65, and the measure of general regulatory quality. All three of these indicators are associated with "protective" motivations for SPS use.[39] The protective motivation of SPS use is also lent support by strong positive coefficients on environmental governance, environmental health, pesticide regulation and biodiversity protection. It appears countries with strong measures of environmental policy and human health use more SPS regulations.

One notable feature of the results in Table 9 is the generally small magnitude of the predicted effects. For non-agriculture HS-2 codes, the probability of a notification is very small in the dataset and several HS-2 codes were only included as one or two countries used them in one or two years in the sample (see many HS-2 codes with only 1 or 2 total SPS notifications in Appendix A.3 on page 348). Thus, Table 10 reproduces the same regressions for the restricted sample including only agricultural HS codes. The signs and relative importance of the covariates are the same as in the full sample results. However, as expected given the use of SPS policy primarily on agriculture products, the magnitudes of the effects are substantially greater in this sample.

The final predictions of the number of SPS measures for HS-2 codes in agriculture are plotted in Figure 8 over bound tariff rates and Figure 9 over environmental governance scores for model (2) in Table 10. The dashed vertical lines in both plots show the 25th, 50th (median), and 75th percentile points in the data for the variable on the x-axis. Confirming the theoretical results of Kono (2006), both plots strongly show that countries that are fully democratic (polity score of 10, which is about 10% of the dataset) notify many more SPS notifications than non-democratic countries (the upper range of closed anocracy[40]). In addition, the difference in notification rates between a 25th and 75th percentile country for environmental governance is slightly higher than for a move from a 75th percentile to a 25th percentile bound tariff rate *ceteris paribus*.

Given that the cross-section ignores the time-series variation, in the next section the impact of bound tariff rate changes are tested in a panel data setting without the environmental

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[39] Democracy is also associated with protectionist uses of SPS and other NTM policies according to the political economy theory discussed by Kono (2006), but generally more democratic countries are associated with more concern for the environment and human health (Li & Reuveny, 2006; Farzin & Bond, 2006; Fredriksson, Neumayer, Damania, et al., 2005).

[40] Full descriptions of the terms associated with different polity2 scores are on the PolityIV project website: http://www.systemicpeace.org/polity/polity4.htm

governance covariates (which lacked variation in time), but with other economic controls (e.g. current account status and exchange rate movement).

Table 10: Cross-sectional correlates of total SPS notifications by country and HS-2 code using a ZIP estimator on a restricted sample of just agricultural HS-2 codes

	(1) SPS		(2) SPS		(3) SPS	
	Coeff.	ΔN	Coeff.	ΔN	Coeff.	ΔN
BND Tariff (wgt. av.)	-0.00202**	-0.406	-0.00265**	-0.558	-0.00128**	-0.248
Log Imports	0.0481**	0.396	0.0443**	0.379	0.0201*	0.160
Log Exports	0.0471**	0.585	0.0493**	0.631	0.0275**	0.331
Log GDP per capita	0.00953	0.0465	-0.0271	-0.137	-0.260**	-1.237
GDP per capita growth	14.70**	0.762	10.82**	0.593	10.38**	0.521
Log Population	0.0210**	0.112	0.0625**	0.322	0.0866**	0.448
Population growth	0.765	0.0396	-19.63**	-0.868	-1.042	-0.0523
Percent aged over 65	6.824**	1.184	3.757**	0.677	5.903**	0.992
Polity	0.0798**	1.606	0.0744**	1.403	0.0569**	1.105
Enviro. governance			0.149**	0.316		
Regulatory quality					0.416**	1.044
Enviro. health					0.0131**	0.815
Pesticide regulation					0.00397	0.0959
Biodiversity protect.					0.00315**	0.258
Observations	2065		1906		2065	

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients and discrete change in predicted number of SPS notifications (ΔN) for a discrete change (± sd/2) in the covariate reported. HS-2 code dummies included in main and inflation equation, but not reported.

Figure 8: Predicted SPS notifications in agricultural HS-2 codes from model (2) in Table 10 over bound tariff for fully democratic and non-democratic countries

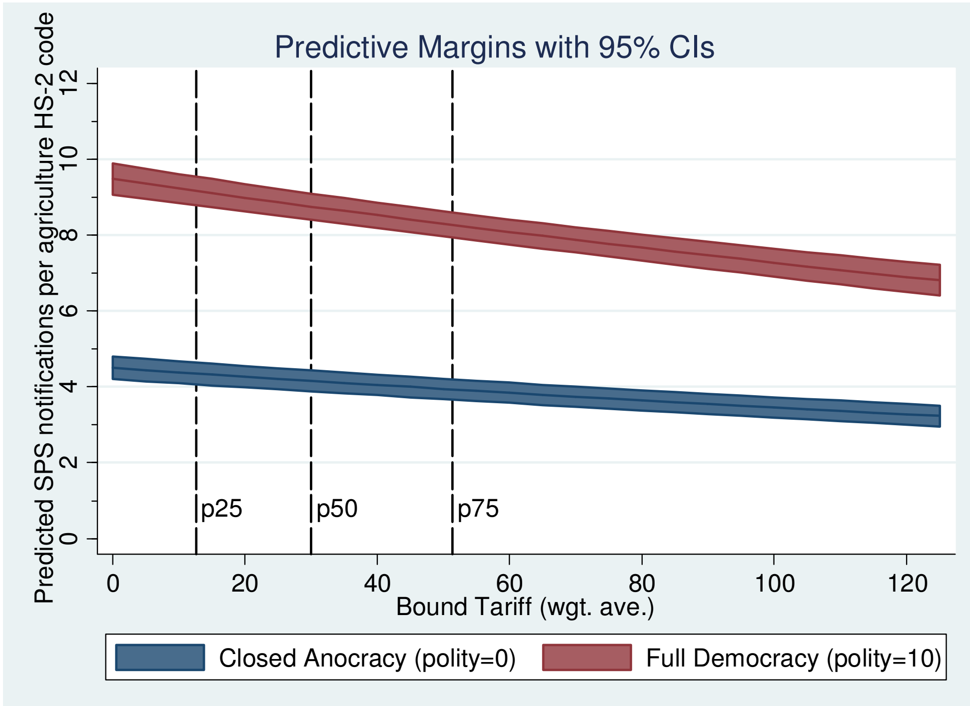
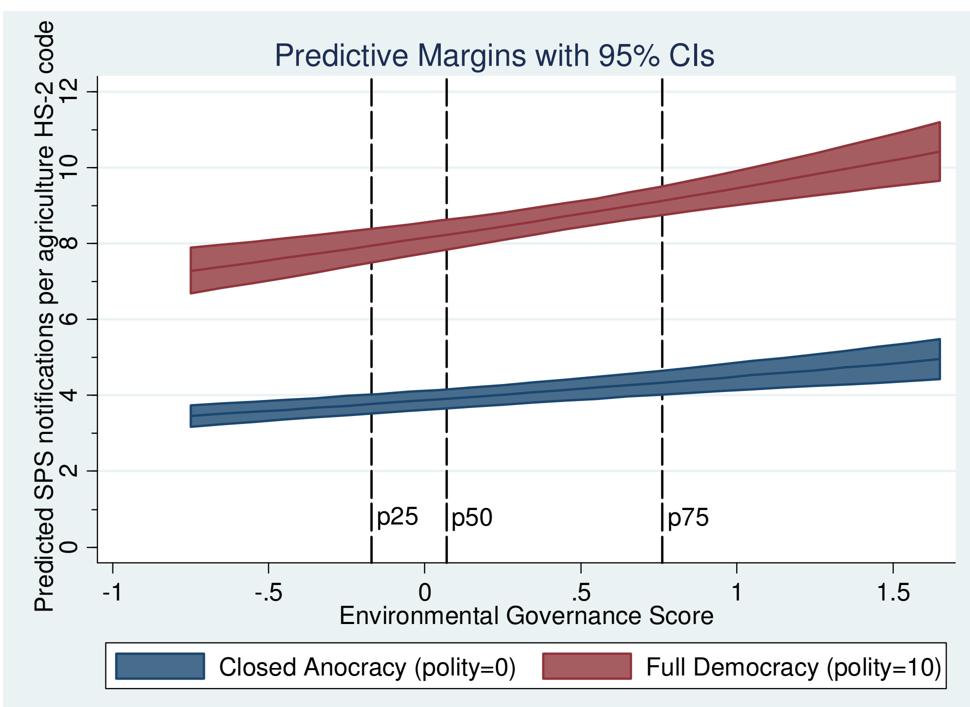


Figure 9: Predicted SPS notifications in agricultural HS-2 codes from model (2) in Table 10 over environmental governance score for fully democratic and non-democratic countries



2.9. TIME-SERIES SETUP

The cross-sectional analysis described in section 2.8 above was necessary in order to make use of important environmental, governance, and demographic variables for which there is insufficient times-series variation. There are, however, a number of advantages of a time-series model for covariates with sufficient data.

2.9.1. Advantages of time-series compared to cross-section analysis

Four main advantages are outlined presently. First (1) is the ability to account for country heterogeneity, which may be correlated with the explanatory variables of interest. The next advantage, (2) is the ability to reduce simultaneity bias by using lagged values as instruments for the imports, exports, and tariffs. Since there is a substantial empirical literature (see section 2.4.3) seeking to measure the trade dampening impact of NTMs like SPS and TBT, the potential for endogeneity if current levels of these covariates are used to predict notifications is apparent. Additionally, (3) time series estimates can include year dummies to control for global shocks such as disease emergence (e.g. avian influenza) and economic conditions (e.g. the Global Financial Crisis) which may have unduly influenced the means of covariates in the cross-section. Lastly, (4) a time-series model of new notifications is more appropriate to the data as there is no information on the levels of SPS and TBT regulations that existed prior to 1996. The notification data is just on new notifications to policy changes, but regulations protecting human, plant, and environmental health have been in existence for decades codified under the GATT Article XX or existing as separate legal frameworks that foreign countries had to comply with to enter a domestic market.

2.9.2. New variables in time-series analysis

The expected predictions for most of the right hand side variables were discussed in section 2.6, but there are two additional variables used in the time series analysis. The first (1) is the real effective exchange rate compared to a trade-weighted basket of currencies. This data, like that for GDP per capita, was extracted from The World Bank (2012). The exchange rate index data is expressed such that an increase indicates currency appreciation. Positive exchange rate movements make it harder for domestic firms to compete in both import and export markets as their prices relative to other currencies are higher. Thus, protectionist motivations predict a positive relationship between exchange rate increases and SPS/TBT use.

The second (2) additional variable in the time-series analysis is whether the current account is positive or negative. Niels & Francois (2006) find a declining current account balance increases the likelihood of using protectionist policy. Additionally, policy makers often claim to want to boost exports and generally help the current account situation of a country. Thus, one might expect the protectionist pressure for SPS and TBT policy use to be greater when the current account turns negative. Although countries that seek to influence their current account balance may also seek to manipulate SPS policy, this endogeneity issue can be reduced by accounting for omitted country characteristics in various ways in the time series. Once the endogeneity problem is solved, it is expected that a positive current account balance would lead to less pressure for protectionism (and thus less protectionist use of SPS notifications).

2.10. TIME-SERIES RESULTS

The first results of the time series analysis are shown in Table 11. The regression of column (1) takes a similar approach to that used in some of the recent literature on anti-dumping initiations (Moore & Zanardi, 2011). Following their approach, industry (HS-2 codes) and year dummies, but no country dummies or fixed effects are included. Also similar to Moore & Zanardi (2011), notification probability is allowed to be a function of both previous levels ($L.variable\_name$) and changes ($D.variable\_name$) in the covariates. Lag tariff changes by one year are used to allow time for notifications to be filed in response. Imports and exports are lagged two years to reduce simultaneity bias from trade outcomes being codetermined with SPS/TBT policy. Due to strong auto-regression in these series, however, this strategy of using lags as instruments for trade flows may only be partly successful in the levels. This issue of auto-regression is discussed more fully below.

Table 11: Logit and conditional logit models of at least one SPS notification by country, year and HS-2

	(1) SPS>1	(2) SPS>1	(3) SPS>1
L.D. BND Tariff (wgt. av.)	-0.00820*	-0.00957*	-0.0170**
	(0.00360)	(0.00417)	(0.00660)
L2. BND Tariff (wgt. av.)	-0.00702**	-0.00424	-0.0143*
	(0.00128)	(0.00241)	(0.00597)
L2.D. Log Imports	-0.0654	-0.148	-0.258
	(0.156)	(0.196)	(0.177)
L3. Log Imports	0.194**	-0.124**	-0.448**
	(0.0372)	(0.0455)	(0.157)
L2.D. Log Exports	0.164**	0.0557	0.0762
	(0.0540)	(0.0664)	(0.0844)
L3. Log Exports	0.195**	0.0448*	0.0810
	(0.0168)	(0.0220)	(0.103)
D. Log Exchange Rate	0.705	1.767**	1.636*
	(0.508)	(0.673)	(0.677)
L. Log Exchange Rate	-0.629*	1.146*	1.214*
	(0.283)	(0.550)	(0.597)
D. Positive Current Account	0.0923	0.170	0.194
	(0.0996)	(0.115)	(0.144)
L. Positive Current Account	-0.0730	0.0746	0.0541
	(0.0461)	(0.0829)	(0.121)
Observations	22,164	19,960	7,613
Conditioning Group	None	None	Country-HS code
Dummies	Year, HS-2	Year, HS-2, Country	Year

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Cluster robust standard errors in brackets. Lag levels and changes of GDPPC and population are included as in the models of Table 10, but not reported here to facilitate discussion on variables of interest between SPS and TBT.

Not surprisingly given the absence of country effects, the results in column (1) of Table 11 above are broadly similar to those obtained in the previous cross-sectional analysis for SPS measures (see Table 9, page 63). Like before, the bound tariff is negatively correlated with SPS notification probability; while imports and exports are positively correlated with it.

Column (2) of Table 11 represents an attempt to control for country heterogeneity through the inclusion of country dummies in the regression. Many of the coefficients become insignificant in column (2), and the coefficient on import levels changes sign to become negative and significant. These changes in comparison to column (1) are due to a combination of the dummies absorbing much of the variation in the data and to the fact that some of the results in the previous column may have been driven by spurious correlation with unobservable country characteristics. The negative and significant result for the level of imports in this column is contrary to expectations discussed in section 2.7.1. This could be due to an endogeneity issue; countries which protect a certain sector more heavily, are likely to have relatively more SPS and relatively less imports in that sector. An alternative explanation is that a strong domestic industry may supply the majority of the domestic market and therefore import values are low; however, given the importance of the industry, they need strong SPS protection from legitimate risks presented by foreign pests/diseases. The US citrus industry fits this sort of description, and it might be a more widely relevant archetype. To address the endogeneity concern, a regression conditioning on country-HS effects is presented in in column (3).

The most obvious impact of conditioning out country-HS effects is to reduce the sample size used for the estimation due to the large number of country-HS pairs for which there is no identifying variation. Secondly, the statistical significance of the bound tariff variables increases. Thirdly, the coefficient on exports becomes insignificant. Otherwise, the results are much the same as column 2, including the negative and significant correlation between import levels and SPS notifications.

The same modelling framework is used on TBT measures as well and presented below in Table 12 below. The relation between bound tariff declines and increasing use of TBT measures found in the cross-section analysis was not robust to time-series investigation. However, the new time-series variables were the only reliable predictors of having at least one TBT measure in an HS-2 code. Interestingly, the direction of correlation with the exchange rate index is opposite the predicted direction. Consistently across all three models, a depreciating currency—which should make exports more competitive, as well as, make imported products more expensive in the domestic market—seem to drive the likelihood of having at least one TBT measure. The mechanism here could be that as the economic conditions improve for the manufacturing sector (where most TBT measures are applied) they are more likely to need to specify additional safety/technical measures on imported products that are inputs to the industry. Rigorous proof of this hypothesis is left for future research.

The other robust predictor of having at least one TBT notification was a negative correlation with a positive current account. The result was especially consistent for a change in current account status ($D.Positive\ Current\ Account$, see Table 12). This is consistent with protectionist motivation for TBT policy application, but the only covariate that indicates this relationship.

Table 12: Logit and conditional logit models of at least one TBT notification by country, year and HS-2

	(1) TBT>1	(2) TBT>1	(3) TBT>1
L.D. BND Tariff (wgt. av.)	0.000455	-0.00704	0.00125
	(0.0110)	(0.0116)	(0.00568)
L2. BND Tariff (wgt. av.)	-0.00268	-0.00558	0.00510
	(0.00213)	(0.00309)	(0.00556)
L2.D. Log Imports	0.0277	0.0961	-0.198
	(0.159)	(0.226)	(0.264)
L3. Log Imports	-0.0743	0.180^{**}	-0.311
	(0.0449)	(0.0588)	(0.265)
L2.D. Log Exports	-0.00403	0.0225	-0.0415
	(0.0339)	(0.0409)	(0.0626)
L3. Log Exports	0.0211	0.108^{**}	0.0132
	(0.0204)	(0.0251)	(0.0895)
D. Log Exchange Rate	-3.318^{**}	-2.011^{*}	-2.182^{**}
	(0.677)	(0.827)	(0.805)
L. Log Exchange Rate	0.762	0.656	0.682
	(0.453)	(0.908)	(0.777)
D. Positive Current Account	-0.369^{**}	-0.737^{**}	-0.752^{**}
	(0.108)	(0.189)	(0.227)
L. Positive Current Account	-0.185^{**}	-0.0708	-0.0600
	(0.0592)	(0.133)	(0.180)
Observations	32,122	28,818	6,186
Conditioning Group	None	None	Country-HS code
Dummies	Year, HS-2	Year, HS-2, Country	Year

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Cluster robust standard errors in brackets. Lag levels and changes of GDPPC and population are included as in the models of Table 10, but not reported.

2.10.1. First differences model

The specification in column (3) of Table 11 and Table 12 is substantially more conservative than those that have previously been published in the literature (see section 2.4.3). Nevertheless, the negative correlation between import levels and SPS use suggests there is still the possibility of bias being introduced by the inclusion of the levels of potentially endogenous variables such as imports and exports. Strong autocorrelation can render lagged levels a poor instrument for current levels (Arellano & Bover, 1995). This problem is largely absent for changes (first differences) in variables. Presenting the results from this approach on SPS measures, Table 13 only includes changes of covariates on the right hand side. In addition to further reducing endogeneity concerns, the first-difference model in Table 13 has the advantage of being easier to interpret than the "error-correction" style model in Table 11 that Moore & Zanardi (2011) use.

Table 13: First differences models using logit and Poisson for SPS notifications by country, year and HS-2

	EU 27 Members		EU Aggregate	
	(1) SPS>1	(2) SPS	(3) SPS>1	(4) SPS
	Cond. Logit	F.E. Poisson	Cond. Logit	F.E. Poisson
L.D. BND Tariff (wgt. av.)	-0.0108*	-0.00378**	0.00530	-0.00601*
	(0.00523)	(0.00204)	(0.00653)	(0.00299)
L2.D. Log Imports	0.0178	0.244**	-0.0364	0.355**
	(0.153)	(0.0730)	(0.173)	(0.134)
L2.D. Log Exports	0.0428	0.0785**	0.0501	0.0872*
	(0.0676)	(0.0222)	(0.0655)	(0.0361)
D. Log Exchange Rate	1.565*	1.203**	-0.545	0.633
	(0.608)	(0.285)	(0.739)	(0.361)
D. Positive Current Account	0.151	-0.0667	0.0588	-0.155
	(0.122)	(0.0574)	(0.169)	(0.113)
Observations	7613	2961	3370	874

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Column (1) conditional logit model of probability of at least one notification, column 2 'fixed effect' Poisson model of number of notifications conditional on there being at least 1. Conditioning group or 'fixed effect' units in both columns are the Country-HS. Year dummies also included but not reported. Columns 3 and 4 treat European countries as a single "EU" entity. Changes of GDPPC and population are included for all columns, but not reported. Cluster robust standard errors in brackets for columns (1) and (3); standard errors in brackets for cols (2) and (4).

Column (1) of Table 13 presents the results of a conservative first-difference conditional logit model of SPS notification. However, even in this regression, the two key indicators of protectionist motives—bound tariff and exchange rate—remain statistically significant with the signs predicted by protectionist theories of SPS policy use. No other coefficients are significant at the 5% level. For TBT measures in column (1) of Table 14 below, again the result for bound tariffs was not significant and the major drivers appeared to be depreciating currency and a current account becoming negative.

Table 14: First differences models using logit and Poisson for TBT notification by country, year and HS-2

	EU 27 Members		EU Aggregate	
	(1) TBT>1	(2) TBT	(3) TBT>1	(4) TBT
	Cond. Logit	F.E. Poisson	Cond. Logit	F.E. Poisson
L.D. BND Tariff (wgt. av.)	-0.000758	-0.0196	-0.00411	-0.0170
	(0.00529)	(0.0127)	(0.00338)	(0.0128)
L2.D. Log Imports	-0.0739	0.130	-0.158	0.0653
	(0.205)	(0.246)	(0.233)	(0.286)
L2.D. Log Exports	-0.0495	-0.106	-0.0595	-0.120
	(0.0428)	(0.0908)	(0.0483)	(0.0912)
D. Log Exchange Rate	-2.055^{**}	-0.590	-2.926^{**}	-0.724
	(0.702)	(0.539)	(0.791)	(0.577)
D. Positive Current Account	-0.660^{**}	-0.178	-0.723	-0.217
	(0.204)	(0.217)	(0.382)	(0.290)
Observations	6186	876	3295	669

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Column (1) conditional logit model of probability of at least one notification, column 2 'fixed effect' Poisson model of number of notifications conditional on there being at least 1. Conditioning group or 'fixed effect' units in both columns are the Country-HS. Year dummies also included but not reported. Columns 3 and 4 treat European countries as a single "EU" entity. Changes of GDPPC and population are included for all columns, but not reported. Cluster robust standard errors in brackets for columns (1) and (3); standard errors in brackets for cols (2) and (4).

Up until this point in the time-series analysis, the analysis has focused on the probability of at least one notification being made in a given country-HS-2-year observation. This focus was appropriate in order to make the analysis more comparable to the existing NTB literature, and since 93% of the observations in the SPS dataset are zeroes (97% in the TBT dataset). However, restricting the estimating sample by conditioning on country-HS as in columns (1) and (3) of

Table 13 and Table 14, the proportion of non-zero observations rises substantially as the permanently zero observations will be excluded because of a lack of identifying variation.

Columns (2) and (4) of Table 13 and Table 14 makes use of the information in the count data about how many notifications are made in a given year. Specifically, columns (2) and (4) estimates a Poisson fixed-effect model of the number of notifications in a year, conditional on there being at least one. Together columns (1) and (2) comprise a two-part model of SPS/TBT notifications. Columns (3) and (4) reproduce the same regressions as the first two columns, but replace the 27 European Union countries with a single "EU" entity as a robustness check since EU members notified both as one unit and by individual nations.[41]

For SPS measures, in column (2) of Table 13 imports and exports are now positive and significant, while bound tariff remains negative and significant. The significance of the trade variables may indicate that the increase in trade does not affect the probability of notifying an SPS measure on a given HS-2 code, but the more trade that occurs the higher the number of SPS measures can be expected, all other things equal. As well, the coefficient on the exchange rate remains consistently positive and significant indicating that an appreciating currency promotes higher numbers of SPS measures notified. However, this currency effect may be driven by the EU nations, as when they are treated as a single country in columns (3) and (4), the significance of exchange rates disappears.

Either treatment of Europe had little effect on the results for TBT notifications, other than the effect of a negative current account causing at least one notification seemed to be driven by individual EU nations. The main robust driver of having at least one TBT notification on a given HS-2 code is a depreciating currency, but this does not have any predictive power on the number of notifications in an HS-2 code. As before, these results may be driven by TBT's use in heavy industry where there is a strong need for technical and safety regulations. An economy that is becoming more competitive in the export market via a depreciating currency may be more likely to issue at least one TBT measure, but it says little about the extent to which the country will become more involved in TBT policy setting.

[41] Review the treatment of EU countries in the two datasets in section 2.5.1

2.10.2. Robustness to alternative specifications

The robustness checks of alternative tariff and country groupings were conducted just on SPS measures. TBT is not included since the tariff result was insignificant (see Table 14, page 73). Additionally, the TBT agreement does not have a mechanism for notifying emergency notifications, so there was only one measure of notifications to use for analysis. The only robust predictor of TBT notifications was currency depreciation, yet it had no predictive power in terms of the total number of TBT measures per HS-2 code. As a result, none of the models tested held tremendous explanatory ability on the use of TBT policy. The results from the cross-section analysis of correlation between TBT notification and bound tariff decline (section 2.8) were likely driven by country-level heterogeneity, which was controlled for with the time-series models.

Throughout the time-series analysis the weighted average bound tariff was used as the tariff constraint measure. In Table 15, as a robustness check, regressions were run in a NB fixed effect model to check if the results are the same for alternative tariff measures. The NB model was chosen to account for the overdispersion in the data from the high zero count at the country-HS-year observation. Fixed effects of country-HS are included to account for country-product level heterogeneity.

Column (1) replaces the bound tariff with the tariff BO—the difference between weighted-average applied tariff and bound tariffs. BO is an inverse measure of the extent to which the bound tariff is a constraint. As shown in the demonstrative plots of the data (Figure 3 on page 49) in section 2.5.2, the expectation is that BO is negatively correlated with SPS use. Column (1) confirms this result.

In column (2) the components of BO are separated out into bound and applied tariffs. Conditional on the bound tariff, a higher applied tariff indicates that the bound tariff is more of a constraint. The expectation is that conditional on the bound tariff, increases in the applied tariff will increase SPS use. The results find a positive relationship between applied tariff and SPS use (see Table 15). This results should, however, be treated with some caution as it is potentially biased upwards due to unobserved increases in the demand for protection in the sector which might simultaneously influence both applied tariffs and SPS use. This potential simultaneity bias issue is the reason why applied tariffs were not included in the analysis of section 2.10.

Columns (3) and (4) of Table 15 confirm that the results are robust to the use of simple rather than trade-weighted average tariff measures. Trade-weighted tariffs have the potential for endogeneity issues with imports as a covariate in the model, but the model was robust to either tariff measure.

Table 15: Alternative tariff measures show consistent drivers of SPS use. Negative binomial fixed effect model of SPS notification by country, year, and HS-2

	(1)	(2)	(3)	(4)
L.D. Tariff BO (MFN wgt.)	-0.00949**			
	(0.00265)			
L.D. BND Tariff (wgt. av.)		-0.0117*		
		(0.00491)		
L.D. MFN Tariff (wgt. av.)		0.00832*		
		(0.00367)		
L.D. BND Tariff (simp. av.)			-0.00944*	-0.0103**
			(0.00388)	(0.00391)
L.D. MFN Tariff (simp. av.)				0.00927*
				(0.00365)
L2.D. Log Imports	0.0255	0.0226	0.0231	0.0337
	(0.153)	(0.152)	(0.153)	(0.153)
L2.D. Log Exports	0.0410	0.0418	0.0415	0.0410
	(0.0676)	(0.0678)	(0.0671)	(0.0668)
D. Log Exchange Rate	1.563**	1.557*	1.566**	1.538*
	(0.604)	(0.605)	(0.607)	(0.604)
D. Positive Current Account	0.146	0.148	0.150	0.147
	(0.123)	(0.123)	(0.123)	(0.123)
Observations	7613	7613	7613	7613

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Fixed effect units are Country-HS. Year dummies also included but not reported. Changes of GDPPC and population are included for all columns, but not reported. Standard errors in brackets.

Having confirmed that the results are robust to the choice of tariff constraint measure, now the choice of SPS measure is tested for robustness. In particular, it is necessary to differentiate between Regular SPS and Emergency SPS notifications. Because of the need for expediency in some cases—such as disease outbreaks—emergency notifications can be made with less justification than regular notifications. One might logically expect more "protectionist" use of emergency measures and, thus, larger coefficients on the tariff and exchange rate drivers of SPS Emergency notifications.

Table 16 provides some support for this claim. The coefficient on exchange rate in the NB regression for SPS Emergency notifications in column (1) is larger than for SPS Regular notifications in column (2). Additionally, the coefficient on the bound tariff term is around 3 times larger for Emergency SPS measures as compared to SPS Regular measures. However, overall it is clear that these covariates predict the use of both policies.

Table 16: Results are confirmed for either Regular or Emergency notifications. NB fixed effect model of SPS notification by country, year and HS-2

	(1) Emergency Notifications	(2) Regular Notifications
L.D. BND Tariff (simp. av.)	-0.0120**	-0.00446**
	(0.00248)	(0.00108)
L2.D. Log Imports	0.0378	-0.0600
	(0.206)	(0.0986)
L2.D. Log Exports	-0.0377	0.0246
	(0.0940)	(0.0429)
D. Log Exchange Rate	3.005**	1.514**
	(0.945)	(0.354)
D. Positive Current Account	-0.0666	0.118
	(0.156)	(0.0680)
Observations	2982	7645

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Fixed effect units are Country-HS. Year dummies also included but not reported. Changes of GDPPC and population are included for all columns, but not reported. Standard errors in brackets.

Many methods were used to address potential sources of endogeneity in the above regressions. However, there is one potential source of spurious correlation between bound tariffs and SPS use that has not been addressed. It is possible that in the brief period after countries join the WTO they experience both falling bound tariffs and become adept at using WTO institutions such as SPS measures. This short-term surge in policy changes to comply with WTO rules and institutions could result in spurious correlation. To check whether this phenomenon could be driving the results, the sample is split according to whether the country joined the WTO during the sample period.

The results, in columns (1) and (2) of Table 17, suggest that new joiners are not driving the results. The coefficient on bound tariff is almost exactly the same in the WTO founders sample as in the full sample (see column (5)). In the new WTO joiners sample, the coefficient on bound tariffs has a larger magnitude, but is statistically insignificant due to the small sample size.

Table 17: Results by country group for NB fixed effect model of SPS notifications by country, year and HS-2

	(1)	(2)	(3)	(4)	(5)
	WTO Founders	WTO New	Developing	Developed	Full Sample
	SPS	SPS	SPS	SPS	SPS
L.D. BND Tariff (simp. av.)	-0.00575**	-0.0174	0.0103	-0.00607**	-0.00571**
	(0.000998)	(0.0386)	(0.0163)	(0.000994)	(0.00102)
L2.D. Log Imports	-0.0157	-0.0122	-0.147	-0.0836	-0.0378
	(0.0941)	(0.376)	(0.139)	(0.130)	(0.0903)
L2.D. Log Exports	0.0150	-0.148	-0.0137	0.0337	0.0231
	(0.0391)	(0.233)	(0.0637)	(0.0554)	(0.0391)
D. Log Exchange Rate	1.742**	-30.30**	2.339**	1.939**	1.507**
	(0.331)	(8.714)	(0.887)	(0.454)	(0.333)
D. Positive Current Account	0.0265	-0.370	0.119	0.0365	0.0807
	(0.0640)	(1.290)	(0.118)	(0.0768)	(0.0633)
Observations	7602	291	1687	6206	7893

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Fixed effect units are Country-HS. Year dummies also included but not reported. Changes of GDPPC and population are included for all columns, but not reported. Standard errors in brackets.

Finally, it is well established that developing countries have different patterns of use of NTMs (such as anti-dumping measures) as compared to advanced economies (Feinberg & Reynolds, 2007). The results in columns (3) and (4) of Table 17 suggest that this finding holds true in the use of SPS as well. In particular, developing countries do not show a negative relationship between bound tariffs and SPS notifications, while developed countries do.

While it is possible that developed countries are more prone to protectionist abuse of SPS, an alternative explanation is because developing countries have been exempt from most of the stringent bound tariff reductions agreed at the WTO. Support for this interpretation is provided by the fact that the coefficients on exchange rate are almost identical in the two samples.

2.11. CONCLUSION

The purpose of this chapter has been to refocus the discussion of NTBs and protectionism from one of protectionist effect—which has been amply demonstrated in the literature—to one of protectionist intent. There is an underlying belief stated on the WTO SPS website (see block quote in section 2.2) as well as variously in the literature (see section 2.3) that the liberalisation of tariff regimes has led to an increase in the use of non-tariff means of protection. This chapter is the first—to the author's knowledge—that rigorous tests of this relationship for SPS and TBT measures in a cross-section and panel data setting.

The primary finding is that the negative relationship between bound tariff levels and SPS use is highly robust throughout a range of increasingly conservative model specifications. The relationship for SPS was true for both regular measures that become part of a country's long run policy as well as emergency measures, which are meant to be temporary policy changes. Bound tariffs are a driver for TBT notification for some countries, but in the time-series, there was no evidence that they are a robust predictor of TBT policy use. Dividing the sample into different subsets of countries revealed that the primary driver of this relationship for SPS is the developed, founding WTO member states. Developing countries, however, are not completely free of evidence of protectionist use of SPS since the coefficient on exchange rate is just as large in their sample as it is for the developed countries. Thus a potential explanation for the fact that developed WTO members seem to use SPS more in response to falling tariffs might be that they are the group who have committed to the most stringent tariff reductions.

Protectionism is, however, far from being the only motivation for SPS measures. Indeed, the cross-sectional results suggest that there are other larger and more important drivers. Good democracy, regulatory quality, environmental governance, and aging populations all show positive relationships that indicate "protective" motivations for SPS use.

While there is a benefit to analysis at this macro-scale, more details about regulations used illegitimately are probably better discerned at a finer scale on the content of the specific measure. The following chapter (Chapter 3) examines Specific Trade Concerns to determine where the disagreements on the legitimate use of SPS/TBT measures exist during the same period as the analysis of this chapter.

Chapter 3. Patterns of Trade Concerns in SPS/TBT Use

Complementing an analysis between bound tariffs and the use of SPS and TBT measures, this chapter and Chapter 4 examine the disagreements that happen between WTO members in the course of setting and implementing SPS and TBT policy. The data used are "Specific Trade Concerns" which are discussed at the WTO in Geneva during SPS and TBT Committee meetings three times per year. STCs are reported as agenda items at the meetings and a notification of the concern is raised via the SPS-IMS and the TBT-IMS.[42]

The raising of a STC is a formal mechanism by which a country can introduce a complaint against another country's SPS/TBT policies regulating imports. SPS/TBT measures which form strong barriers to trade and are motivated by protecting domestic producers—rather than preventing a legitimate risk—are likely to be raised as a concern by other WTO members. Conversely, one would expect legitimate measures to receive fewer complaints. SPS/TBT measures that are (1) with scientific merit, (2) not overly restrictive to trade, and/or (3) not on an important commodity are unlikely to be questioned with a STC. As a result, STCs may also provide interesting insight into where protectionist measures, potentially motivated by loss of tariff protection, have been used. The analysis of this chapter will solely be on STCs and what motivates the raising of a concern; the outcomes when those concerns proceed to official disputes under the Dispute Settlement Body (DSB) of the WTO are not analysed (see literature review in section 3.3 for references on WTO disputes under the DSB).

This chapter is divided into several sections. First, an introduction (section 3.1) motivates the study of trade concerns as a way to illuminate the challenges in SPS/TBT compliance. The research questions are presented (section 3.2) and followed by a review (section 3.3) of the empirical literature on general WTO disputes. While several authors have examined the determinants of WTO disputes and their outcomes (see section 3.3), only one peer-reviewed study (Disdier & van Tongeren, 2010) and three working papers[43] use STC data in their empirical work, as far as the author could find. From informal discussion with one of the authors (Jasmin Gröschl) at the European Trade Study Group conference in Leuven in

[42] The same reporting system as the notification data acquired for the research in Chapter 2. The TBT data is available at <http://tbtims.wto.org/> and the SPS data at <http://spsims.wto.org/>

[43] (Horn, Mavroides & Wijkström, 2013; Crivelli & Gröschl, 2012; Fontagné, Orefice, Piermartini, et al., 2013)

September 2012, the author confirmed that STC data is under-utilized given the attention paid to SPS/TBT coverage measures in the empirical trade literature. Section 3.6 presents analysis on determinants of SPS STCs using data on the 292 SPS STCs raised from 1996 to 2010 paired with the SPS measure notifications from Chapter 2. Section 3.7 concludes.

Some of the summary results from sections 3.5 were presented along with the early work of Chapter 4 on plant health related STCs by the author as an invited speaker at a special topic session of the American Phytopathological Society (APS) Annual Meeting in August 2012.[44] Some results from sections 3.5 and resolution rates of STCs in Chapter 4 were also presented and discussed with WTO staff members of the SPS Secretariat at an informal meeting organized by the author in December 2012 in Geneva.

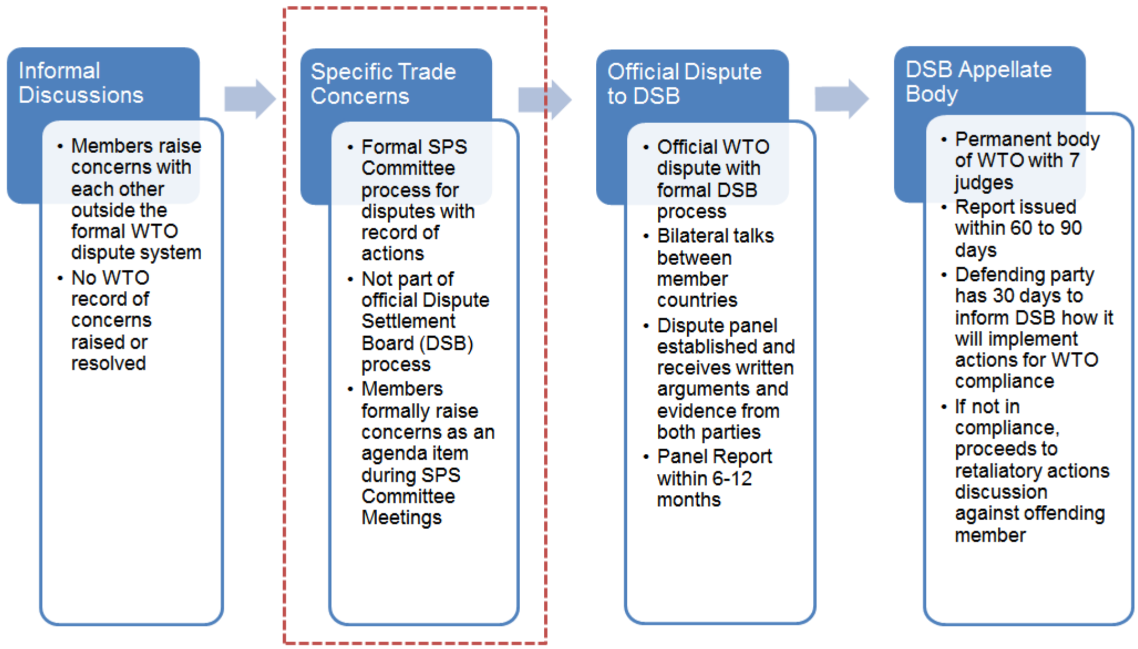
3.1. HOW STCS ARE RAISED

While the SPS and TBT agreements have been in place for decades, implementation of some countries' risk-based measures has not been without controversy. Like other agreements of the WTO, disputes were anticipated in the SPS/TBT regulatory framework given the uncertainty of scientific evidence used to justify risk-based regulations.[45] As such, the system was designed to have a formal process to address these disagreements.

An overview of the dispute process is shown in Figure 10 for the SPS agreement—the process for the TBT agreement is analogous. A thorough review of the process can be found in a chapter written by the long-time Secretary of the SPS Secretariat, Gretchen Stanton, in an edited volume on the SPS agreement (Stanton, 2012).[46] Within the SPS agreement, informal discussions of issues often precede the raising of a STC. Once a specific concern is raised as an agenda item at the SPS Committee meeting, it will be discussed and outcomes recorded in

[44] Pearson, L. "From Boom to Busted: Trade Concerns under the WTO's SPS Agreement" Special Session 'Right of the Boom: Deciding to Act, React, or Let Go in a Fluid Data Environment' American Phytopathological Society (APS) annual meeting, Providence, Rhode Island, 8th August, 2012.
[45] Although TBT measures do not require the same rigorous scientifically-based risk assessment as SPS measures, compelling cases must still be made for implementing measures and the process for reporting disputes is the same.
[46] The author also acknowledges information received informally about aspects of the STC mechanism of the SPS by Gretchen Stanton and other members of the SPS Secretariat when presenting work in early form from Chapter 2 and Chapter 4 of this PhD at the WTO in Geneva on Dec 20th, 2012.

the meeting minutes. Afterward, all of the information is recorded, coded, and made publically available online via the SPS-IMS (or equivalently, TBT-IMS for TBT STCs).



Note: Red dashed box highlights the stage of interest to this chapter. This figure is informed by the written process discussed in Stanton (2012).

Figure 10: Outline of escalation of disputes between WTO member countries on SPS/TBT matters

Most concerns will not be resolved within the context of one meeting. STCs are often raised again (called "re-raised" throughout this chapter and Chapter 4) at subsequent SPS Committee meetings when they are unresolved in the interim period by the disputing[47] members. If a concern is resolved between meeting periods, it will be reported as "resolved" in the subsequent meeting and if possible, the specific agreement reached in the resolution to the issue will be recorded in text form in the notification to the SPS-IMS. The rates of resolution vary quite significantly by country, and the drivers of resolution are examined subsequently in Chapter 4.

[47] "Dispute" or "disputing" is used with its colloquial meaning about a disagreement occurring between two or more parties throughout this chapter. In the context of this work, it does not mean a formal WTO DSB dispute.

3.2. RESEARCH QUESTIONS

This chapter contains analysis on the count-based data of every STC under the SPS and TBT agreement first raised from 1996 to 2010. Three research questions are addressed:

1) Are STCs initiated against SPS measures more often on HS codes where the bound tariff has fallen comparatively more?
2) Are initiated STCs re-raised more often on HS codes with tighter tariff BO?[48]
3) Do STCs appear more often on HS codes that have only a few SPS measures notified?[49]

The research questions are addressed by combining the data on SPS notifications from Chapter 2 with the new data from SPS STCs. The main question tested (1) is whether bound tariffs have influence on the initiation of trade concerns. As discussed in Chapter 2, the liberalisation of tariff regimes from successive rounds of WTO multilateral agreements has not displaced the domestic political-economy drivers for industry protection. As a result, the expectation is that non-tariff means of protection will be implemented as tariffs fall (Baylis, Nogueira & Pace, 2012; Ray, 1987; Yu, 2000; Feinberg & Reynolds, 2007; Mansfield & Busch, 1995). While Chapter 2 did find robust evidence for this relation in the notification of new or changed SPS policy, the hypothesis here is that SPS measures that are flagged for concern as potentially protectionist (or somehow illegitimate) via the STC mechanism would have an even stronger relation to declining bound tariffs. It was not possible to conduct the analysis for the TBT agreement due to the lack of HS-2 code information on STCs in the TBT-IMS.[50]

In addition to this analysis, summary information detailing the use of TBT/SPS STCs by country and by HS-2 code[51] is presented in section 3.5. The summary statistics and cross-tabulations of the data are presented since there are few studies that have utilized this data.

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[48] Recall from section 2.6.1 that SPS measures appeared to be notified more often by countries with tighter tariff binding overhang (tariff BO is the difference between the bound tariff and the applied tariff, which reflects the ability of a country to raise its applied tariff to achieve trade policy goals).
[49] An implication from Disdier, Fontagné & Mimouni (2008) discussed in the literature review (section 3.3).
[50] Only 5 out of 282 STCs raised in the sample had HS-2 code information in the TBT-IMS entry.
[51] Just for SPS STCs due to the data constraints on TBT STCs

3.3. LITERATURE REVIEW

Isaac (2004) asserts that the SPS agreement is where the agri-food challenges of the 21st century will occur. This, he argues, is for two reason: (1) the ambiguity of what is characterized as "legitimate" and (2) the unilateral power the agreement gives members to set "unchallengeable" market access barriers (Isaac, 2004). He contends that SPS measures are overly influenced in the process of setting regulations by political economy pressures. Isaac (2004)—in this author's opinion—over-states the ability of members to use SPS arbitrarily given (1) the need for measures to based on a risk assessment and (2) that challenges are possible via STCs. Nevertheless, his study motivates the importance of studying SPS implementation challenges.

Isaac (2004) also argues that developing countries may use "special and differential treatment"[52] to put in place SPS measures that are effective in blocking imports, but do little to protect health. This assertion would suggest that developing countries notify more SPS measures than developed members notify, or have more STCs raised against them. Given their smaller economic size, one might argue some, like Peru, are overrepresented in SPS notifications (see SPS Regular notification rates in Chapter 2); however, many developing countries notify few, if any, measures. To further investigate the issue, STC use by country is explored in section 3.5.1.

3.3.1. Literature analysing SPS/TBT STC data

There are only four papers available (all but the first are working papers) that use SPS or TBT STC data as their main source for analysis. (1) Disdier & van Tongeren (2010) use SPS STC data for just OECD countries from 1996 to 2006 as one of three variables in their cluster analysis of NTMs. They conclude that there are six different types of protection using NTMs. One of the clusters of products (mostly meat and dairy) are found to have both high trade coverage, high SPS notification rates, and high STC rates suggesting that SPS policy may be protectionist in these types of products for OECD countries (Disdier & van Tongeren, 2010). This finding is slightly counter to an earlier work by Disdier suggesting that protectionist

[52] Special and differential treatment is a provision in the WTO to help developing countries who may struggle to fully implement regulations and follow all the rules in a timely manner. More information can be found on the WTO website: http://www.wto.org/english/tratop_e/devel_e/dev_special_differential_provisions_e.htm

policies would likely be in HS codes where few countries have issued SPS measures (Disdier, Fontagné & Mimouni, 2008). Following the earlier paper's line of argument, one would expect "protectionist" SPS/TBT policies in HS codes with few SPS/TBT measures, but many STCs. The evidence for the patterns of trade concerns against SPS notification rates by HS 2-digit code will be considered by the author in the cross-section regressions in section 3.6.2.

(2) Crivelli & Gröschl (2012) use a Heckman selection model to estimate the impact of SPS STCs on trade in agricultural products occurring between pairs of countries. They find that SPS STCs negatively affect the probability of trade occurring between countries, but conditional on trade being present, the presence of STC measures increased the amount of trade. Particularly, they find their results are strongly influenced by conformity assessment types of STCs and that these measures form the strongest barriers to market entry (Crivelli & Gröschl, 2012). They cite that only one other author has used data from SPS STCs, but the author was combining them along with other measures on a single sector of trade and thus, excluded from this review.[53]

(3) At a more micro-scale than the study of Crivelli & Gröschl (2012), Fontagné, Orefice, Piermartini, et al. (2013) use firm-level data from French exporters to study the intensive and extensive margins of trade on 4-digit HS codes covered by SPS STCs. They find robust evidence that the presence of a trade concern on a product line reduces the probability of a firm to export by 2.2% and tentatively suggest that larger firms increase prices in destination markets or increase market share as a result. They—like Crivelli & Gröschl (2012)—do not look at what motivates a STC or how they get resolved either; the STCs are simply a key exogenous variable in their regression models.

Lastly (4), Horn, Mavroides & Wijkström (2013) look at the number of STC generated that do not proceed to formal disputes with the DSB. They conclude that the STC mechanism of the SPS and TBT Committees are effective at preventing escalation of disputes. Their work on dispute resolution is discussed further in Chapter 4.

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[53] Crivelli & Gröschl (2012) cite that Schlueter, Wieck & Heckelei (2009) study also uses SPS STC data; however, Schlueter, Wieck and Heckelei use all SPS regulatory notifications (i.e. including STC, Regular, Emergency, etc.) combined in one variable and only considering specific 4-digit HS codes in meat trade (HS02). As such, their paper does not address the use of STCs specifically nor distinguish them from other trade metrics.

3.3.2. The drivers of raising official WTO disputes on SPS issues

The most related studies to examine drivers of SPS disagreements are in the legal literature. The main thrust of the literature examines various aspects of WTO DSB disputes citing the SPS agreement. Several authors have written about the first dispute that was settled under the SPS agreement: the US-EU beef hormone dispute (Kastner & Pawsey, 2002b; Charlier & Rainelli, 2002; Bureau, Marette & Schiavina, 1998; James, 2000). The "beef hormone case"—as it is commonly referred to—was a landmark case for the SPS agreement. The complaint originated with the EU banning the use of hormones as growth promoters in cattle in 1989 (Kastner & Pawsey, 2002b). The dispute highlighted: (1) the importance of lobbying, as US beef producers successfully convinced the US government to pursue the dispute against the EU and (2) the upholding of SPS rules, as the lack of a science-based risk assessment lead to the loss of the case by the EU (Kastner & Pawsey, 2002b). Other SPS WTO disputes followed. Smith (2000) presents case studies on Mediterranean Fruit Fly, Foot and Mouth Disease, and Exotic Newcastle Disease in order to discuss the drivers of dispute in these three challenges. Smith (2000) concludes that the key drivers of dispute are (1) a lack of transparency and (2) not showing equivalence to international standards.

Overall, while several authors have recognized the importance of understanding the drivers of agricultural trade disputes, none have specifically looked at the drivers of STCs in the SPS agreement. Despite the widespread belief that NTMs like SPS measures may be motivated by protectionist factors, there has not been an empirical test to see if those factors motivated the SPS measures later subject to formal dispute by an STC.

3.4. DATA AND METHODOLOGY

STC data were downloaded from the SPS-IMS for all countries and all products where the concern was first raised from 1996 to 2010. Globally 292 SPS STCs were raised for the first time during that period; many concerns are raised multiple times over many years, but tracked by the same STC identification number until they are reported as "resolved" or "not resolved".[54] Additional data was included on those trade concerns that were re-raised in 2011

[54] There were 16 SPS STCs where the result was "partially resolved". These were excluded from the data set as some are reported as being "partially resolved", but then subsequently re-raised, while others remain throughout

and 2012 as well. Two extra years account for over 90% of the first re-raise events (for justification of this sampling methodology, see Figure 88 on page 356 in Appendix A.7). Countries that raised the concern are referred to as "raising members" and the countries they raised the STC against are referred to as "maintaining members" throughout Chapter 3 and Chapter 4.

Equivalently to the SPS data, STC data for concerns raised under the TBT Agreement were acquired from the TBT-IMS. Globally 282 TBT STCs were raised for the first time from 1996 to 2010. Additional data was included on those trade concerns that were re-raised in 2011 and 2012 as well. Unfortunately, under the TBT system the products (i.e. HS codes) upon which the STC is based are not directly coded in the system. Of the 282 STC raised, only five were coded with at least a HS-2 level product category. For the vast majority of STCs the product categories must be deciphered from the free text description of the concern or in the text of the title of the STC. Due to this limitation, the analysis on the TBT agreement was much more limited than for the SPS agreement. The summary statistics for TBT STC use are reported in section 3.5, but it is not used in the analysis of determinants of STC notifications in section 3.6.

STCs are usually reported three times per year from the SPS/TBT Secretariat when the Committee meets in Geneva. The categories of data available for each STC is given in Table 18, however, many STCs lack information in one or more categories. For simplicity of analysis, concerns are coded by the author by the year in which the meeting occurred. However, the count variable created for the number of times a concern is raised accounts for multiple raising events in a single year.

the sample period. Therefore, it is difficult to disentangle what happened in these cases without a more in-depth case-by-case analysis. With partially resolved STCs included, the number of SPS STCs was 308.

Table 18: Information recorded in the notification of a STC to the SPS/TBT Secretariat of the WTO

Used for analysis in Chapter 3 and Chapter 4	Also available
• Products covered (by 2-, 4-, or 6-digit HS codes), • Current status as "resolved", "partially resolved", or "not reported" • Date the concern is first raised • Dates it is subsequently raised • Date reported as "resolved" • Member(s) raising the complaint/concern • Member(s) maintaining the controversial SPS measure • Members supporting the STC[55] • Description of content[56]	• Subject keywords[57] • Links to relevant documents • Description of solution/resolution

Additionally, many STCs are raised as one concern, but apply to many products at the 4-digit or 6-digit HS level. For the majority, the first product reported in the STC will have the same 2-digit HS code as the other products reported in the STC. As a result, the first product's HS-2 code will be considered the "primary" HS-2 code for the concern in this chapter. The primary HS-2 code is used to merge with the SPS measure notification data (from Chapter 2) for the analysis of STC determinants discussed in section 3.6 below. The summary statistics on STC use in section 3.5 will also report the "primary" HS-2 code about which the concern is raised.

Given the lack of empirical analysis in the literature on SPS/TBT STCs, extra attention is given to summarizing the information contained within this data source. Summary information with insights into how WTO member countries have used the mechanism in SPS and TBT Committees is given in section 3.5 and accompanying summary tables in Appendices A.5, A.6, A.8, A.9, and A.10. These summary cross-tabulations report on the full STC data acquired as explained above. The preparation for analysis of determinants involved some modifications to the data, which is explained in the next section, 3.4.1.

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[55] Only used in the analysis in Chapter 3 and Chapter 4 as a binary variable called "is support?" which is 1 if there is at least one country supporting the raising member's concern and 0 if not.
[56] Used in analysis of plant health STCs only (section 4.5 in Chapter 4)
[57] Terms like "animal health", "food safety" etc. Section 4.5 analysis is on STCs with "plant health" as a keyword

3.4.1. Testing drivers of STCs from SPS notifications

From Chapter 2, each of the 8,487 SPS notifications[58] from 98 WTO members on 69 different HS 2-digit (HS-2) codes from 1996 to 2010 form the basis of the potential set of regulations that a STC can be issued against during the same time period. The SPS STCs are then observed on the same set of countries, products, and years. The main difference between the dataset constructed in Chapter 2 and the one here combined with STC data is that observations of zero SPS notifications are removed. While those observations were necessary for considering the probability of notifying an SPS regulation, the analysis here assumes a STC is raised against one of the notified SPS regulations. As a result, the variable of interest is of a previously notified SPS measure subsequently being raised as a STC. Of the 292 total SPS STCs raised, only 244 have both HS-2 code and maintaining member countries identified as required for the analysis.

The European Union presented a dilemma since members report trade concerns as a union and as individual nations. Unlike the SPS measures data in Chapter 2 though, the number of individual EU members subject to STCs were relatively few. Combined, there were only 13 STCs raised against Poland, France, Romania, Czech Republic, Hungary, and Slovakia. Except for France, all countries had complaints against them before ascending to the European Union in 2004 (2007 for Romania). In contrast, the EU as a block had 49 STCs raised against them on specific HS-2 codes in the period. As such, the STC data is merged with the EU aggregate[59] dataset of Chapter 2 where individual EU members will be excluded.

Excluding these individual EU members as well as those that lack HS-2 or maintaining country information, the final dataset for analysis has 231 STCs paired with SPS notification data and the relevant covariates from that dataset in Chapter 2.[60] The model to test then is the number of STCs expected, given the covariates, on a country-HS-year combination where at least one SPS measure was previously notified. A count data model was chosen over a logistic or probit model since observations of STCs on a given country-HS-year observation ranged up to eight

[58] Both Emergency and Regular notifications are included

[59] The method of treatment of notifications in the EU aggregate and disaggregated versions of the SPS/TBT notification data is explained on page 39 and the treatment for covariates on page 43 in Chapter 2.

[60] The covariates used in the analysis are: trade data (imports and exports) by country-HS-year, trade-weighted average bound tariff rates by country-HS-year, exchange rate index by country-year, current account status by country-year, GDP per capita by country-year, population by country-year, and finally, environmental governance score by country. The sources and preparation of these data are discussed in section 2.5 from pages 39 to 43.

STCs. Given the over-dispersion and excess zeroes, the negative binomial (NB) estimator was favoured over a Poisson model (Long & Freese, 2001).

In the data, around 5% of the unique country-HS-year observations of at least one SPS measure notification are also subject to a STC in the same year.The primary difficulty to address is the issue of time lags between the changing of an SPS policy, issuing of an SPS measure, and the subsequent raising of a STC by a third party. Since the STCs do not specify directly which SPS measure they are raising a concern against, assumptions are made and tested in two treatments of the dependent STC variable. The assumption made in the analysis is that the STC refers to either: (1) the current year's SPS notification of the maintaining member country on that HS-2 code or (2) the last previously notified SPS notification from one to several years prior to the STC. Results presented starting on page 97 for the cross-section (section 3.6.2) and page 103 for the time-series (section 3.6.3) analyse the data for either assumption. The summary statistics for the variables used in the regression models are found in Appendix A.14, page 369. Section 3.6 begins, however, with a look at the trends in STC use by category of tariff BO. The methodology of this brief analysis is discussed in the next section (3.4.2).

3.4.2. Raise count by tariff binding category

Complementing the above approach, an alternative test for protectionist bias via the tariff motive is whether the STCs that are re-raised more often are found on HS-2 codes with tighter tariff binding. Horn, Mavroides & Wijkström (2013) study argues that disputes that are re-raised many times are likely issues that are more contentious or "serious". Therefore, the re-raise count for a STC might be an indication of how difficult and unfair the raising member perceived the SPS measure to be.

The analysis presented in section 3.6.1 tests if the raise count of each STC has any relation to the tariff BO. For the maintaining member countries, the number of STCs per country-HS observation were grouped according to their quartile of tariff BO for the year they were issued.[61] Statistical tests (including two-sample T-tests and rank-sum tests) were used to test

[61] There is certainly a time lag between the tariff binding which caused an illegitimate SPS measure to be issued that was then later called into dispute by a STC, but the simplifying assumption of using current year was used. Given that the point of comparison is between STCs issued, the error should bias groups equally.

for differences in notification rates between tariff binding groups. The data set used is the same as the one described above in 3.4.1.

3.5. SUMMARY INFORMATION ON SPS/TBT TRADE CONCERNS

3.5.1. Top countries for SPS STCs

Table 19 below contains the ten countries that raised the most trade concerns from 1996 to 2010 in the SPS Committee. The full list of raising countries is in Appendix A.8 on page 357. For each member, Table 19 reports the total number of STCs that were resolved by 2012 as well as the mean number of years it took to resolve the concern and the mean number of times that the concern was re-raised before resolution.

Table 19: Top 10 countries raising STCs under the SPS Agreement from 1996 to 2010

Raising Member	Num. STC Raise	Num. STC Resolve	(mean) Years until Resolve	(mean) Num. Times Raised	% of STC with Support	(max) Num. of Supporters	(total) SPS Notification of Raising Member	(mean) SPS Notif.'s of Maintaining Members
1. United States	59	15	3.8	2.5	51%	11	538	455
2. European Union	54	27	5.6	2.3	31%	4	1,082	290
3. Argentina	28	14	3.3	2.5	39%	4	147	337
4. *certain members*	23	5	4.4	5.4	74%	13		670
5. Brazil	21	4	1.8	2.8	29%	7	408	309
6. China	18	2	3.0	6.0	33%	3	322	618
7. Canada	15	8	3.9	1.9	60%	5	184	490
8. Thailand	7	3	2.3	8.0	43%	4	202	326
9. Mexico	7	0			43%	5	213	256
10. Australia	5	0			60%	3	201	802
ALL COUNTRIES	292	94	3.8	3.0	44%	13		444

Note: Counts of the number of STC raised in column 2 do not include re-raising of concerns, they reflect unique concerns raised.

The resolution rate varies greatly by country. For example for the EU, around half of all STCs are eventually resolved, but for China the rate is only 11% (column 3 divided by column 2 of Table 19). Of the STCs that the USA has raised, 51% have had at least one other WTO member register support for the concern (column 6), but for Brazil only 29% of raised STCs have had other WTO members express support for the concern. Additionally, the time it takes to resolve the concerns ranged from 6 years on average for concerns raised by the EU to around 2 years for Brazil. For Mexico and Australia, none of their STCs have officially been resolved. The differences in resolution rates observed between raising countries are examined in Chapter 4 starting on page 109.

Some countries are both top raisers of trade concerns and have the most concerns raised against them (see Table 20). The United States and the European Union top both lists, which is likely driven both by their large trade in agriculture products and by their status as large economic markets that foreign exporters want to access. Also on both lists are Brazil, China, Mexico, and Australia. The presence of countries like Brazil and China indicate that emerging powers are both subject to pressure to make their markets non-discriminatory, while concurrently pursuing fair access to other countries' markets.

Table 20: Top 10 countries maintaining measures subject to SPS STCs first raised from 1996 to 2010

Maintain Member	Num. STC Against	Num. STC Resolve	(mean) Years until Resolve	(mean) Num. Times Raise	% of STC w/ Support	(max) Num. Member Support	(total) SPS Notif's Maintain Member	(median) Binding Overhang w/ STC	(median) Binding Overhang w/ SPS[62]
1. European Union	57	9	5.5	3.6	60%	13	1,082	1.7	1.0
2. United States	31	6	3.3	3.3	32%	5	538	1.7	0.5
3. Japan	23	4	3.5	4.0	57%	7	553	2.2	0.4
4. certain members	18	5	4.4	4.0	39%	6			
5. China	16	6	2.3	2.5	31%	3	322	-0.1	0.2
6. Australia	13	7	4.6	3.0	85%	7	201	1.2	3.4
7. Brazil	12	4	3.8	2.3	33%	5	408	21.0	21.3
8. Mexico	9	3	3.3	7.3	22%	2	213	19.5	26.1
9. Indonesia	8	2	1.5	4.0	38%	3	36	42.3	34.4
10. Korea	8	2	1.0	3.0	38%	5	209	6.8	3.9
ALL COUNTRIES	292	94	3.8	3.0	44%	13		3.0	1.0

Note: Counts of the number of STC raised in column 2 do not include re-raising of concerns, they reflect unique concerns raised.

Several countries are in the top ten for raising STCs, but much further down the list in measures raised against them. These countries include Argentina, Canada, and Thailand. A defining feature of all three of these countries is that they are all major net exporters of agricultural products. In 2011, Argentina was the second largest net exporter of agricultural products by

[62] Recall tariff binding overhang is the difference between the bound and the applied tariff, indicating a country's flexibility to raise the applied tariff without violating WTO commitments. See section 2.5.2 on page 41.

value (for the full country list of agricultural net trade see Appendix A.11 on page 361).[63] This provides some suggestive evidence that STCs are raised to improve market access against allegedly unfair policies in markets of some importance for the exporter. It also suggests that agricultural export value or net agricultural exports may be an important country-level driver of being an active raiser of STCs against other members.

There are also several countries that are not significant raisers of trade concerns, but have many raised against them (see Table 20). From the top ten, this list includes Japan, Indonesia, and Korea. Looking again at the net agricultural trade from 2011, Korea and Japan are among the top net importers of food (see again Table 72 in Appendix A.11 for data). These Asian markets represent a large target market for exporters to sell their agricultural goods. As a result, they are possibly subject to more scrutiny by other WTO members who raise STCs against them.

While the conclusions of the work of Chapter 2 were that tariffs were a driver of SPS notification and could potentially indicate a protectionist bias in SPS use, the tentative suggestion from the summary statistics in Table 20 is that tariff binding[64] does not seem to be tighter on measures subject to trade concerns as compared to general SPS measures. The median tariff BO of all HS-2 codes with any SPS notification from maintaining members in Table 20 (last column on right) is lower than the median BO of just the HS-2 codes with STCs (2nd column from right). However the conclusion here is tempered by missing data: 89 out of 292 STCs (30%) lack tariff binding data due to (1) the applied or bound tariff data being missing (54 observations) or (2) the STC not being assigned to a HS code in the SPS-IMS (35 observations).

3.5.2. Top countries for TBT STCs

While the SPS agreement had 38 countries that have raised STCs from 1996 to 2010, the TBT agreement has had only 16 countries raise at least one STC in the period. These countries are listed in order of concerns raised in Table 21. Unlike the SPS agreement, some of the top raisers of STCs have issued relatively few TBT measures of their own. For example, Canada has only

[63] Data from FAOSTAT (2014) for exports minus imports in 2011 by value on all products in the group of agricultural products as defined by FAO.
[64] Recall tariff binding overhang (BO) is the difference between the bound and the applied tariff, indicating a country's flexibility to raise the applied tariff without violating WTO commitments (review section 2.5.2).

issued 10 TBT notifications indicating new/changed Canadian TBT policies, but have questioned the validity of four other members' regulations. However, four is not many STCs to issue in a 15-year period. The result that stands out when examining the TBT STC data is that the top five complainants drive the majority of concerns. In the TBT agreement, the majority of issues are raised by several members working together to question another members' TBT regulations (*certain members* in first column of Table 21). The TBT agreement had 50% of total STCs raised by *certain members* as compared to the SPS agreement with less than 8% raised by *certain members*. The top five countries (including the *certain members* category) account for 91% of all TBT STCs raised as compared to 63% for the top 5 raisers of SPS STCs.

Table 21: Rank of countries by number of STCs raised under the TBT Agreement from 1996 to 2010

Raising Member	Num. STC Raise	(mean) Num. Times Raise w/o Resolve	(total) TBT Notifications of Raising Members	(mean) TBT Notifications of Maintaining Members
1. *certain members*	141	4.7		213
2. European Union	65	1.9	129	199
3. United States	24	2	650	185
4. China	20	1.9	505	404
5. Japan	8	1.5	376	191
6. Canada	4	1.3	10	174
7. Mexico	4	1.3	2	399
8. Switzerland	3	2.7	23	291
9. Argentina	2	1.5	2	578
10. Australia	2	1	22	650
11. India	2	1	3	390
12. Indonesia	2	1.5	41	390
13. Chile	2	2	2	83
14. Malaysia	1	1	13	129
15. Norway	1	2	2	10
16. Slovenia	1	1		
ALL COUNTRIES	282	3.3		229

Who did these 16 countries raise concerns against? The markets with potential issues in their TBT policies are more diffuse than the group that raises concerns against them. There are 40 countries that have had at least one of their TBT policies questioned by another WTO member (see the full list of countries in Appendix A.10 on page 360). Recalling from section 2.5 in Chapter 2 that only 68 countries have issued any TBT notifications in the period, then 59% of members have had at least one complaint against a TBT policy that they have changed—a higher percentage than the SPS agreement where 47 out of 98 members (48%) have had at least one STC raised against their notified SPS policies.

The top ten countries with the most STC raised against them of the 40 maintaining members are listed in Table 22. Unlike the SPS agreement, in the TBT agreement trade concerns are most often raised against individual member countries. While the 4th largest "country" maintaining suspect SPS measures in Table 20 on page 92 was *certain members*, in the TBT system there was only one STC raised against *certain members* maintaining the measure.

Another feature that stands out in Table 22 for TBT trade concerns is that many of the top markets maintaining concerns raised against them by other countries have notified relatively few TBT measures. For example, India has 15 STCs against them, but have only issued three TBT measures during the period. Similarly, Argentina has had seven complaints raised against them, but have only issued two TBT measures. This would indicate for the TBT system, many complaints are raised against WTO members' policies that have not been notified officially to the TBT-IMS. Either there is (1) a lack of notification due to misunderstanding or lack of capacity, or (2) it could indicate countries not notifying their protectionist-motivated policies.

Table 22: Top 10 countries maintaining measures subject to TBT STCs first raised from 1996 to 2010

Maintaining Member	Num. STC Against	(mean) Num. Times Raise w/o Resolve	(total) TBT Notifications of Maintain Member
1. European Union	62	4.5	129
2. China	34	2.9	505
3. United States	33	2.4	650
4. Korea	19	2.7	43
5. India	15	4.9	3
6. Brazil	14	3.5	281
7. Japan	11	2.1	376
8. Canada	9	3.3	10
9. Indonesia	9	2.7	41
10. Argentina	7	2.7	2
ALL COUNTRIES	282	3.3	

While the product-level information is not present for TBT STCs, the presence of many concerns in places with few notifications could indicate protectionist use by countries. This issue of underreporting in the TBT system hinders research on TBT notifications; TBT STCs will not be explored further in this chapter.

3.5.3. Top HS-codes for SPS STCs

The full cross-tabulation of SPS STCs by country and the HS-2 codes they were raised against is reported in Appendix A.5 for raising members and Appendix A.6 for maintaining members. Since TBT STCs lacked good coverage of HS-2 codes, they are not reported. Table 23 below presents the summary statistics of resolution rate and type of country involved in the STCs by HS-2 code.

Table 23: Total SPS STCs by HS-2 code with resolution and country information

							Raising		Maintaining	
HS Code	Num. STC Raise	Num. STC Resolve	(mean) Years until Resolve	(mean) Num. Times Raise	% STC w/ Support	(max) Num. Member Support	Num. Unique Nations	% Dev.	Num. Unique Nations	% Dev.
2	77	25	3.0	2.9	27%	8	34	61%	17	42%
8	36	14	3.5	3.2	44%	12	15	28%	19	74%
NA	36	7	5.4	3.4	58%	11	14	37%	12	31%
1	25	5	3.2	1.8	52%	4	15	63%	12	46%
7	17	6	4.2	2.7	65%	5	13	53%	9	38%
4	14	8	5.7	2.6	43%	5	9	62%	6	23%
6	12	4	2.5	2.8	58%	2	8	18%	9	55%
10	11	6	5.2	4.7	9%	5	9	55%	5	36%
5	9	1	7.0	7.0	78%	11	4	22%	4	14%
21	9	2	2.5	4.0	56%	13	4	0%	6	88%
44	9	4	6.8	1.5	56%	8	4	14%	7	38%
3	8	3	3.0	2.3	38%	6	5	25%	5	50%
23	8	5	3.0	2.0	38%	1	7	38%	5	50%
16	5	1	3.0	8.0	20%	2	4	40%	4	80%
9	5	1	1.0	2.0	80%	13	1	0%	5	100%
33	2	0			50%	3	2	50%	2	0%
17	2	0			50%	2	2	0%	2	50%
22	2	0			50%	1	2	100%	2	50%
20	1	0			0%	0	1	0%	1	0%
88	1	1	2.0	2.0	0%	0	1	100%	1	100%
30	1	0			100%	3	1	100%	1	0%
11	1	1	4.0	2.0	0%	0	1	100%	1	0%
18	1	0			0%	0	1	0%	1	100%
TOTAL	292	94	3.8	3.0	44%	13	38	47%	47	44%

Note: “% Dev.” is the percentage of the total number of STCs in that HS-2 code that are raised or maintained by developing countries.

As shown in Table 23, the HS-2 product line with the most concerns raised is HS02 (Meat) followed by HS08 (Edible Fruits and Nuts). Meat is a particularly active sector as 34 out of 38 total nations that have ever raised a STC have raised at least one on meat against one of 17 other member nations. The most active and difficult category to achieve consensus might be HS05 (Products of Animal Origin NES[65]). Only one of nine concerns have been resolved; the concern that was resolved took seven years and seven meetings where it was re-raised before resolution was reached.

Table 23 also suggests that some product categories vary in importance by the countries' development status. HS08 (Edible Fruit and Nuts) and HS06 (Live Trees and Other Plants) mainly have concerns raised by developed nations (72% of HS08 STCs, 82% of HS06 STCs) against developing country nations (74% of HS08 STCs, 55% of HS06 STCs). Further down the list, HS21 (Misc. Edible Preparations) has concerns raised only by developed countries against mostly developing countries (88% of HS21 STCs). On the other hand, HS04 (Dairy, Birds' eggs, honey), HS07 (Edible Vegetables), and HS01 (Live Animals) are all majority raised by developing countries against developed nations. While the reasons behind this are not explored in the current research, the HS code factors are controlled for in the regression models that follow in section 3.6 and in the analysis of STC resolution in Chapter 4 to make sure the results are not driven by product level heterogeneity.

3.6. DETERMINANTS OF STCS FROM SPS MEASURES

The determinants of SPS measures being subject to a STC are explored in this section. The section begins in 3.6.1 with an analysis of the data to answer two questions motivated by the literature and Chapter 2 results. The first (1) is whether STCs are re-raised more often when they concern products with tighter tariff BO. The assumption is that STCs raised once are simple issues like information requests, whereas, the STCs that are raised many times are likely serious complaints against a protectionist SPS policy that may have been put in place to compensate for lost tariff protection (Horn, Mavroides & Wijkström, 2013). The second (2) question is whether STCs are raised more often on products that have very few SPS notifications. The assumption is that SPS risks should vary more by product than country, so a

[65] NES – not elsewhere specified (i.e. animal products not included in HS1, HS2, etc.)

country using SPS measures on a product that has few notifications globally may be motivated by protectionism (Disdier, Fontagné & Mimouni, 2008).

The subsequent sections (3.6.2 and 3.6.3) examine the determinants of an SPS measure being subject to a STC. The cross-section results (section 3.6.2) test to see if at the country-level the total number of SPS measures used correlates to the number of them that are subject to STCs. The time-series (section 3.6.3) does a more thorough investigation to find a relation between the bound tariff and the likelihood of putting in place an SPS measure that will be subject to a trade concern.

It is important to emphasize that the analysis is on the probability and expected number of SPS measures being raised as a STC. As such, for example if the STC raised in 2005 is mapped to an SPS measure in 1999, it is the conditions of the covariates in 1999 that are of interest as that was the year the suspect policy was put in place. The models say nothing about why the raising member chose 2005 as the year to raise the concern for example. The question of the conditions in the raising member's country that lead to raising concerns is left for future research.

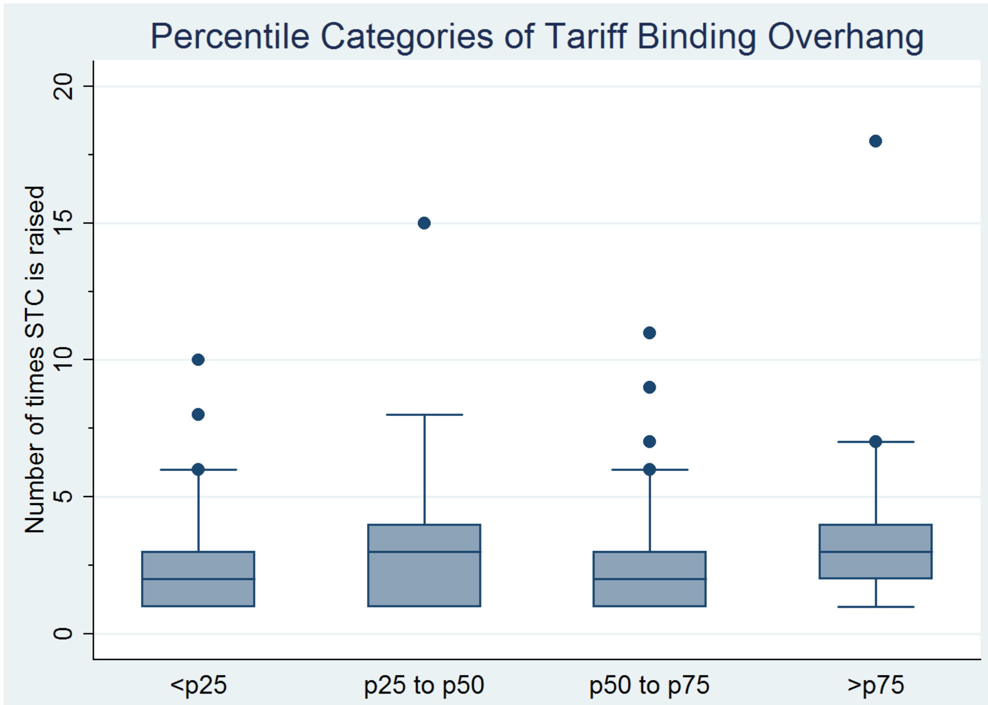
3.6.1. STC trends on SPS notifications

Horn, Mavroides & Wijkström (2013) use the number of times a STC is raised in the SPS/TBT Committee as a proxy of the "seriousness" of the concern.[66] They logically assume that concerns that are more contentious, impact more trade for the raising country, or are more legitimate complaints against a protectionist policy will receive more attention from raising members. If a SPS measure was put into place due to protectionist drivers like a tight tariff BO preventing the country from raising the applied tariff to achieve trade policy goals, one would expect that more "serious" STCs would be raised on products with a tighter tariff BO. As shown in Figure 11, there is no evidence for this prediction.

The median raise count for STCs in each category of tariff binding are very close (see Figure 11), and the means are not significantly different by a two-sample T-test. Whether the tariff BO was tight or very loose, the number of "serious" concerns raised is relatively constant. Said

[66] They arbitrarily define any concern raised over three times as "serious"

another way, the mean number of raising events for a given STC is not influenced by the tariff BO category of the HS-2 product line for the country it is raised against.



Note: Categories by percentile tariff BO on the HS-2 code of the STC maintaining member in the year of STC notification. <p25 indicates the country-HS observations with the tightest binding overhang and least ability to raise the applied tariff rate. The BO rates were: p25=0.31%, p50=3.13%, p75=21.25%.

Figure 11: Median number of times a STC is raised by percentile tariff BO

Disdier, Fontagné & Mimouni (2008) suggest that HS codes with few SPS notifications may signal that the SPS measure was motivated by protectionism and not a legitimate risk. Comparing the percentage of SPS measures in each HS that were later raised as STCs, there is very little evidence that this is occurring for the sample of maintaining countries used in this section.[67] The number of STCs and SPS notifications by HS-2 code are presented in Table 24. The HS-2 codes are ranked by the percentage constructed from the total number of STCs divided by total number of SPS measures notified on that HS code globally.

[67] As explained in part of the methodology section (3.4.1), STCs from EU individual members are excluded as well as STCs raised against “certain members” without a defined maintaining WTO member. As a result, the total number of STCs in Table 24 will be lower for some HS codes than those given in the summary in section 3.5.3 which included the full sample of countries.

Table 24: Top ten HS-2 by percentage of SPS measures that become STCs for period 1996 to 2010

Rank	HS-2 Code	Total SPS Notif's	Total STCs	% of SPS Raised as STC
1	88	3	1	33.3%
2	21	82	9	11.0%
3	33	19	2	10.5%
4	17	29	2	6.9%
5	08	542	34	6.3%
6	44	136	7	5.1%
7	02	1411	65	4.6%
8	07	365	15	4.1%
9	10	262	10	3.8%
10	06	297	11	3.7%

While there are certainly some HS-2 codes with few SPS notifications that had a high percentage raised as STCs (e.g. HS88 or HS17), the majority of STCs are in HS codes with many SPS notifications (see Table 24 above). The full table in the Appendix (A.12, page 366) reveals that there are many HS codes with sparse SPS notifications that were subject to no STCs. The lack of correlation between total number of SPS measures raised and number of STCs on country-HS observations is confirmed in the cross-section model that follows (section 3.6.2).

3.6.2. Cross-section results

The results below are in a cross section set-up with the total number of STCs as the dependent variable and the independent variables are the means by country-HS observation (i.e. collapsing the data over the years observed, 1996 to 2010). The first version of the model presents the results assuming the STC is due to the notified SPS measure in the same year (columns (1) and (2) in Table 25 below). The second set of models assume that the STC pertains to the last previously notified SPS measure (columns (3) and (4) in Table 25 below).

The results of Table 25 below show that lower bound tariffs on HS 2-digit level products from maintaining member countries were not correlated with more STCs being raising against them. This was true whether the STC was assumed to be raised against the same SPS regulation notified that year (columns 1 and 2) or the last previously raised SPS notification in that HS-2 code (columns 3 and 4). The only significant predictor of SPS measures having STCs raised against them were the GDP of the maintaining member country.

Larger economy countries were predicted to have higher numbers of STCs raised against their SPS measures. This provides some confirmation to the suggestion from Bown (2004c) that wealthier (i.e. more powerful) countries will be more likely to implement policies that are outside the legal bounds of a trade agreement. However, a major caveat is that it is impossible to know from this data if the STC was a worthy complaint (i.e. the SPS measure was indeed protectionist). In fact, the lack of correlation with the bound tariff suggests that protectionism—in terms of compensating for lost tariff protection—is not a driver. As STCs are raised about market access restrictions that the raising member deems unfair, it is not surprising that raising countries would petition for access to larger markets.

Table 25: Cross-sectional correlates of total STCs by maintaining country and HS-2 using NB estimator

	STC (Present Year SPS)		STC (Last Notified SPS)	
	(1)	(2)	(3)	(4)
BND Tariff (wgt. av.)	0.00206	0.00124	0.00133	0.000299
	(0.00254)	(0.00257)	(0.00312)	(0.00318)
Log Imports	0.0738	0.107	0.0911	0.116
	(0.0657)	(0.0672)	(0.0758)	(0.0782)
Log Exports	-0.0470	-0.0556	-0.0168	-0.0235
	(0.0401)	(0.0395)	(0.0477)	(0.0475)
Log GDP	0.596**	0.570**	0.608**	0.571**
	(0.0798)	(0.0803)	(0.0917)	(0.0927)
Total SPS	-0.00216	-0.00249	-0.00158	-0.00219
	(0.00305)	(0.00299)	(0.00333)	(0.00329)
Enviro. Governance		-0.116		0.0141
		(0.169)		(0.195)
$\ln(\alpha)$[68]	-1.230*	-1.344*	-1.104*	-1.178*
Observations	868	834	868	834

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. HS-2 code dummies included. Standard errors in brackets.

One check of the result with maintaining member's GDP is to restrict the sample to just STCs that are suggested by Horn, Mavroides & Wijkström (2013) to be "serious" concerns. Eliminating STCs that are raised just once or twice should remove many of the STCs that are not legitimate complaints against an unfair SPS policy. The model is re-estimated on a

[68] The value of α confirmed significant over-dispersion in the data (i.e. $\alpha \neq 0$), hence the choice of the NB estimator over Poisson.

restricted sample for the expected number of STCs, assuming the STCs in that country-HS observation are raised more than two times. The results from the restricted sample regression are in Table 26.

Table 26: Cross-sectional correlates of total STCs (raised more than two times) by maintaining country and HS-2 using NB estimator

	STC (Present Year SPS)		STC (Last Notified SPS)	
	(1)	(2)	(3)	(4)
BND Tariff (wgt. av.)	0.00352	0.00231	0.00131	-0.000128
	(0.00354)	(0.00356)	(0.00402)	(0.00412)
Log Imports	0.0491	0.0855	0.107	0.145
	(0.104)	(0.106)	(0.112)	(0.115)
Log Exports	-0.0952	-0.107	-0.0904	-0.101
	(0.0658)	(0.0650)	(0.0730)	(0.0726)
Log GDP	0.778**	0.735**	0.772**	0.729**
	(0.130)	(0.129)	(0.142)	(0.143)
Total SPS	0.000343	-0.000790	0.000674	-0.000619
	(0.00627)	(0.00617)	(0.00657)	(0.00647)
Enviro. Governance		0.0331		0.0250
		(0.304)		(0.340)
ln(α)[69]	0.162	0.0922	0.0888	0.0303
Observations	807	773	807	773

Note: * p < 0.05, ** p < 0.01
Coefficients reported. HS-2 code dummies included, but not reported. Standard errors in brackets.

The estimated from Table 26 are very similar to the results of the full sample which included STCs raised two or fewer times as well (Table 25). The coefficient on $Log\ GDP$ is higher in Table 26 suggesting again that wealthier countries have more STCs raised against their SPS measures, which is not driven by either the product categories (HS-2 codes) they tend to trade in, nor the total number of SPS measures ($Total\ SPS$) in the country-product observation. Future research accounting for the validity of the complaint and better identification to match the STC to the specific SPS measure it is against would be needed to come to a robust conclusion. The preliminary suggestion from the estimations is that larger economies are subject to more concerns raised against them, likely motivated by raising members wanting

[69] The value of α could not confirm over-dispersion in the data (i.e. $\alpha \neq 0$). Thus, the results were checked using a Poisson regression, which reported the same sign and significance for all covariates (results not shown).

enhanced market access and not because the maintaining member is more protectionist due to its power, since the result on $BND\ tariff\ (wgt.av.)$ is not significant.

There was a non-significant, negative correlation between the total SPS raised in an HS code and the number that are subject to STCs. The lack of a significant positive relationship indicates that STCs are not raised uniformly against SPS measures, since a greater number of SPS measures on the country-HS observation does not lead to a greater number of STCs against them. Nor is there statistically significant evidence of negative correlation, which would have led confirmation to the suggestion in the study of Disdier, Fontagné & Mimouni (2008) that posits that HS codes with few SPS notifications may mean that the country raising the measure was motivated by protectionism and not a legitimate risk—hence expected to be subject to a STC, However, it is possible that countries have different HS codes in which they are more likely than other countries to use protectionist policies. If many countries had a unique HS code that they used for illegitimate policies, most of the identifying variation may be absorbed by the HS-2 code dummies in the models in Table 25. Models that do not control for HS-level heterogeneity found a positive correlation: higher (lower) numbers of STCs are expected against HS-2 codes with globally more (fewer) SPS notifications—opposite the suggestion of Disdier, Fontagné & Mimouni (2008).[70] All evidence suggests that STCs are not more likely to occur on products with relatively few SPS measures notified on them, so there is little support for the hypothesis that protectionist SPS measures may occur more often on less-notified HS codes.

3.6.3. Time-series results

Next, a time-series framework based on the modelling conducted in section 2.9 for SPS measures in Chapter 2 is used for those SPS measures that become STCs. Again, the models are run with two versions (i.e. present year SPS and last notified SPS) of the dependent STC count variable on the country-HS-year observations due to the lack of identification as to what SPS measure the STC applies to in the data.

[70] Results in Appendix A.13, page 358

Table 27: First differences models using logit and Poisson for STCs raised on SPS measures maintained by country, year, and HS-2

	STC (Present Year SPS)		STC (Last Notified SPS)	
	(1) STC>1	(2) STC	(3) STC>1	(4) STC
	Cond. Logit	F.E. Poisson	Cond. Logit	F.E. Poisson
L.D. BND Tariff (wgt. av.)	0.0292	0.0156	0.133*	0.0817
	(0.0343)	(0.0871)	(0.0517)	(0.0694)
L2.D. Log Imports	-1.212	-0.629	2.719**	2.071
	(0.926)	(1.913)	(0.944)	(1.521)
L2.D. Log Exports	0.519	-0.353	-0.344	-0.172
	(0.373)	(1.162)	(0.203)	(0.427)
D. Log Exchange Rate	-4.712	-10.18*	-8.571**	-3.125
	(2.640)	(4.505)	(3.314)	(3.124)
D. Current Account (+)	-0.343	-0.602	-1.602	-1.430
	(0.828)	(1.528)	(1.545)	(1.154)
Observations	269	154	219	174

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Columns (1) and (3) conditional logit model of probability of at least one notification. Columns (2) and (4) 'fixed effect' Poisson model of number of notifications conditional on there being at least 1. Conditioning group or 'fixed effect' units in both columns are the Country-HS. Year dummies also included but not reported. Changes of GDPPC and population are included for all columns, but not reported. Cluster robust standard errors in brackets for columns (1) and (3); standard errors in brackets for columns (2) and (4). The same model is used as that previously for Table 13 on page 72 in section 2.10.1.

Table 27 presents the results from a conditional logit model and fixed effect Poisson model. Conditioning on country-HS to examine observations with identifying variation over time, the probability of a STC being raised on the given SPS measure is shown to have no statistically significant relationship to declining bound tariffs. If anything, the model with the assumption that the STC is raised about the previous SPS notification (column (3)) finds a weakly significant relation that declining bound tariffs within a country-HS group *decrease* not increase the probability of that SPS measure being raised as a STC.

The same model (Table 27) also finds evidence in some specifications (e.g. column (3)) that SPS measures issued with increasing imports and depreciating currency are also more likely to be raised as a STC. This result is worthy of future investigation, however, first there needs to be clear identification between the STC and the specific SPS measure under dispute before further detailed econometric analysis. More insight may be gained from looking at specific STCs and a country's reason for raising the concern; this is conducted for concerns related to plant health in section 4.5 of Chapter 4.

As one check of the validity of the assumption on when the STC is raised in the past, a model using the next, future SPS measure as the object of the STC is used (see results in Table 28). Since it is impossible that a STC would be raised *before* an SPS measure has notified a new policy or change, the model results should be completely insignificant. There is little reason to expect any relationship between a STC and the covariates on future SPS measures, except for the trade variables. One would expect that the STC could cause a decrease in trade in the following years. Certainly, future years' GDP, population, and the bound tariff should be exogenous to the STC raised in the past.

Table 28: Specification check of first difference model using logit and Poisson for STCs on *future* SPS regulations by country, year, and HS-2

	STC (Next notified SPS)	
	(1) STC>1	(2) STC
	Cond. Logit	F.E. Poisson
L.D. BND Tariff (wgt. av.)	-0.0167	-0.0173
	(0.0117)	(0.0227)
L2.D. Log Imports	-1.889	-1.761
	(1.066)	(1.518)
L2.D. Log Exports	-0.360	-0.319
	(0.255)	(0.361)
D. Log Exchange Rate	2.789	0.695
	(2.729)	(3.511)
D. Positive Current Account	0.633	1.202
	(1.180)	(1.739)
Observations	238	180

Note: * $p < 0.05$, ** $p < 0.01$
Coefficients reported. Column (1) conditional logit model of probability of at least one notification. Column (2) 'fixed effect' Poisson model of number of notifications conditional on there being at least 1. Conditioning group or 'fixed effect' units in both columns are the Country-HS. Year dummies also included but not reported. Changes of GDPPC and population are included for all columns, but not reported. Cluster robust standard errors in brackets for column (1); standard errors in brackets for column (2).

As expected, in Table 28 the future bound tariffs had no relation to the issuing of a STC. The sign is also in the opposite direction as the plausible models in Table 27. While the result is not statistically significant, both exports and imports seem to be lower as predicted by reverse causality. The assumptions made on the dependent variable in the previous regressions did not appear to be obviously flawed based on these results (i.e. there were not spurious correlations using covariates on future notified SPS measures after a STC).

The results from both the cross-section and the time-series indicate that the decline of the bound tariff does not result in compensating protectionist use of unfair SPS measures (as measured by measures that are later subject to a STC). In context with the results of Chapter 2 that SPS measures are more likely to be issued on products that have experienced bound tariff declines, how can this be interpreted? It is likely that SPS policy makers in countries need to prioritize their work on new SPS policies. This may be influenced by which products are more important to the domestic sector, and domestic agricultural industries may push for products that are under more competition from loss of tariff protection. However, the results on STCs seem to indicate that this bias in prioritization of work does not result in a bias towards issuing unfair SPS policies. While all SPS measures seem to be driven to some extent by a tighter binding tariff, that same tariff variable does not drive the issuing of protectionist SPS policies (as deemed by other members raising STCs against them).

3.7. DISCUSSION AND CONCLUSIONS

Fair open markets with reliable regulatory policies on agri-food trade is an important part of securing food security for the 21st century and key to enabling developing countries to benefit from their agriculture-focused economies in the global market. SPS policies help secure borders from unnecessary risks, but often countries dispute over the legitimacy of some regulatory policies and the science used to justify them. This chapter explored a few of the myriad of issues that arise from SPS regulations and some of the ongoing debates about what motivates disputes from the academic literature by analysing STC data from the WTO.

From section 3.5, the summary statistics of the data revealed that the United States and the European Union both are among the largest raisers of STCs as well as among the top countries that have SPS policies called into question. One key feature that emerged was the importance of the agriculture sector to the trade of the country in differentiating raising and maintaining members. While larger economies like the US and EU were at the top of both raising and maintaining STCS, the key feature that made countries raise more relative to the number they maintained was their net agricultural export. Major net agricultural exporters like Thailand and Argentina raised many more STCs than were raised against them. Alternatively, major net importers of agriculture products like Japan and Korea had many more STCs raised against them than they raised against others. This provides some suggestive evidence that STCs are raised to improve market access against unfair policies in large markets.

The main question analysed in this chapter was what the drivers are of an SPS measure being subject to a STC. There was little evidence that STCs are motivated by a declining bound tariff. Section 3.6.1 showed that the number of times a STC is re-raised (a reflection of its seriousness) is not significantly different across all quartile groups of tariff BO. Additionally, SPS measures that are raised on obscure HS-2 level codes are not more likely to be raised as a STC—indicating that using that metric as a proxy of protectionist use is likely poor. The cross-section (3.6.2) and time-series (3.6.3) results also strongly indicated that tariff binding does not influence the likelihood of an SPS measure being subject to a STC. The main drivers of SPS measures being subject to STCs seem to come at the country-level. Countries with larger markets (as measured by GDP) are more likely to have their SPS measures later petitioned by a STC—even when controlling for HS-2 code heterogeneity and total SPS measures raised.

The results of Chapter 2 found that SPS measures are more likely on products that have experienced declining tariffs. The present results of Chapter 3 suggest declining tariffs do not make the SPS measure more likely to have a STC raised against it. The combination of these results may indicate that SPS bodies within countries may be influenced to apply SPS measures on products that are more sensitive or experience more lobbying, but the measures applied are in full compliance with the risk-based requirements of legitimate SPS policies. Certainly, disputes occur and faulty protectionist policies are called into question with STCs, but there does not seem to be a systematic bias in their use as a compensatory mechanism to liberalisation.

There were several limitations and assumptions in the analysis. For one, there could be a selection bias in the concerns that are raised as STCs. Countries often discuss issues outside formal mechanisms and attempt to achieve clarification or understanding on a given regulation. The extent of these back channel communications is unknown, but thought to happen quite often among country representatives at SPS Committee meetings in Geneva.[71] When these back door communications fail—or are not used—the formal dispute process begins with the raising

[71] Personal communication with Gretchen Stanton, Secretary, SPS Secretariat in Geneva Dec 20, 2012.

of a STC. There could be a selection bias in the issuing of a STC as a result, however, analysis of this bias is not conducted due to the difficulty of finding good instruments (i.e. exclusion restrictions) for the selection equation that are not in the outcome estimation. In such cases, correcting for the bias may produce more inaccurate estimates than the original selection bias (Brandt & Schneider, 2007).

Another assumption in this analysis presented in the cross-section (3.6.2) and time-series (3.6.3) is that STCs always refer to previously notified SPS measures. This may be a weak assumption given the analysis just of plant health STCs in section 4.5 following in Chapter 4. That analysis reveals that STCs are also raised for clarification of information and are not just raised in order to question the scientific validity of the new/changed regulatory measure. Short of individually analysing the contents of all STCs with full data, the simplifying assumption that the majority are raised against previously issued SPS measure had to be used.

Chapter 4. STC Resolution and Plant Health Cases

In addition to signalling which SPS measures are potentially protectionist, STCs may also highlight which aspects of the obligations included in the SPS and TBT agreements tend to generate the most disagreement between member nations. Analysing the issues that have arisen in implementation can help design better mechanisms to prevent future disputes. The SPS and TBT agreement have obligations both for the evidence used to justify the policy measure as well as obligations to undertake measures in the way that is least restrictive to trade. Disputes arise when countries fail to meet these obligations in the opinion of a trading partner.

Whether a SPS measure meets these economic obligations (e.g. implementing least trade-restrictive policies) and/or scientific obligations (e.g. evidence of legitimate risk assessment) are often called into question by STCs. These different reasons for raising trade concerns may result in the different rates of resolution. As highlighted in the summary tables in section 3.5 of Chapter 3, countries have very different rates of resolution for concerns they raise. Resolution of trade disputes under the GATT and WTO is the subject a substantial amount of academic research (see literature review, section 4.2). However, the drivers of resolution of STCs under the SPS agreement has not been analysed to date in the literature. The research questions guiding the chapter and order of presentation are reviewed in the next section (4.1).

4.1. RESEARCH AIMS

The main purpose of this chapter is to examine the drivers of resolution of STCs under the SPS agreement. For SPS STCs the first research question and related sub-questions are:

1) What factors predict SPS STC resolution?
    a. How do developing countries fair in dispute resolution?
    b. Are democratic countries more likely to resolve STCs before they proceed to official WTO dispute?[72]

[72] This is an implication of the results of the studies of Busch (2000) and Busch & Reinhardt (2006), which is discussed further in the literature review (section 4.2)

The next set of work in the chapter attempts to classify STCs according to the type of complaint the raising member alleges against the maintaining member's regulations. This methodology was piloted on a subset of STCs from the main sample that related to "plant health".[73] Future research could apply the methodology discussed to all STCs for a more robust investigation of the dynamics of the STC system. Two additional questions are analysed for plant health concerns:

1) Does the reason for raising the STC affect the probability of resolution?
2) Does the value of trade on the HS code under concern for both raising and maintaining members of the STC affect the probability of resolution?

Resolution of a STC is reported in the SPS-IMS database for each STC.[74] Diagrammatically the possible outcomes after raising a STC are shown in Figure 12. The SPS STC resolution rates by country (section 3.5.1, page 91) and by HS[75] code (section 3.5.3, page 96) from 1996 to 2010 were reported previously as part of the summary work in Chapter 3.

The chapter is organized as follows. Section 4.4.1 examines the trends in one country against one country disputes (also called "dyadic disputes" in the literature) and multiple party disputes (i.e. "non-dyadic" disputes) using STCs. A few of the most significant multiple party disputes are discussed. Section 4.4.2 examines just dyadic STCs, where one member raises the STC against one other member's SPS policies. The drivers of resolution from country-level factors suggested by the WTO dispute literature are examined to understand how they differ for SPS STCs. Section 4.5 contains work on STCs related to plant health. Section 4.5.1 shows the breakdown in the use of different complaint reasons for plant health STCs. Section 4.5.2 analyses whether these reasons for raising a STC have an impact on the probability of complaint resolution. Finally, section 4.5.3 briefly examines the impact of bilateral trade on dispute resolution between two countries. Section 4.6 concludes.

[73] See data section (4.3.2) for sampling methodology

[74] For reasons unknown to the author, the resolution statuses of TBT STCs are not reported in the TBT-IMS. As such, the resolution rates and analysis can only be conducted on SPS STCs.

[75] Harmonized System (HS) see previous footnote (number 18) explaining the HS system on page 38.

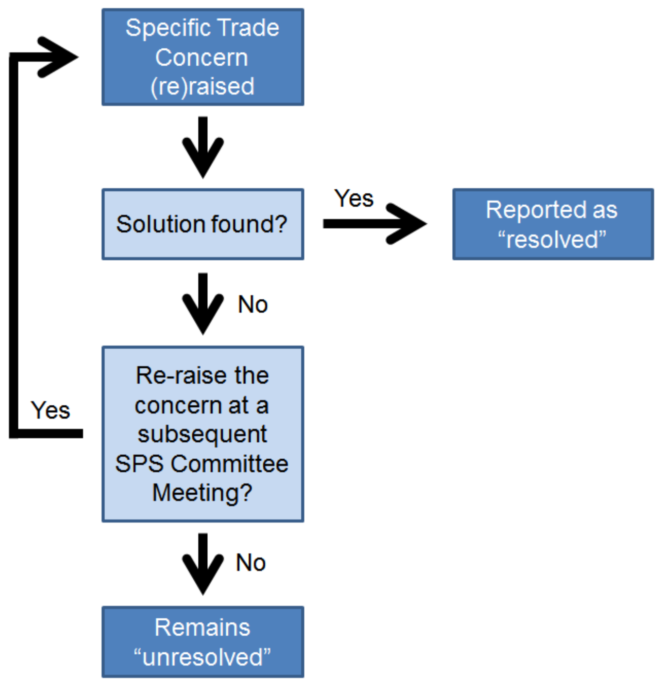


Figure 12: Flow chart for outcomes of raising a trade concern in the SPS Committee (author's own).

Early drafts of the work on notification rates and resolution rates for plant health related STCs (section 4.5) was presented by the author as an invited panellist to a special session at the American Phytopathological Society (APS) Annual Meeting in August 2012.[76] Early results on resolution rates of all SPS STCs (section 4.4.2) were also presented and discussed with WTO staff members of the SPS Secretariat at an informal meeting organized by the author in December 2012.

4.2. LITERATURE REVIEW

Busch (2000) uses a rare-events logit model to study the effect of democracy on GATT dispute outcomes that could go to an official panel, but often end in consultations instead. Two democratic countries with a dispute (termed a democratic "dyad") may prefer to empanel as the legal proceedings appeal to them, but this escalation also raises the costs of the conflict outcome, which highly democratic countries would not prefer. Busch (2000) results show that

[76] Pearson, L. "From Boom to Busted: Trade Concerns under the WTO's SPS Agreement" Special Session 'Right of the Boom: Deciding to Act, React, or Let Go in a Fluid Data Environment' American Phytopathological Society (APS) annual meeting, Providence, Rhode Island, 8th August, 2012.

highly democratic countries are more likely to settle at the consultation phase, but not if it goes to a panel. Busch (2000) suggests high audience costs prevent democratic countries from making concessions in a panel so defendants are less likely to resolve. Audience costs are further examined in Busch & Reinhardt (2006) for WTO disputes, finding similarly that when more countries officially join the dispute in support of either side, it makes the dispute less likely to resolve early and more likely to proceed to a final WTO DSB ruling.

Bown (2004c)—in a seminal work published in the *Journal of International Economics*—investigates the drivers of illegal use of the safeguards provision[77] of the GATT from 1973 to 1994. Bown asks why there are disputes at all under GATT rules, and whether there are economic drivers that motivate governments to make trade policy adjustments counter to their international agreements. The study finds evidence of governments implementing policies to better their nation's terms of trade, which may lead to a trade dispute. The results suggest that the ability of a trade partner to retaliate determines whether that country pursues a legal or illegal safeguard measure. The power dynamic between a developing and developed country—and similarly, that between a large and small economy—in a bilateral trade relationship is potentially fraught with unfair policies put in place by the more powerful partner. The empirical results of Bown (2004c) show that the more powerful trading partner is more likely to pursue aggressive trade policies outside of the confines of international agreements when they know that their partner is unlikely (or unable) to retaliate. In related work, Bown & Hoekman (2005) show that developing countries are mostly excluded from the DSB official settlement process despite legal aid being offered to their representatives. Bown (2004b) as well confirms that power dynamics have a significant effect on economic resolution to WTO and GATT disputes.

Contrary to Bown (2004c), others like Horn, Mavroidis & Nordström (1999) argue that the findings on country power are more due to the value and diversity of trade that developed countries engage in and their legal capacities for disputes, rather than pure power considerations. Similarly, Davis & Bermeo (2009) contend that developing countries face start-up costs to legal capacity and experience with WTO dispute initiation, and once these are initial capacity constraints are overcome, developing countries use the system well. Contrary to these legal capacity arguments, for WTO DSB dispute initiation Götz, Heckelei & Rudloff (2010)

[77] A similar agreement allowing for legitimate reasons to protect the market like the contemporary mechanisms in the WTO available from SPS and TBT measures.

study finds no significance for measures of legal capacity, export diversity, or importance of the export sector in likelihood of initiating an official dispute in the agri-food sector. Instead, the only significant predictors of dispute initiation were aggregate measures of market protection from the maintaining member and raising member. Götz, Heckelei & Rudloff (2010) study found raising countries that were more liberalized and maintaining countries that were more protectionist were more likely to be involved in disputes. There is no conclusive answer to the differential initiation of disputes and resolution outcomes by country development status. A full legal review of the WTO disputes from 1996 to 2006 can be found in Petersmann (2006) and with a focus on the lack of dispute mechanism use by African countries in Alavi (2007).

Lastly, Horn, Mavroides & Wijkström (2013) look at the number of STC generated that do not proceed to formal disputes with the DSB. They argue that the body provides a way to diffuse trade tensions before they become intractable trade disputes. They differentiate between "trivial" and "serious" concerns by the number of times the STC is raised. Those that are raised at only one meeting are "trivial" and those that are raised at over three meetings are "serious". As such, they argue that many concerns in the SPS system that are left unresolved, may just be "trivial" concerns that were not worth bringing up in a subsequent meeting. In their analysis, they only use one ordinary least squares (OLS) regression model; the model showed that the number of meetings a concern is discussed at (their proxy of seriousness) is influenced by the number of other countries supporting the concern as well as the number of countries the concern is raised against. The majority of their argument is a qualitative one about the usefulness of the system for resolving disputes without a formal dispute proceeding—though they concede less than half of their "serious" SPS STCs are reported as resolved (Horn, Mavroides & Wijkström, 2013).

The following analysis presented in this chapter—that was mostly conducted in 2012 before Horn, Mavroides & Wijkström (2013) —improves upon their work in a number of ways. Firstly, more details on the time to resolution by country and the drivers of resolution are examined. The regression models incorporate country level factors (e.g. GDP, Environmental Governance metrics, etc.) into the analysis of outcomes for developing countries. Finally, disaggregated analysis on the actual content of the STC is conducted for plant health related concerns.

4.3. DATA AND METHODOLOGY

As before for Chapter 3, STC data were downloaded from the SPS-IMS and TBT-IMS for all countries and all products with concerns that were first raised from 1996 to 2010. Complete details of the process are found in section 3.4 (page 86) of Chapter 3. TBT STCs are used in this chapter only to compare to SPS STCs on the percentage of disputes that are dyadic (section 4.4.1).[78] Modifications to the data were made for the analysis of resolution rates for SPS STCs (see explanation in next section, 4.3.1) and for the subset of SPS STCs related to plant health concerns (see explanation in section 4.3.2).

4.3.1. Dyadic disputes and resolution

The majority[79] of SPS STCs involve one country raising an issue against another WTO member's SPS policy. It is also possible for multiple countries to raise a concern or for one raising country to raise a STC, but name multiple maintaining countries that have questionable SPS regulations. The analysis on resolution rates is primarily concerned with disputes occurring between just two nations—also referred to in this chapter as a "dispute dyad" or "dyadic dispute" to match the common terms used in the conflict studies literature (Sattler & Bernauer, 2010; Busch, 2000; Guzman & Simmons, 2005).

Non-dyadic disputes are sometimes ambiguously recorded in the SPS-IMS database as being raised or concerning "certain members". It is difficult to analyse disputes when the country it concerns is ambiguous (i.e. *certain members*). As a result, the cases of multiple countries either raising a concern or maintaining a measure are considered briefly (see section 4.4.1 on non-dyadic disputes) and are then excluded from the main analysis on the resolution rates of dyadic disputes (section 4.4.2). Of the 292 SPS STCs raised for the first time from 1996 to 2010: 21 were raised by *certain members*, 16 were maintained by *certain members*, and 2 had *certain members* on both sides of the dispute. After excluding these non-dyadic STCs, there were 253 dyadic SPS STCs for analysis.[80]

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[78] TBT STCs lacked resolution status data in the entries in the TBT-IMS.
[79] See section 4.4.1, page 125, for breakdown summary of STCs into dyadic and non-dyadic dispute types
[80] The main differences between the data samples in Chapter 3 and Chapter 4 is that the resolution analysis of this chapter includes individual EU members and STCs that lack HS-2 information, while the determinants sample used in Chapter 3 includes STCs raised by "certain members".

Models are estimated for the probability of resolution using a logistic regression model (results are discussed in section 4.4.2). The dependent variable of interest is $Resolved$ which is a binary variable that is 1 if the STC has been resolved at some point up until 2012 or 0 otherwise. The STC data are combined with a variety of covariates from country and country-product level sources (discussed below).

From the literature review, the expectation is that a country's GDP and development status will have an impact on their ability both to raise and to resolve a dispute. The implication from the results of Bown (2004c) study is that raising members that are much poorer than maintaining member countries will be less likely to achieve a resolution to the dispute. GDP data is acquired by country and year in constant year 2000 US dollars from the World Development Indicators (WDI) of World Bank (2010). Status as a developed nation is also from the same source.

The results of Busch (2000) for GATT disputes would suggest that more democratic countries should be more likely to resolve STCs so as to prevent the movement of the trade concern to an official WTO DSB dispute. Democratic data comes from the polity2 measure of democracy from the Polity IV project (Marshall & Gurr, 2011). The joint-democracy score is created by summing the polity2 scores of both raising and maintaining members of the STC; higher numbers express more fully democratic countries involved in the dispute dyad.

The review of the qualitative factors affecting resolution of historic food safety disputes covered by Kastner & Powell (2002) suggests there are three factors: (1) domestic economic considerations, (2) public perception of risk, and (3) government's willingness to cooperate on regulatory matters with other countries. There are not clear variables to measure the last two qualitative factors, but there are proxies. Regulatory quality score differences and democracy score differences between disputing countries may proxy Kastner & Powell's 3rd factor. Assuming the public can engage in setting of other environmental policies, the environmental governance scores of nations may proxy Kastner & Powell's 2nd factor. These factors may help shed light on how STC resolution fits into the context of resolution of historic food safety disputes. Environmental Governance data by country is acquired from the ESI database of Esty, Levy, Srebotnjak, et al. (2005). Country level regulatory quality indicators come from the WGI of World Bank (2010). Democracy scores come from the Polity IV project (Marshall & Gurr, 2011). All variables are from the same data sources used in Chapter 2.

Summary statistics for all variables used in the analysis of section 4.4.2 are in Table 77 of Appendix A.14 on page 370.

4.3.2. Examination of plant health concerns

Analysis on the content of the STC (i.e. the text description of why it was raised) and the amount of trade covered between disputing parties was conducted just for STCs that had "plant health" as a keyword of the STC.[81] Data from the SPS-IMS were compiled from all members that initially raised a concern from 1996 to 2010. In total, members initiated 79 new STCs in the period related to plant health.

Deciphering the text content of the STC description for analysis is difficult to standardize. Partially this is due to the heterogeneity in usage of the text box and difference in severity of the complaint. At the lower end of text word count was 33 words for STC #105 raised for the first time in 2001 by Argentina against Cuba questioning restrictions on apples and pears.[82] At the upper end with over 2,700 words, STC #277 was raised by China in 2008 against NAPPO[83] members (Canada, USA, and Mexico) for standards on cargoes from areas infested with Asian gypsy moth (*Lymantria dispar asiatica*). Many STCs were around 1,000 words with multiple additions to the text to summarize the positions expressed by both parties during subsequent re-raise events and SPS Committee meetings. Some members would cite the specific section of the SPS agreement that the proposed violation had occurred in, while most would explain the violation in words. The method used by the author to document the reasoning for the complaint was to mark concerns according to five categories of complaint type, which collectively covered the various reasons for all STCs in the sample. Table 29 shows these five categories and an STC excerpt in each.

In cases where multiple reasons were given by the WTO member for raising the STC, each reason for the concern was recorded for the STC. An example was STC #316 raised by Costa

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[81] Review Table 18 on page 89 for what information is available in the SPS-IMS system for each STC

[82] All future STCs discussed will be referred to by the STC number. Full details of each STC can be found using the WTO SPS search facility using the "number of the specific trade concern" in the first search box at: http://spsims.wto.org/web/pages/search/stc/Search.aspx

[83] NAPPO is one of the Regional Plant Protection Organizations (RPPOs) further defined below on page 122

Rica against the USA in 2011 that was both a request for pest-free recognition and arguing the SPS measure applied by the maintaining member was disproportionately trade restrictive:

> Costa Rica stated that Costa Rica *was free from Chrysanthemum White Rust* and had requested the United States to reduce post-entry quarantine to two months. However, the United States continued to request a post-entry quarantine of six months. On 27 April 2010, APHIS had provided a post-entry permit restricting chrysanthemums from Costa Rica to 2000 cuttings, *this was a disproportionate measure...*" [emphasis added] (STC #316).

In summary, 55 of the 79 disputes (70%) were categorized as being raised for only one of the five reasons in Table 29. Of the other 24 measures with multiple reasons for raising, 21 (26%) were raised for two reasons and 3 (4%) were raised with three of the five reasons from Table 29 mentioned. The most common grouping of two reasons given together were members both (1) disputing the scientific evidence or Pest Risk Assessment (PRA) used to justify the concern while also arguing (2) it was disproportionately trade restrictive compared to alternative ways of meeting the risk mitigation objective of the maintaining member.

Table 29: General reasons for raising plant health SPS STCs and examples

Reason Type	Reason of Complaint	Example from STC in sample
Science	Pest-free area recognition	"… expressed concerns regarding Indonesia's Decree 37 implemented in March 2006, which established new phytosanitary requirements on fruit imports that failed to recognize fruit fly free areas in the United States." (STC #243)
Science	Disputed PRA or scientific evidence	"…asked Japan to explain the scientific rationale behind its measure, and the risk assessment it was based on" (STC #56)
Economic	Regulatory time delay	"The undue delays and changes in the procedures undertaken by Australia were a concern to Chile." (STC #194)
Economic	Disproportionately trade restrictive	"Canada urged India to use the least trade-restrictive measures as stipulated in the SPS Agreement." (STC #186)
Information	More information requested	"Australia was a major grain exporter and was especially interested in the documents which should accompany shipments." (STC #174)

There were six STCs raised by two members together that were named in the data. Unlike the previous analysis of Chapter 3 where multiple raising members were grouped with the *certain members* category, these six STCs were treated as separate observations for each identified raising member country. There were still four STCs raised ambiguously against *certain members* that were left unchanged since the members were not named in the entries in the SPS-IMS.

Some STCs cover a variety of products at the highly aggregated product level of 2-digit HS codes (e.g. edible fruit), while others are more specific at the 6-digit HS level (e.g. fresh apples). Eight STCs did not specify product categories, but expressed concern about cross-cutting, general phytosanitary issues related to plant health. Eight STCs listed two distinct HS codes (products) they applied to and three STCs listed three HS codes they were concerning. Where the STC concerned multiple products, it was split such that each product was treated as a separate observation.[84] This methodology was used since the amount of bilateral trade was investigated so it was important to have the concern applied at the most disaggregated level possible. After separating multiple raising countries and multiple products covered into separate observations, the total observations of SPS plant health STCs was 108.

Trade data at the level reported for the STC (2-digit, 4-digit, or 6-digit HS codes) was downloaded from (UN COMTRADE, 2012). Three pieces of trade data were acquired for each observation: (1) the exports of the product of the raising member to the maintaining member's market, (2) the total export of the product from the raising member to all countries, and (3) the total export[85] of all countries to the maintaining member's market for the HS code of the STC. Calculations made by the author using the trade data are shown diagrammatically in Figure 13.

[84] Unlike Chapter 3 where the first HS-code was treated as the primary HS code to merge with SPS notifications.

[85] Effectively the total export from all countries to the maintaining member's market is the "import" into that market, however, the export from all countries is used to avoid the differences in value due to the way exports are reported in UN COMTRADE as free on board (FOB) and imports include costs of insurance and freight (CIF).

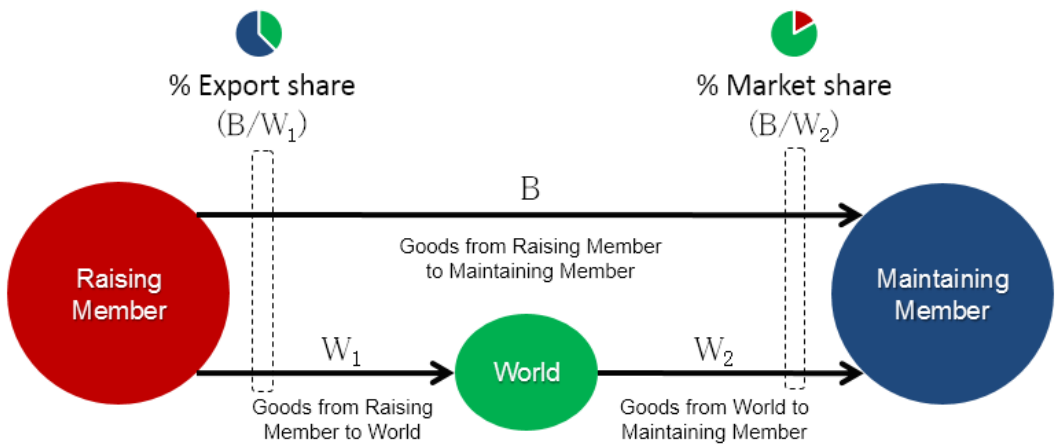


Figure 13: Conceptual diagram demonstrating export share and market share calculations from trade flows for dyadic STC dispute

The "export share" is defined for the purposes of this chapter as the percentage of the raising member's total exports for the HS code of the STC that are exported to the maintaining member's market (see left side of Figure 13). The "export share" should reflect the importance of the maintaining member's market for the raising member's export industry in that sector. For instance, in the on-going dispute by South Africa against the EU over phytosanitary restrictions on citrus imports due to Black Spot (fungal disease: *Guignardia citricarpa*), the EU imported 40% of South Africa's citrus production in 2013 (Shanghai Daily, 2014). This would be defined as the EU accounting for 40% of South Africa's citrus "export share".

Analogously, the "market share" is defined as the percentage of the total imports into the maintaining member that the raising member accounts for of the HS code of the STC (see right side of Figure 13). The larger the market share, the more important the raising member should be for the maintaining member's supply of that product in their domestic market.

Data on the maintaining and raising members' GDPs were acquired from World Bank (2012). Data on which Regional Plant Protection Organization (RPPO) the country belonged to was extracted from the lists on each organizations' website available from the IPPC website.[86] The full name of each RPPO can be found in Table 33 (page 136).

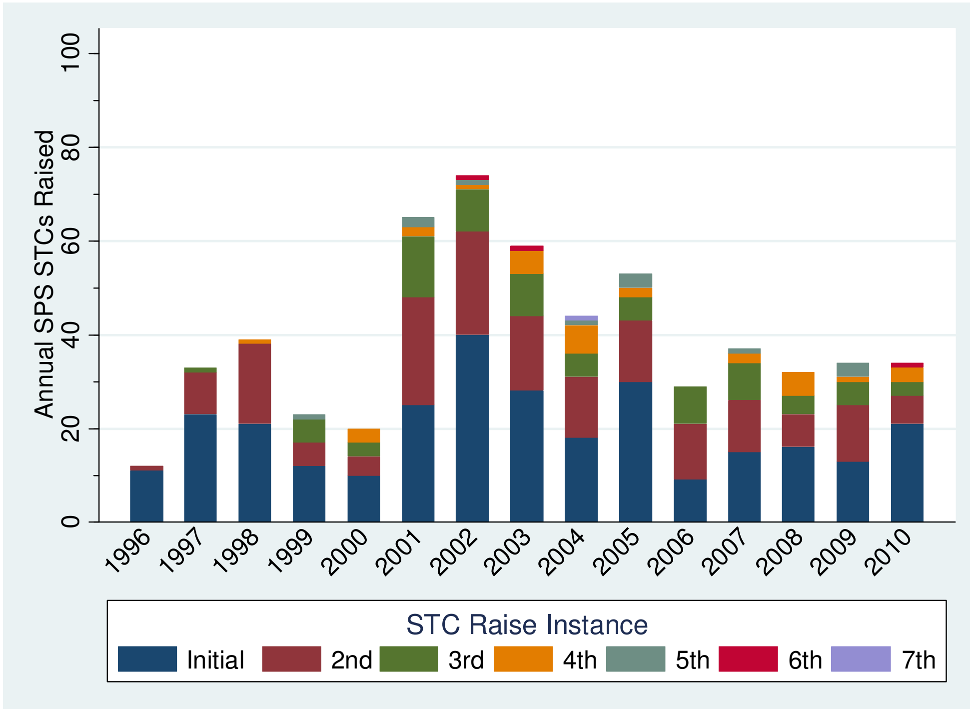
[86] IPPC website portal with list of the RPPOs:
https://www.ippc.int/partners/regional-plant-protection-organizations

A few countries belong to multiple RPPOs (e.g. Mexico is a member of both NAPPO and OIRSA, and the United States is a member of NAPPO and PPPO). Countries in multiple RPPOs were assigned to the RPPO where they would make up a larger share of the total STCs raised, or in the event of a tie, where the nation would be one of fewer members (i.e. have more representation). For example, in the case of Mexico, this meant that the nation was assigned to OIRSA for this analysis as Mexico contributes a larger share of raising and maintaining STCs in this group as opposed to NAPPO. The United States would make up the largest STC raiser and maintainer in any RPPO, so it was assigned to NAPPO where it would be one of two members. The summary statistics available in the Appendix (A.15) report the STCs by country both grouped by UN region and, alternatively, grouped by RPPO for complete transparency.

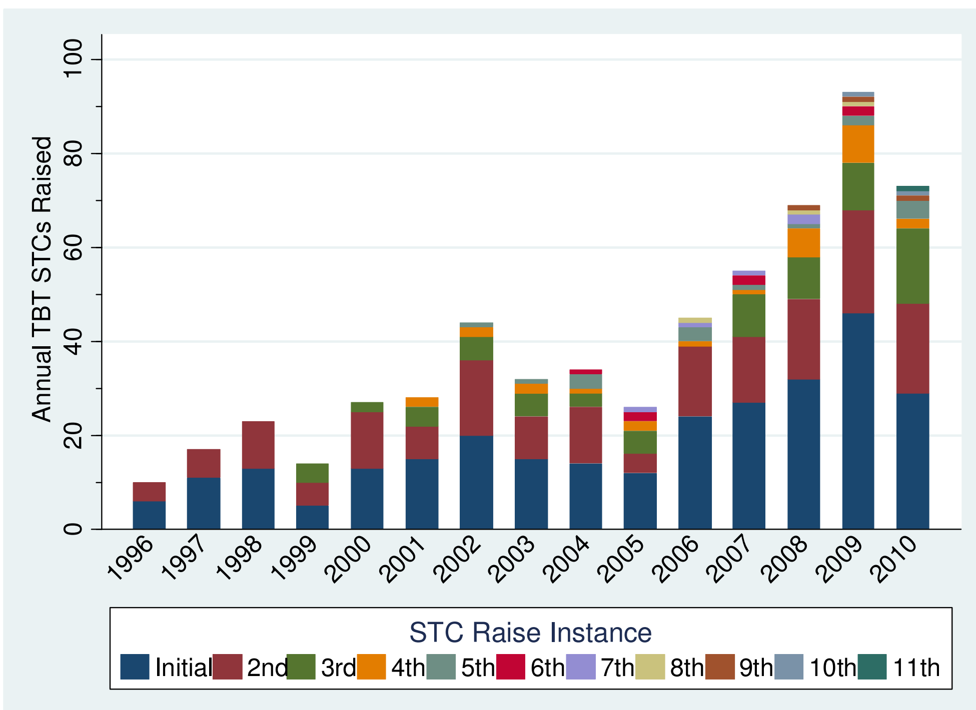
4.4. STC TRENDS AND RESOLUTION RATES

As explained in the methods section (4.3.1), 292 unique SPS STCs were raised for the first time from 1996 to 2010. Ones that are unresolved often will be raised again at a subsequent meeting. New STCs are initiated every year, but for many of the years from 1996 to 2010, around half of the STCs raised annually are previous STCs that are re-raised since a resolution could not be reached (see panel (a) for SPS and panel (b) for TBT of Figure 14 on the next page). Several STCs are re-raised multiple times in a given year, but for ease of presentation, it is only counted in the figure for the first raise per year. At the upper end of re-raises, one SPS STC was re-raised for the 7th year in 2004. For the TBT agreement, the number of re-raises is even higher. There are five STCs that were raised at meetings for at least 7 years of the 15-year period and one STC that was re-raised for the 11th year in 2010. While the TBT agreement does not report resolution status, the high number of re-raises would suggest many are unresolved.

In particular, after 2005 there has been an increased load from both unresolved STCs being re-raised at meetings and an increase in the number of new STCs initiated (blue bars at the bottom of stacks in panel (b) of Figure 14). The drivers of this shift in TBT STCs and their impact is unknown and worthy of future investigation. For the SPS agreement, the number of new STCs initiated is relatively consistent from year to year (blue bars at bottom of stacks in panel (a) of Figure 14).



(a)



(b)

Figure 14: Annual STCs raised, bars stacked by the number of times the STC has been raised for (a) SPS agreement and (b) TBT agreement

The SPS agreement has information on the resolution status of STCs and so it is possible to look at the trends in resolution rates of the concerns. As shown in Figure 15, the number of new STCs initiated each year is, with the exception of 2004, always greater than the number that are resolved. As a result, the cumulative unresolved cases is increasing over time (green line in Figure 15). From 1996 to 2010, WTO members reported that only 93 of the 292 STCs (32%) were resolved. Given the low rates of resolution, the drivers of what allows some cases to achieve resolution while others do not is a clear question.

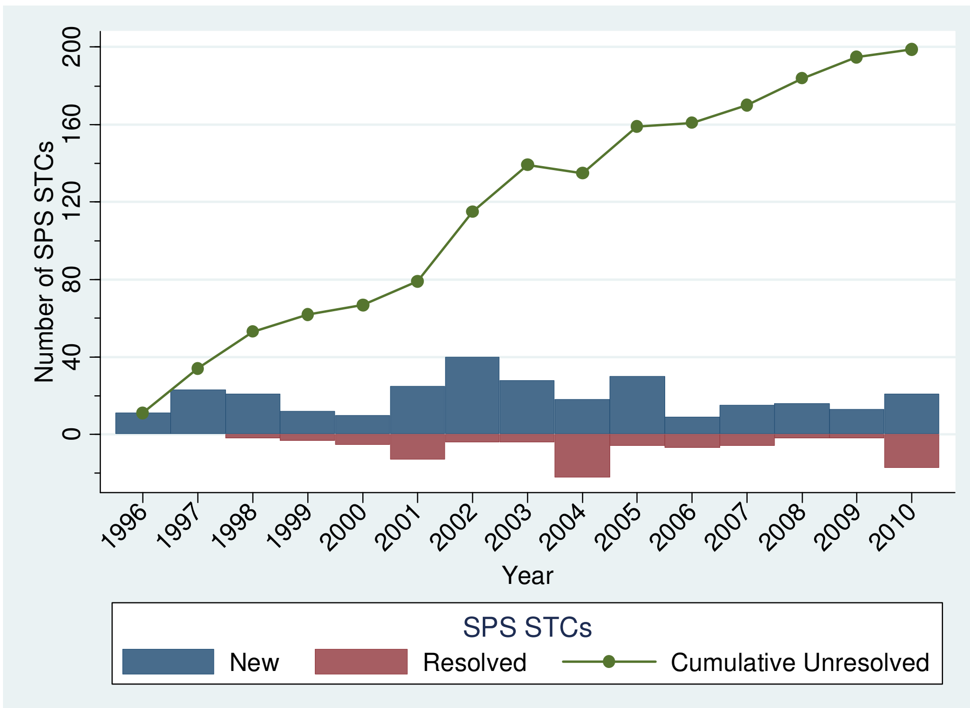


Figure 15: Initiating new SPS STCs outpaces resolving of previous SPS STCs

4.4.1. Analysis of non-dyadic STCs

The focus for the remaining two sections of 4.4 now turns to resolution of STCs. In a few cases in the STC data, there were concerns raised jointly by many countries against several countries or by one country against several nations. As shown in Table 30, however, the majority of trade concerns are dyadic, but this is driven by the SPS agreement. Under the TBT agreement, half of the total STCs are raised by multiple raising countries against one maintaining member (see third quadrant of right side of Table 30).

Table 30: Number of dyadic and non-dyadic disputes under the TBT and SPS agreements from 1996 to 2010 raised by WTO members against other member countries

		SPS Maintaining Member	
		One	Multiple
SPS Raising Member	One	253	16
	Multiple	21	2

		TBT Maintaining Member	
		One	Multiple
TBT Raising Member	One	140	1
	Multiple	141	0

The fact that the TBT agreement has so many STCs where there are multiple countries making the claim could explain the difference in the re-raise rates between the agreements that was alluded to by Figure 14 above on page 121. Busch & Reinhardt (2006) find that in early WTO disputes with many claimants working together it was more difficult to achieve resolution since each member will have differing priorities in an acceptable solution to the dispute. While the TBT does not report resolution status, the number of concerns that are re-raised multiple times could indicate this phenomenon.

The re-raise rates are different for dyadic and non-dyadic disputes in both agreements. As shown in Figure 16 below, it appears non-dyadic disputes are re-raised more times.

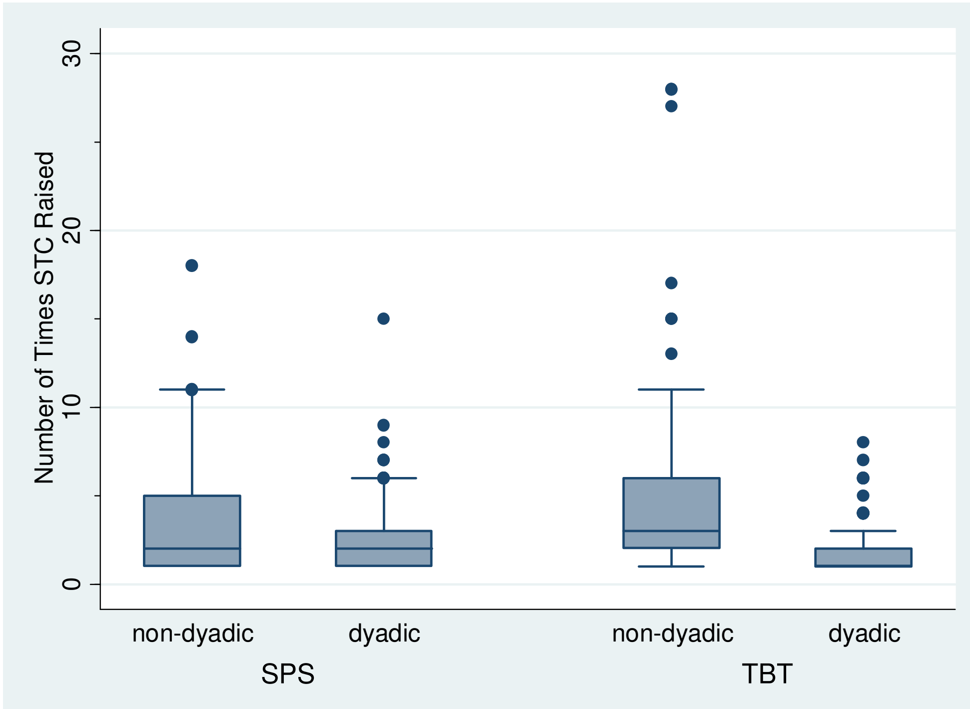
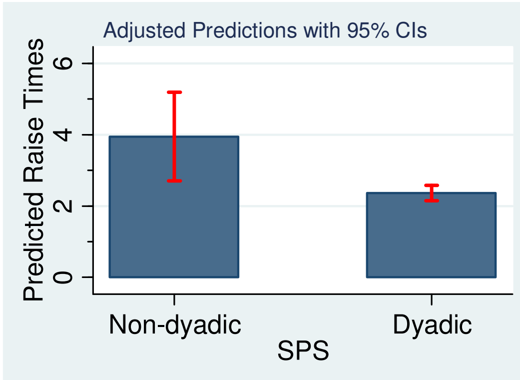


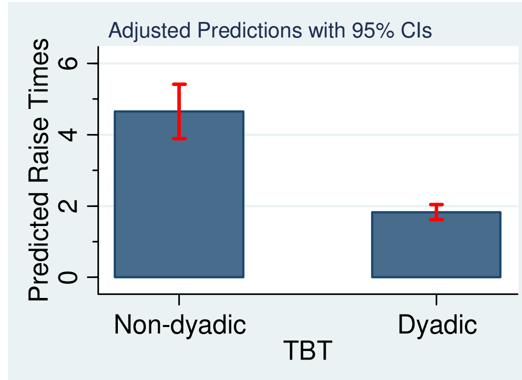
Figure 16: Boxplots of numbers of re-raises for dyadic and non-dyadic STCs in the SPS and TBT system

In order to formally test for differences in the number of re-raise events per STC, a standard T-test or Wilcoxon-Mann-Whitney test could potentially be invalid for discrete and skewed count data like the re-raise counts of STCs (McElduff, Cortina-Borja, Chan, et al., 2010). McElduff, Cortina-Borja, Chan, et al. (2010) study shows that with this type of data a negative binomial (NB) regression with a single predictor is the more accurate model to test for differences. This was used for both SPS and TBT STCs separately with the only predictor being a binary variable if the STC was a dyadic dispute or non-dyadic dispute.

The NB model was estimated with robust standard errors to reduce the bias from heteroscedasticity of the error terms. The predicted counts for each group are shown in Figure 17 panel (a) for SPS STCs and panel (b) for TBT STCs. As expected, the mean number of times a given STC is raised is significantly higher for non-dyadic concerns compared to dyadic concerns in both agreements. However, for the TBT agreement, the difference is larger and the 95% confidence intervals are narrower. Non-dyadic STCs in the TBT agreement are expected to be raised over twice as many times as dyadic STCs on average.



(a)



(b)

Figure 17: Predicted number of raises for dyadic and non-dyadic concerns from single predictor NB model with robust standard errors

The non-dyadic disputes raised by several countries may indicate a particularly onerous SPS/TBT policy that a maintaining member put into effect. When a measure has been shown to be quite restrictive and with little scientific support, many countries may join in raising a concern against the country (162 STCs have occurred like this in the TBT and SPS system, as seen in Table 30, page 123). An example of this type of dispute is SPS STC #10 raised in 1998 by 11 nations against the European Union for its modified SPS policy on allowable aflatoxin residue levels on several agricultural products.

The SPS policy that STC #10 disputed was the subject of analysis on the magnitude of cancer risk the EU was actually mitigating from such stringent aflatoxin standards. Otsuki, Wilson & Sewadeh (2001) showed that while the restrictions cost African exporters some $670M USD annually in lost trade, the amount of cancer risk avoided by the EU population was approximately 1.4 mitigated deaths per billion people per year—a miniscule risk to the EU population. The policy was shown to be without merit and resolved by the EU modifying the standard.[87]

Multiple countries disputing against multiple countries' policies are quite rare events; only two have occurred from 1996 to 2010 and both in the SPS agreement. These two cases were SPS STC #84 first raised in 2001 and SPS STC #183 first raised in 2003. In the first case, STC #84 was an animal health concern raised by several exporting countries (mainly from Eastern

[87] A full review of history of EU mycotoxins policy can be found in Van Egmond, Schothorst & Jonker (2007).

Europe) that were considered free from Bovine Spongiform Encephalopathy (BSE) or having BSE-free zones. The STC was raised by them against many countries outside Europe that had been using emergency notifications to ban several dairy and beef products from raising members due to BSE concerns.

The second concern STC #183 was related to plant health in the timing of implementation for International Standards for Phytosanitary Measures (ISPM) number 15 standards. ISPMs were developed by the International Plant Protection Convention (IPPC) in order to promote standardization and harmonization among countries for common phytosanitary issues affecting plants. ISPM 15 was specifically developed to prevent the spread of wood boring insects (e.g. Bark Beetle and Bark Borer) which were becoming a common vector for invasion primarily via wood pallets used in international shipping (Haack & Brockerhoff, 2011). Chile and Uruguay had requested more time and consideration of different treatment methods in order to comply with ISPM 15 standards on wood products required by many WTO members at that point in 2003.

Both of these concerns reflected broad policies (i.e. BSE restrictions or ISPM 15) which affected many exporters and importing countries for the wide range of products that the policies covered. For the most part though, disagreements between WTO members occur on a more narrow range of products and/or trade relationships.

The number of non-dyadic disputes does vary each year. The number of STCs by the type of the dispute (i.e. dyadic or non-dyadic) is shown in Figure 18. In 2005, as little as 14% of the total number of STCs raised in the SPS and TBT Committees were non-dyadic disputes, but in other years the non-dyadic percentage peaks to 49% (2009). Overall, though, there is no monotonic trend for the percentage of non-dyadic disputes over time.

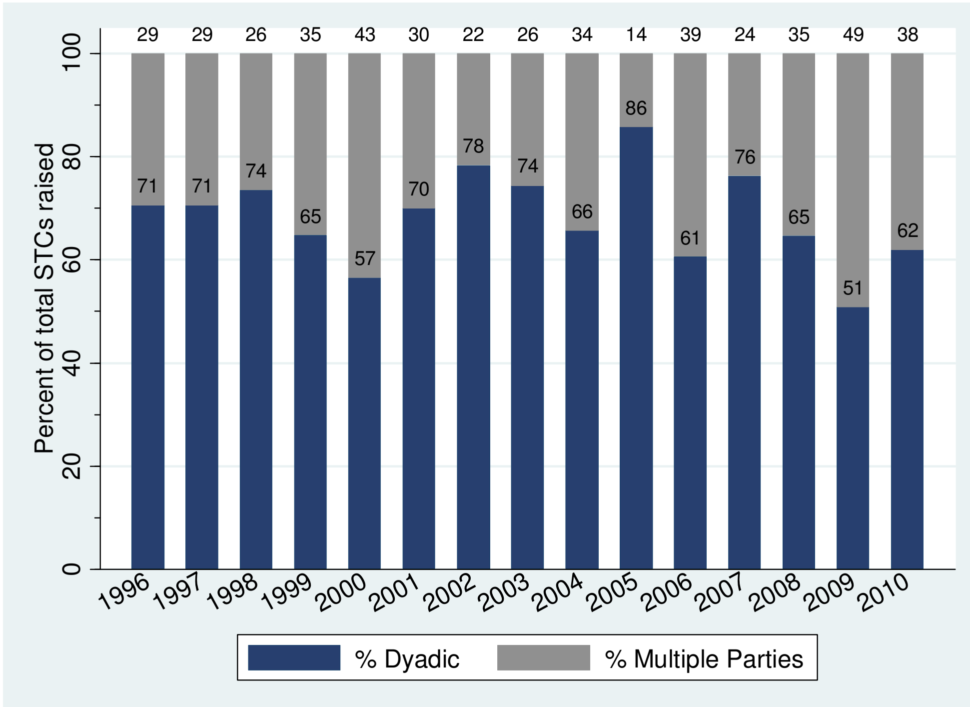


Figure 18: Percentage of annual new SPS and TBT STCs that are dyadic disputes from 1996 to 2010

Lastly, the mean resolution rates for non-dyadic and dyadic SPS STCs are compared using a two-sample test of proportions. Of the 253 SPS STC dyadic disputes, roughly 33% ended in resolution. For the 39 non-dyadic disputes, around 26% ended in resolution. However, the mean resolution rates for the two types of dispute were not significantly different by a two-sample test of proportions ($z = -0.9407, p = 0.3469$). This is counter to the findings for WTO DSB disputes of Busch & Reinhardt (2006) where third parties made dispute resolution less likely. As a result, there may be factors in common with dispute resolution for dyadic and non-dyadic concerns. However, the factors driving concern resolution are investigated below in section 4.4.2 just for dyadic disputes to take advantage of country and country-product level information in the STC. Given that non-dyadic concerns are raised significantly more times than dydadic concerns in the TBT and SPS agreement (refer back to Figure 17), it is likely that non-dyadic concerns take longer to resolve due to the multiple parties involved, but ultimately are not significantly less likely to end in resolution as compared to dyadic disputes.

4.4.2. Resolution rates for STCs

Given the importance of resolving food safety disputes to food security and the economies of many countries, it is important to understand the factors that seem to drive resolution (Kastner & Powell, 2002). As shown above in Figure 18 of the previous section, the majority of concerns raised in the SPS and TBT system are dyadic disputes between two nations. In these disputes, others often offer official support for the concern, but do not officially join as a disputing party.[88] It was also previously shown at the beginning of section 4.4 that there are more concerns raised each year than there are resolutions to past concerns (Figure 15, page 122). As a result, over time there is an increase in the number of outstanding and unresolved STCs. The question remains what makes dispute resolution more likely for some of these STCs?

The first results analyse the impact of the power of the country involved in the dispute as measured by the GDP or development status, similar to Bown (2004c) and (Bown, 2004b) for WTO and GATT disputes. Table 31 below shows the results of the logistic model for the probability of resolution of the STC with four different models measuring the relative economic size of countries on either side of the STC.[89] In all models, HS-2 code dummies are included to control for product-level heterogeneity in resolution rates that could be driven by certain products being easier to agree on than others are.

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[88] Recall from Table 18 (page 89) in the data section, one piece of data given for STC entries in the SPS-IMS is the number of other members that have offered "support" to the concern. The author created a binary variable to keep track if there were other countries supporting the concern or not.

[89] Review the data description section 4.3.1 and the literature review (section 4.2) for variables considered and predictions of factors that should matter for dispute resolution.

Table 31: Resolution probability using logit model on SPS STCs first raised from 1996 to 2010

	(1) Pr(Resolve=1)	(2) Pr(Resolve=1)	(3) Pr(Resolve=1)	(4) Pr(Resolve=1)
# Supporting	-0.104	-0.112	-0.105	-0.130
	(0.0947)	(0.0964)	(0.0905)	(0.0924)
Raise Count	0.242*	0.251**	0.269**	0.263**
	(0.0972)	(0.0920)	(0.101)	(0.0985)
Raise ln(GDP)	0.115			
	(0.0696)			
Maintain ln(GDP)	-0.367**			
	(0.0808)			
Diff. ln(GDP)		0.243**		
		(0.0560)		
Raise Developing?			-0.828*	
			(0.332)	
Maintain Developing?			0.775*	
			(0.328)	
Raise ln(GDPPC)				0.330**
				(0.127)
Maintain ln(GDPPC)				-0.198
				(0.128)
Observations	242	242	242	242

Note: * $p < 0.05$, ** $p < 0.01$
Robust Standard errors in brackets. Coefficients reported. HS-2 dummies included, but not reported.

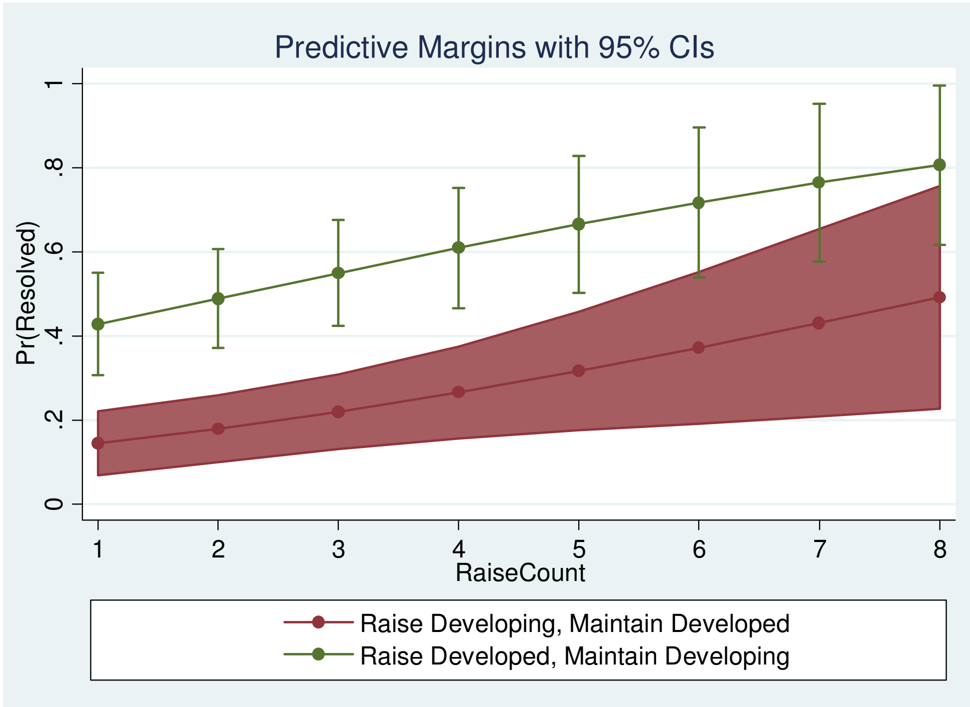
The number of times a STC was raised ($Raise\ Count$ in Table 31) was the most robust determinant of STC resolution. There are two ways to interpret this result. The (1) first is that the raise count could reflect measures that are valid concerns on serious issues for the raising members. This is the interpretation of the raise count used by the study of Horn, Mavroides & Wijkström (2013). The fact that the resolution rate is higher for "serious" concerns could mean that the STC mechanism is effective at resolving issues that are important for members, and the less serious issues are simply disregarded by members without resolution, or without reporting resolution. An alternative interpretation (2) is that raise count just reflects how persistent the raising member is about the issue. If a country keeps raising the problem at subsequent meetings, it is more likely to achieve resolution eventually with the maintaining member. Definitive conclusions cannot be made. Regardless, there were still independent effects on developing country members in dispute resolution.

The results of Table 31 show in column (1) that the lower the GDP of the maintaining member country, the more likely the dispute is to be resolved. Similarly, in column (2) instead of each countries' GDP, the difference in their GDPs is used.[90] Positive (negative) differences reflect a member raising a dispute against a relatively smaller (larger) economy. The positive and significant coefficient on $Diff.ln(GDP)$ indicates that concerns are more likely to be resolved when the raising country's economy is larger than the maintaining member's economy. Column (3) indicates that developing countries are less likely to resolve STCs they raise, but more likely to resolve when the STC is raised against their SPS policies. Column (4) shows that wealth of the nation as measured by GDP per capita (GDPPC) indicates that richer countries are more likely to resolve disputes they raise. All four models add evidence that the resolution of STCs is similarly impacted by power in the way that Bown (2004c) showed for trade disputes under the GATT. Developing countries are less likely to achieve resolution on concerns they raise and more likely to have concerns raised against them end in resolution.[91]

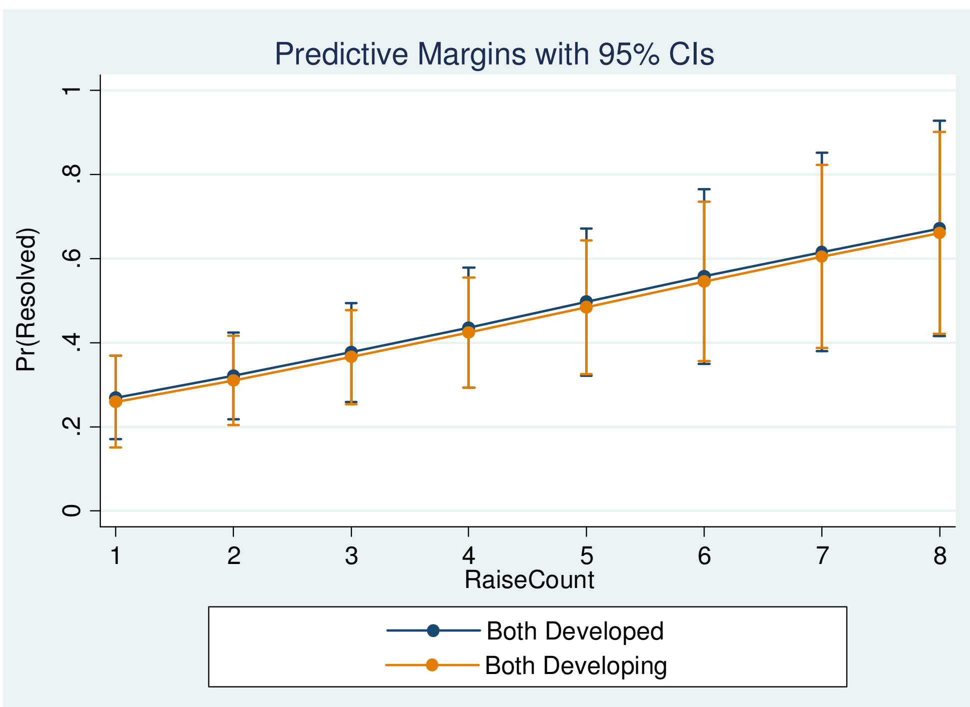
The predicted probabilities from the model in column (3) of Table 31 are plotted below in Figure 19 to understand the outcomes for different country combinations in the disputes and the relation to the number of times the STC is re-raised. Figure 19 shows that it is the difference in country power that results in differing rates of STC resolution. As seen in panel (b) of Figure 19 when the dispute is between two developed members or two developing members, the predicted resolution probabilities are approximately the same. Panel (a) reveals that especially for STCs that are not re-raised many times, developing countries are significantly less likely to resolve disputes they raise than developed members are.

[90] Calculated raising member minus maintaining member

[91] However, the current metric does not express how the resolved claims end (i.e. which country "wins" the dispute). Further research analysing and coding the claims that do report the outcome would be needed.



(a)



(b)

Figure 19: Predicted probabilities of STC resolution over Raise Count for: (a) raising and maintaining members with opposite development status, (b) with the same development status

In the next set of models, the impacts of democracy, regulatory quality, and environmental governance are examined.[92] Like the previous models in Table 31, Table 32 shows that $Raise\ Count$ and $Diff\ ln(GDP)$ were robust determinants of the probability of resolving a STC even with the new environmental and governance covariates.

Table 32: Resolution probability using logit model on SPS STCs first raised from 1996 to 2010 including environmental and governance covariates

	(1)	(2)	(3)	(4)	(5)	(6)
# Supporting	-0.170	-0.122	-0.139	-0.112	-0.182	-0.160
	(0.107)	(0.102)	(0.0993)	(0.0963)	(0.112)	(0.106)
Raise Count	0.277**	0.249**	0.266**	0.250**	0.279**	0.252**
	(0.0958)	(0.0937)	(0.0933)	(0.0925)	(0.103)	(0.0909)
Diff. ln(GDP)	0.225**	0.231**	0.245**	0.243**	0.216**	0.246**
	(0.0671)	(0.0690)	(0.0684)	(0.0698)	(0.0594)	(0.0567)
Maintain Enviro. Governance	0.263					
	(0.327)					
Raise Enviro. Governance	0.525					
	(0.347)					
Diff. Enviro. Governance		-0.114				
		(0.239)				
Maintain Regulatory Quality			0.199			
			(0.241)			
Raise Regulatory Quality			0.153			
			(0.231)			
Diff. Regulatory Quality				-0.00304		
				(0.169)		
Maintain Democracy Score					0.0113	
					(0.0380)	
Raise Democracy Score					0.134**	
					(0.0465)	
Joint Democracy Score						0.0560
						(0.0334)
Observations	238	238	242	242	238	238

Note: * $p < 0.05$, ** $p < 0.01$
Robust Standard errors in brackets. Coefficients reported. HS-2 dummies included, but not reported.

Previous work on GATT disputes (Busch, 2000) and early WTO disputes (Busch & Reinhardt, 2006) suggested that more democratic countries would be more likely to resolve disputes before they proceed to a panel. The results from SPS STCs shows that this effect was true only for raising members, but the democratic score of the maintaining member was irrelevant to resolution likelihood (see column (5) of Table 32). More democratic raising member countries were more likely to resolve their dispute regardless of the government of the maintaining

[92] The choice of covariates is discussed previously in section 4.3.1

member.[93] There was no evidence that regulatory quality or differences in environmental governance had any impact on dispute resolution, despite the suggestions in the literature from historic food safety disputes (Kastner & Powell, 2002). It could be that the ESI Environmental Governance score is a poor proxy for the public's perception of food risk—Kastner & Powell (2002) second factor that related to resolution of historic food safety disputes. As well, the differences in regulatory quality between nations may be a poor indicator of their willingness to cooperate on regulatory regimes with each other—Kastner & Powell (2002) third factor.[94]

4.5. ANALYSIS OF PLANT HEALTH CONCERNS IN DETAIL

The drawback to using a count-based metric for STC analysis above is the lack of detail of what reasons members give for raising the dispute. Additionally, the impact of trade on dispute resolution was not considered for the full sample of STCs. These will be considered in some detail for a sub-set of SPS STCs that were raised concerning plant health. A quick overview of which nations raise STCs about plant health, which nations maintain the most controversial measures, and what products seem to generate the most concerns is presented below. This is followed by an analysis of (1) the text given with the STC notification explaining the reason the concern was raised and (2) the value of trade the STC covers.

Plant health related STCs are unsurprisingly raised on agricultural product codes mostly related to crops, fruits, nuts, and wood. Aggregating products to the highest level (HS 2-digit codes) to allow comparison in Figure 20, HS08 (edible fruit and nuts) was the subject of 42% of concerns raised. This group has as many complaints as the next three categories combined (HS07 – edible vegetables and tubers with 17% of concerns, HS06 – live trees and other plants with 13% of concerns, and HS44 – wood and other articles of wood with 11% of concerns). The number of concerns in each HS-code that are resolved by 2010 are plotted for each bar as well. Figure 20 suggests that concerns about HS10 (cereals) may be easier to resolve than STCs

[93] A model was also run with the covariate of the difference in the polity2 democracy scores between the raising and the maintaining member, however, the results (not shown) were also insignificant.

[94] David Vogel of University of California at Berkeley has written extensively on the issue of international regulatory coordination (Vogel, 2012; Kelemen & Vogel, 2010; Roberts & Unnevehr, 2005). Particularly relevant to the present issue, the EU and the USA both have high metrics of regulatory quality, but different domestic considerations that have evolved in the past 50 years on their willingness to engage multilaterally on policy coordination. Kelemen & Vogel (2010) details the drivers of this change.

in other products, however this figure does not account for the year the concern was raised or the countries involved, so no definitive conclusions can be drawn.

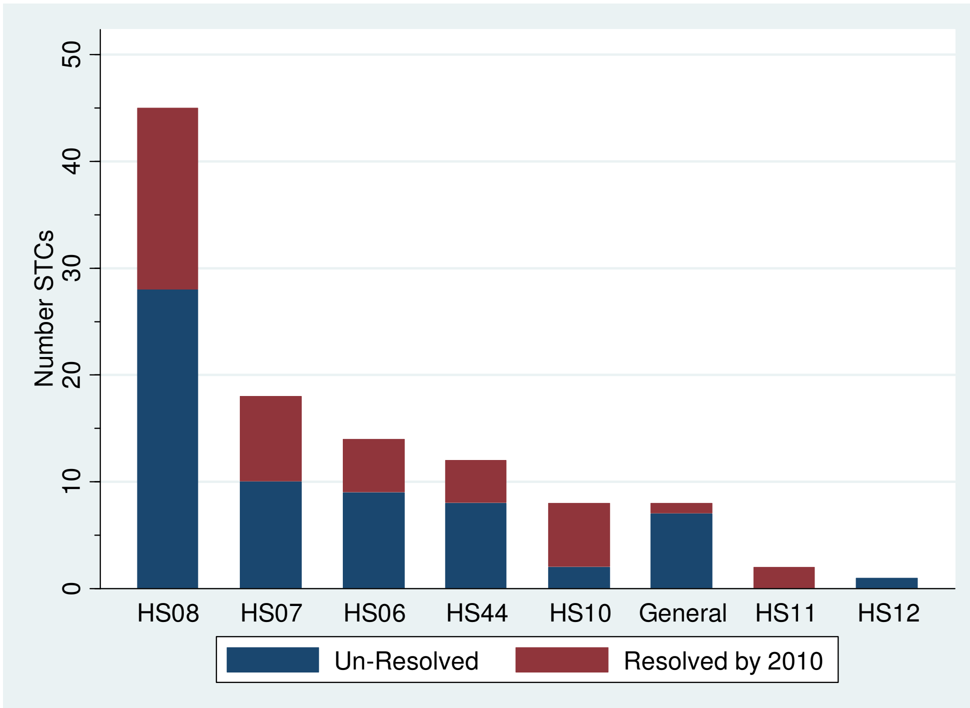


Figure 20: Number of plant health SPS STCs raised from 1996 to 2010 by HS-2 code and resolution status

Similarly to the entire set of STCs under the SPS agreement, many of the years in the sample have more concerns re-raised than new plant health STCs initiated (see Figure 21 below). There is a noticeable decline in new STCs raised after a peak in 2001 (with the exception of 2005). As a result, the cumulative unresolved plant health related STCs have actually held relatively constant in the mid-2000s and have declined in 2010 (see Figure 22). It appears at least for plant health STCs that the implementation of SPS measures has been more agreeable among WTO members, at least in the past five years approximately.

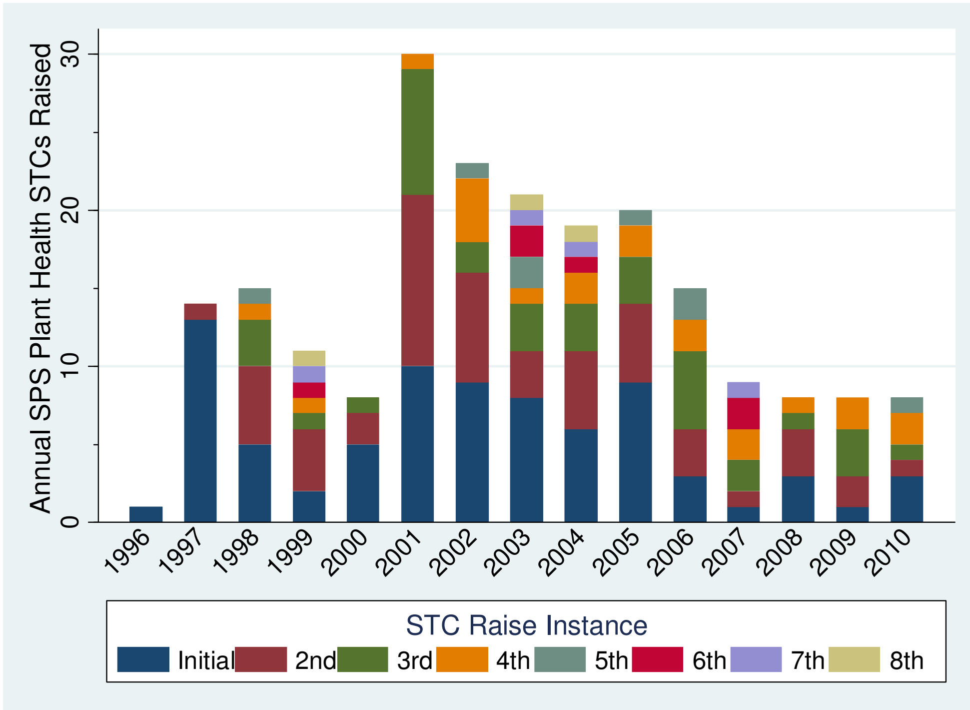


Figure 21: Annual plant health STCs raised, bar stacked by the number of times the STC has been raised

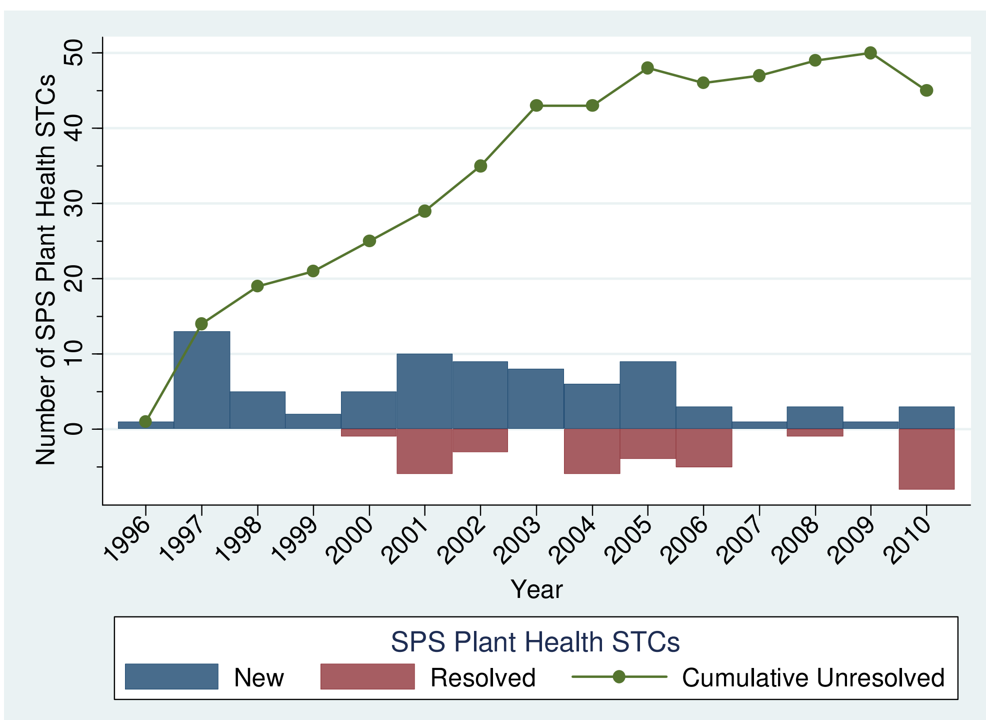


Figure 22: Annual new and resolved plant health STCs along with cumulative unresolved concerns

The most active country raising plant health related concerns was the United States with 32 STCs raised from 1996 to 2010 (30% of the global total for the period). The European Union was the second most active raising member with 18 concerns raised (17% of global total). Argentina was third with 11 STCs (10% of global total). The full list for each raising country by UN Region (Table 80, page 373) or RPPO (Table 81, page 374) is in Appendix A.15.

The country that had the most concerns raised against it was also the top raiser of STCs: the USA had 17 concerns raised against them. The EU was tied with Australia with 9 STCs raised against them, however, the EU was surpassed by Japan with 13 concerns raised against them. Argentina was not subject to any plant health STCs against their SPS policies. The full details by maintaining country by UN region (Table 78, page 371) and by RPPO (Table 79, page 372) is also in Appendix A.15. A summary table of totals by RPPO is given in Table 33 below. The vast majority of STCs are raised between members of different UN regions. Only 6% of all STCs were between members in the same UN region suggesting that often disputes may be about policies meant to keep non-native species out of a country, however, the details of the concerns are discussed in the next section (4.5.1).

Table 33: Plant health STCs by RPPO

Full Name of RPPO	STCs Raised	% Raised	STCs Maintained	% Maintained
NAPPO - North American Plant Protection Organization	36	33.3%	18	16.7%
APPPC - Asia and Pacific Plant Protection Commission	22	20.4%	31	28.7%
EPPO - European & Mediterranean Plant Protection Organization	20	18.5%	20	18.5%
COSAVE - Comité de Sanidad Vegetal del Cono Sur	19	17.6%	7	6.5%
OIRSA - Organismo Internacional Regional de Sanidad Agropecuaria	4	3.7%	9	8.3%
CAN - Comunidad Andina	2	1.9%		
Independent	2	1.9%	19	17.6%
NEPPO - Near East Plant Protection Organization	2	1.9%		
CPPC - Caribbean Plant Protection Commission	1	0.9%	4	3.7%
TOTAL	**108**	**100.0%**	**108**	**100.0%**

4.5.1. Breakdown of plant health STCs by reason for complaint

As described in the methodology section for the plant health concerns (4.3.2), the author read the text of each of the 79 STCs raised from 1996 to 2010 to determine the basis of the concern and specific rule of the SPS agreement that the raising member claimed the maintaining member violated with their SPS policy. If raising members claimed multiple reasons for raising the STC, it was counted in multiple categories of complaint. The summary table below (Table 34) reflects the percentage of each of the five common reasons for raising a STC that were mentioned in the final analysis sample of 108 observations of STCs.[95] By the nature of the methodology, the percentages are weighted more heavily by the STCs that are raised by multiple members, on multiple products, and/or with multiple reasons for complaint.

Table 34: Percentage of all plant health SPS STCs that mention five reasons for complaint

Reason Type	Reason for Complaint	Num. of STCs	% of STCs
Science		**48**	**44%**
	Pest-free area recognition	12	11%
	Disputed PRA or scientific evidence	36	33%
Economic		**93**	**86%**
	Regulatory time delay	42	39%
	Disproportionately trade restrictive	51	47%
Informational		**5**	**5%**
	More information requested	5	5%

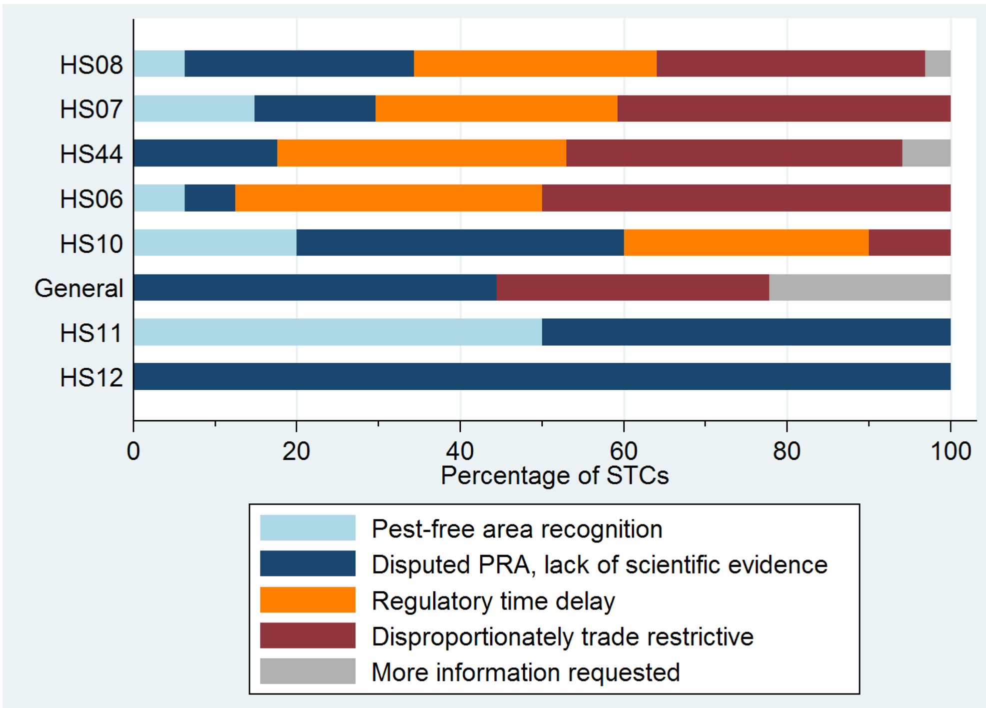
Note: % of STCs adds to more than 100% as several STCs cite multiple reasons for raising the concern

Overall it appears that STCs more often cite economic reasons like that the SPS measure has too long of a regulatory time delay or that it is implemented in a way that is too restrictive to trade. However, 44% cite scientific concerns as well. While not reported in the table, there are three observations where both a pest-free area was disputed along with an economic concern raised as well. The majority of the dual or triple reasons for concerns relate however to countries concurrently disputing the PRA or scientific evidence for the SPS measure along with arguing it is: overly trade restrictive (8 observations), a regulatory time delay (4 observations), or both (6 observations). There was only one observation of the raising member arguing an SPS measure needed clarification (i.e. more information requested) while simultaneously arguing it was a regulatory delay.

Figure 23 below breaks down type of complaint by HS-2 code. It is clear that the type of concerns are not grouped on any particular product type. However, for HS10 (cereals), there

[95] Review 4.3.2 (specifically page 120) for how the 79 STCs were broken down for multiple raising countries and multiple products into 108 separate observations for the analysis sample.

does seem to be a higher percentage of complaints involving the PRA or other scientific-based concerns as compared to other HS codes.[96]



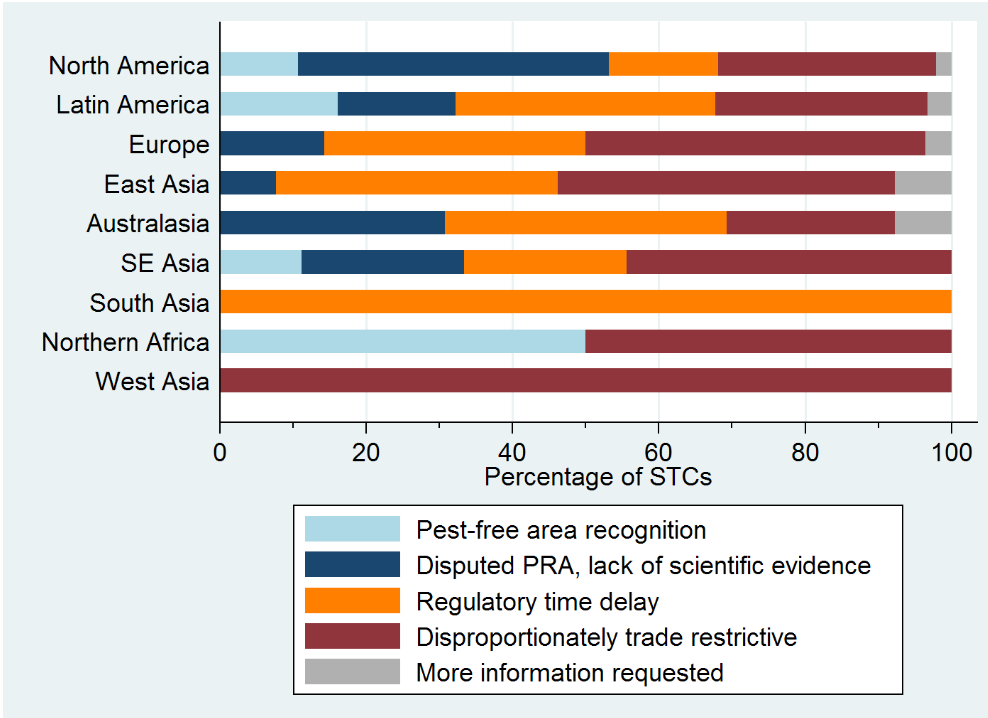
Note: Scientific reasons in light/dark blue; economic reasons in light/dark red; information requests in grey. HS-2 codes ordered from most STCs (top) to least STCs (bottom).

Figure 23: Percentage of total STCs by complaint type for each HS-2 code

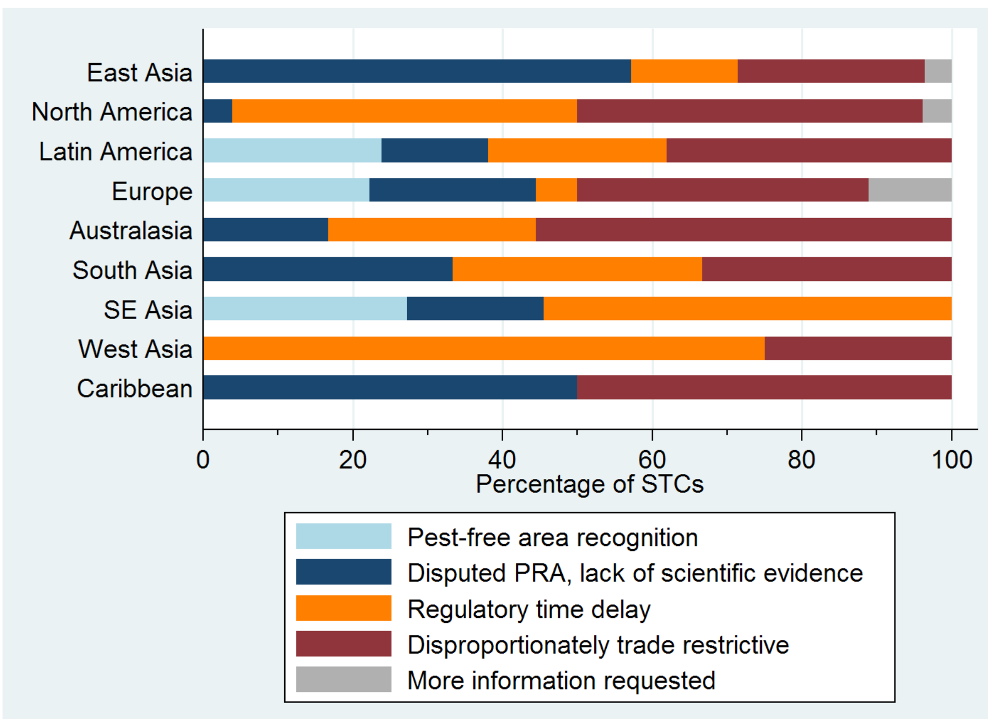
Looking at the reasoning for the STC by region, the percentages of economic or scientific motivations for raising the dispute is more revealing. By region maintaining the measure in panel (b) of Figure 24, it is clear regions have different types of concerns raised against them. North America (mainly the United States) has concerns raised against it due to regulatory delays in setting policy or bringing products to market, and SPS policies going beyond a less-trade restrictive option that would reduce the risk equivalently (in the raising countries' opinions). Meanwhile, East Asian countries primarily have concerns raised against them due to a lack of solid scientific evidence for their policies. Southeast Asia, Europe and Latin America are petitioned the most by raising member countries to recognize pest-free areas; most of these concerns are being raised by Latin American and North American countries.

[96] HS11 and HS12 had only a few STCs in total, see Figure 20 (page 137), so their percentage breakdown in Figure 23 is not too informative.

In panel (a) of Figure 24, it appears that East Asia and Europe primarily raise concerns against other members citing economic violations of the SPS agreement (i.e. that the SPS measures of the maintaining member are overly trade restrictive or have too many regulatory delays). North American, Latin American, and Australasian countries have a higher percentage of STCs raised citing a lack of scientific evidence to support a maintaining member's policy or petitioning for the maintaining member to recognize their pest-free area. The question remains whether the reason for the concern has an impact on how the STCs gets resolved. This question is briefly explored next (section 4.5.2) using the same models of resolution used on the full sample of STCs in section 4.4.2.



(a)



(b)

Note: Scientific reasons in light/dark blue; economic reasons in light/dark red; information requests in grey. UN regions ordered from most STCs (top) to least STCs (bottom).

Figure 24: Percentage of total STCs by complaint type for each UN region of (a) raising countries and (b) maintaining countries

4.5.2. Effect of type of complaint on resolution

A logit model of probability of resolution was estimated using the significant factors of the models in section 4.4.2 along with the new $Science$ variable. The variable $Science$ was constructed as a binary variable that was 1 if the STC was solely concerning a lack of scientific evidence or a request on pest-free status recognition. It was 0 if the concern was solely about a regulatory time delay or the measure being overly trade restrictive. STCs that cited multiple concerns were excluded from the analysis. The results in Table 35 below show that whether the concern was about a scientific request or an economic-based concern, the resolution rates were not significantly different due to that factor. Even in the increasingly simplified models in columns (4) and (5) only including the factor $Science$; it had no predictive power for the probability of resolving a concern.

Table 35: Resolution probability using logit model on plant health STCs considering complaint type

	(1) Pr(Resolve=1)	(2) Pr(Resolve=1)	(3) Pr(Resolve=1)	(4) Pr(Resolve=1)	(5) Pr(Resolve=1)
Raise Count	0.601**	0.608**	0.597**		
	(0.263)	(0.257)	(0.256)		
Raise ln(GDP)	0.140				
	(0.133)				
Maintain ln(GDP)	-0.115				
	(0.129)				
Science	-0.261	-0.238	-0.300	0.225	0.240
	(0.730)	(0.685)	(0.733)	(0.592)	(0.489)
Diff. ln(GDP)		0.128			
		(0.0897)			
Maintain Developing?			-0.375		
			(0.599)		
Raise Developing?			-0.965		
			(0.666)		
Observations	66	66	66	69	72

Note: * p < 0.10, ** p < 0.05, *** p < 0.01
Columns (1) to (3), robust standard errors in brackets. Columns (4) and (5) standard errors in brackets. Columns (1) to (4) HS-2 code dummies included, but not reported.

Given the time needed to generate scientific-based risk evidence, it is hypothesized that STCs based on a raising member's belief that the maintaining member's SPS policy lacks scientific grounding may take longer to resolve than a concern about regulatory time delays or trade restrictiveness. Taking the difference between the year of the STC initiation and the year of resolution, a variable for the time it takes to resolve the concern is constructed. Science-based concerns may also be raised more often before they are resolved. Two NB regressions are then constructed—following the recommended methodology of McElduff, Cortina-Borja, Chan, et al. (2010) for this type of data—to test for differences in science-based vs. economics-based concerns in the prediction for (1) the number of years it takes to resolve a concern and for (2) the predicted number of times a STC is raised. The results from the two NB models are shown below in Figure 25 and Figure 26.

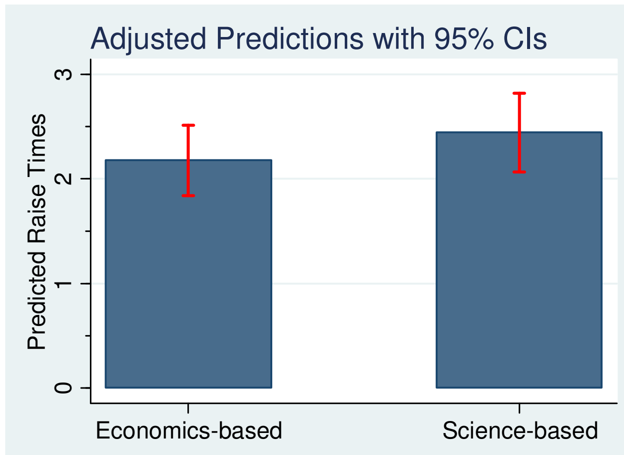


Figure 25: Predicted number of times a STC is raised depending on the type of complaint

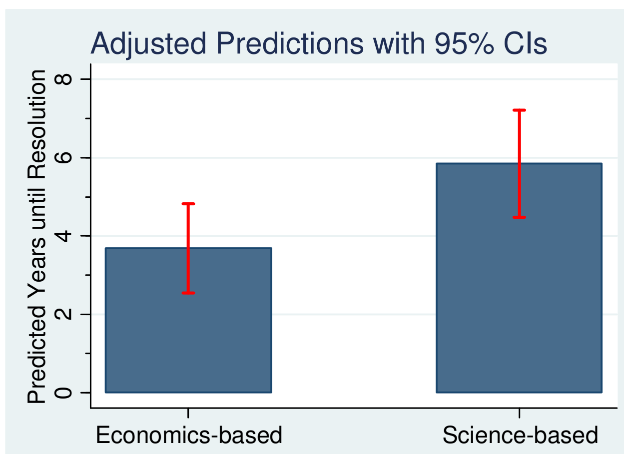


Figure 26: Predicted number of years until resolution for resolved STCs depending on complaint type

Figure 25 shows that the difference is in the number of times a concern is raised is very small between the concern types. The 95% confidence intervals overlap significantly and considering the dependent variable is a count metric, both types of concerns are expected to be raised around 2 times on average. The number of years it takes to resolve a concern shows a larger difference between STCs with economics-based reasons and STCs with science-based reasons.

The science-based concerns take around 2 years longer to resolve on average than the economics-based concerns.[97]

4.5.3. Impact of bilateral trade value on resolution rate

Trade value may have an impact on the likelihood of dispute resolution. The expectation discussed in section 4.3.2 is that concerns raised by countries with higher export shares will be more important to resolve for them than concerns with lower export shares. A higher percentage export share is expected to indicate that the maintaining member is a more important market for the raising countries exporters as they take a higher percentage of the total exports of the product line from the raising country. Additionally, concerns raised on products with higher market shares may be more important for maintaining members to resolve, as the raising country represents a larger source of the product in their market. Figure 27 presents summary box plots of the breakdown of export share and market share by final resolution status of the STC.

Figure 27 suggests that concerns that are resolved tend to be more important concerns for the maintaining member, since the raiser is a larger portion of their total share of the product to their market. It also suggests that resolved concerns tend to be less important to the raising members' exporters as the export share looks to be smaller compared to the unresolved concerns. Two-sample T-tests are used to confirm the difference in mean export share and market share for each group as the inter-quartile range (IQR) is very high, especially for the market share data, reflecting great variation between STCs.

[97] The 95% confidence intervals have a small overlap so the result could not be considered statistically different by the methodology of McElduff, Cortina-Borja, Chan, et al. (2010). A two-sample T-test with unequal variances and Wilcoxon rank test both confirmed significant differences in the means of the two groups (results not shown), but cannot be considered accurate for the reasons mentioned in McElduff, Cortina-Borja, Chan, et al. (2010) for count data. However, the accuracy of the T-test and rank test models should be closer to the truth since there are not many 0 counts in either model, which are a large source of the bias issue discussed in their study.

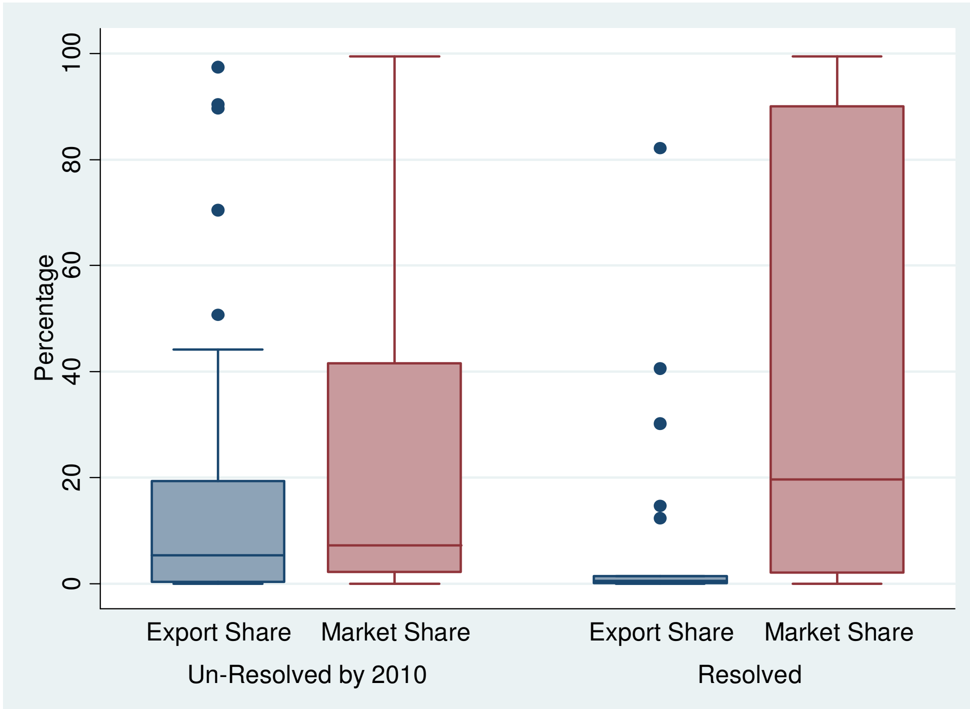


Figure 27: Raising member's export share and market share by resolved status

A two-sample T-test with unequal variances[98] is used to compare the mean export share and mean market share between resolved and unresolved STCs. The results show that the mean export share for resolved concerns is 6.9% ± 3.3% and is 17.1% ± 3.8% for unresolved concerns ($t = 2.0432, p = 0.0448$). The mean market share for unresolved STCs was $23.3\% \pm 4.3\%$ and for resolved STCs the market share was $40.0\% \pm 7.8\%$. While the T-test results suggest that there are differences due to export share and market share, to confirm whether these factors are driving the resolution or just associated with other factors predicting resolution are tested in a logistic model of dispute resolution.

The results of the model are presented below in Table 36. Only in the simplified models including only the market share and export share covariates were the coefficients significant. Considering the heteroscedasticity of the error, the use of standard errors as opposed to robust errors is likely flawed with standard errors too narrow in columns (4) and (5). The marginal significance of the export share even with the relaxed assumptions suggests it may not be a

[98] Levene's test rejected the hypothesis of equal variances for both market share and export share data

strong determinant of resolution probability. The market share had more predictive power. Both covariates had relatively consistent values for the coefficients and the same sign in each specification; with a larger sample size, statistical significance might have been achieved. The lack of significance of the $Raise\ Count$ covariate in all the models in Table 36 could be due to the small sample size as well, since the correlation coefficient with either $Export\ Share$ or $Market\ Share$ was very low (below 0.1).

Table 36: Resolution probability using logit model on plant health STCs with trade covariates

	(1) Pr(Resolve=1)	(2) Pr(Resolve=1)	(3) Pr(Resolve=1)	(4) Pr(Resolve=1)	(5) Pr(Resolve=1)
Raise Count	0.101	0.0849	0.0402		
	(0.127)	(0.127)	(0.135)		
Raise ln(GDP)	0.0729				
	(0.148)				
Maintain ln(GDP)	-0.197				
	(0.146)				
Export Share	-0.0173	-0.0172	-0.0309	-0.0281*	-0.0277*
	(0.0250)	(0.0267)	(0.0317)	(0.0237)	(0.0213)
Market Share	0.0126	0.0123	0.0166*	0.0153**	0.0146**
	(0.00925)	(0.00914)	(0.00851)	(0.00805)	(0.00741)
Diff. ln(GDP)		0.130			
		(0.122)			
Maintain Developing?			-0.637		
			(0.688)		
Raise Developing?			-0.637		
			(0.644)		
Observations	72	72	72	72	74

Note: * p < 0.10, ** p < 0.05, *** p < 0.01
Columns (1) to (3), robust standard errors in brackets for Columns (1) to (3). Columns (4) and (5) standard errors in brackets. Columns (1) to (4) HS-2 code dummies included, but not reported.

Overall, there was some evidence that resolution is more likely for raising countries that raise concerns on products with higher market share for the maintaining member. It appears that maintaining members may be more likely to agree to resolution when the raising country is a larger source of that product in their market. The fact that resolution happens more often for lower export share products (by the two-sample T-test results, page 144) could indicate a few different influences. Either (1) the raising member is more likely to make concessions to achieve resolution on a product in a relatively less important market or (2) raising members that are large global exporters of a product (hence export share for any maintaining market is relatively low) are more likely to achieve resolution to their STCs. The fact that there was some weak evidence of these two trade factors influencing resolution in just a small sector of SPS STCs suggests it is worthy for future research on the full sample of STCs.

4.6. DISCUSSION AND CONCLUSIONS

Results on resolution status indicate that many concerns are raised multiple times before achieving resolution (if at all). For many years in the sample, there are more concerns re-raised than there are new concerns initiated for either the TBT or SPS agreement (section 4.4). As a result, the outstanding unresolved cases for the SPS agreement particularly are increasing with time. The majority of disputes in the SPS agreement are dyadic (one raising member vs. one maintaining member). For the TBT agreement, half of all concerns are multiple countries raising a concern against one maintaining member. Non-dyadic disputes are re-raised significantly more times than dyadic ones, but at least for the SPS agreement, are no less-likely to be resolved than dyadic concerns (4.4.1).

For dyadic SPS concerns, the most robust predictor of resolution was the raise count of the dispute. However, even when controlling for this, the results found that developing countries that raise concerns are less likely to resolve them than their developed counterparts if the other party in the dispute is not developing as well (section 4.4.2). The analysis showed that it was the difference in relative economic size between disputing parties that determined the difference in resolution rate. Potentially this is evidence that the power dynamics discussed by Bown (2004c) for GATT and WTO disputes applies to the outcomes of SPS STC disputes as well. This result could also be explained by the fact that developing countries may lack scientific and technical capacity to effectively argue their claims—a similar argument to that of a lack of legal capacity used by Horn, Mavroidis & Nordström (1999) and Davis & Bermeo (2009) in explaining the bias against developing countries in GATT and WTO DSB disputes. The developing country complainants conceivably cannot contend with the scientists and lawyers defending the SPS regulation of the developed country. When a developing country raises a STC against another developing country, however, there is a more level playing field. The drive for building technical capacity among developing countries in the SPS and TBT system may help address these disparities and should be encouraged.

Kastner & Powell (2002) suggest that public risk perception and government's willingness to cooperate on regulatory agendas with other countries affect the outcomes of food safety disputes. However, the regression results of section 4.4.2 could not find any support for this. The main drivers of dispute resolution were consistently the raising member being a large, wealthy country and the maintaining member being a smaller economy. The strength of the results may be limited though by the lack of strong covariates to proxy Kastner & Powell (2002) suggested qualitative factors that matter for dispute resolution.

For plant health concerns it was found that there was little perceivable difference across HS-codes in the type of reason given for raising the STC (section 4.5.1). However, there was some indication that STCs on cereals (HS10) were both easier to resolve and more often based on disputes over the science justifying the measure. In the models estimated for plant health STCs, however, the type of complaint (science or economics) did not have predictive power for the likelihood of resolution of the STC (section 4.5.2). The only variation appeared to be that STCs calling into question the science behind an SPS measure took longer on average to resolve (~4 years vs. ~6 years between initial raising of the STC and notification of resolution). Lastly, there was limited evidence that concerns that are more important to the maintaining member (as measured by market share) were more likely to be resolved. There was little evidence that export share played a role in resolution likelihood (section 4.5.3). However, the analysis was limited by a small sample size and should be applied in the future on the entire sample of STCs.

The decline in new plant health STCs in the past 5 years is a positive sign of effective regulation, given the ongoing emergence of new plant pests and risks due to climate change (MacLeod, Pautasso, Jeger, et al., 2010). Vectors such as live plant imports both historically and in the 21st century have been a large source of threats to food security and environmental health (Strange & Scott, 2005). Pimentel, Zuniga & Morrison (2005) famously estimated loses due to invasive species in the US at $120 billion each year, a large portion due to plant pests and pathogens. While policy makers likely consider the threat of dispute due to plant health SPS policies, the potential losses due to unmitigated risks can be much worse. Beginning with Chapter 5, the following chapters examine the actions of Ugandan farmers and the organization of an industry (coffee) that has suffered extreme losses due to foreign plant pests and diseases.

Chapter 5. A Case Study of Responses to SPS Issues

While SPS regulations on imports affect trade of products at the border, many SPS issues—as well as controls—start well before export. The decisions of actors within a country's supply chain ultimately determine whether the product can meet the final quality check at export to comply with the SPS measure. Even effective SPS regulations at the border can be thwarted by an inability to consider the incentive structure and decision-making process of the growers and traders in the industry. It is important to study the decision-making process of growers to see how they interpret and act on risks from pests. Additionally it is crucial to consider how growers and traders will respond to incentives from government policies conveyed to them as best practices to follow. There are four related reasons studying actors in an export supply chain is useful for understanding SPS regulations: (1) maintaining a reputation for trustworthy SPS certifications is vital for maintaining market access; (2) border rejections of unsafe food, as well as some SPS STCs, originate in practices in the supply chain behind the border; (3) accurately estimating the potential impacts from an outbreak of a new pest in a PRA need to consider actions from stakeholders in the supply chain; and lastly, (4) crop losses due to poor on-farm and transport practices are a significant threat to food security and rural incomes.

Pests, diseases, and invasive species have differing impacts depending on actions that are taken within a country to control their spread. As highlighted by the analysis of plant health STCs in section 4.4 of the previous chapter, controlling plant diseases are often contentious topics of policy. For developing countries that are highly dependent on agricultural commodity exports, mitigating the spread of plant diseases within their borders is important for both ensuring adequate supply to the market, as well as demonstrating ability to maintain quality control and phytosanitary health within production areas. For fruit, vegetables and many other agricultural production systems, the decisions made on the farm, in transport, and finally at the packaging and final shipping stage have a large impact on whether or not pests get through the supply chain. As demonstrated recently with the debate between the EU and India over the poor phytosanitary levels of India's fruit and vegetable exports, the inability of a country to maintain "clean" exports can have significant economic implications for the country's producers (Menon, 2014).[99]

[99] India topped the list of countries exporting fruit and vegetables to the UK with the most interceptions and border rejections for several years, despite issuing phytosanitary certificates that claimed to meet the agreed SPS

Studying the behaviours of stakeholders in a supply chain is also important to have better models of behind the border pest control in the process of setting SPS regulations. When designing SPS regulations and ensuring they mitigate against significant risks, a pest risk analysis will include the likely impact (socioeconomic as well as ecological) of a pest if it were to establish in the growing regions for the agricultural product (Kumschick & Richardson, 2013). These models include estimates of the yield losses for the potential areas affected by the given pest or disease. However, the assessment of impact is difficult. As Kumschick & Richardson (2013) state: "how to effectively incorporate impact into the RA [Risk Assessment] and how to predict impact need to be studied more thoroughly". Many studies have reported the importance of managers' responses to pests in determining the impact or optimal response to an invasion (Elbakidze, 2008; McKee, Goodhue, Zalom, et al., 2009; Halbert & Manjunath, 2004; Richards, Shanafelt & Fenichel, 2014; Oerke, 2006). As demonstrated quite significantly with the consequences of citrus greening disease (*huánglóngbìng* or HLB) on the orange industry in Florida, it is important to consider how individual actors on the ground respond to the incentives presented to them by a policy.[100]

Bioeconomic models are increasingly used to elucidate the impact of various parameters of the crop and disease to understand the optimal decisions for a grower to take (Elbakidze, 2008; McKee, Goodhue, Zalom, et al., 2009). Elbakidze (2008) for example models the impact that policy incentives may have on decisions backyard flock owners make to control avian influenza. In the empirical data as well, there is clear evidence that the economic impact from an invasive or pest is quite dependent on changes in human activity in response to the event (Richards, Shanafelt & Fenichel, 2014).

For these two general reasons (i.e. designing more effective policies to maintain a country's reputation for pest control, and generating better economic impact estimates in the design stage of SPS regulations), it is key to better understand how farmers respond to diseases and what influences their decisions on the farm. Understanding the factors that motivate their decisions

regulations on the goods. The United Kingdom decided to ban some fruit and vegetable imports from India. The UK argued that insects (like whiteflies and Thrips palmi) coming from India could establish in the United Kingdom, threatening British salad production as well as the UK's pest free status for fruit flies (Menon, 2014).

[100] In Florida, backyard citrus tree owners harboured a reservoir of disease. The lack of incentives for them to control their stock of trees likely expedited the spread of the disease across the state—hugely affecting the commercial growers (Halbert & Manjunath, 2004).

can help inform policies aimed to incentivize growers to produce cleaner products and control pests when they are observed. Failed certifications from poor quality at the port of the intended export market often originate back to the farm. This chapter introduces a case study that explores these issues for coffee pests and diseases in rural Uganda. Results from fieldwork in December and January 2013/14 during the coffee harvest season inform the analysis.

5.1. UGANDA'S COFFEE INDUSTRY AS A CASE STUDY

One of the unexplored questions arising from Chapters 2, 3, and 4 is what happens with SPS issues in the subset of WTO members (almost solely developing countries) who are not active participants in the SPS Committee in Geneva? From the perspective of a developing country, the previous chapters have been illuminating in two respects. Chapter 2 demonstrated that the majority of SPS notifying members are developed countries influenced by falling binding tariffs. Chapters 3 and 4 showed which nations were involved in SPS disputes and found evidence that developing countries struggle to resolve trade concerns with developed country trading partners maintaining suspect SPS measures. However, these chapters did not address some consequences for a developing country, such as consequences from a lack of (1) effective SPS controls within a country and (2) active participation in SPS policy setting at the international level.

Uganda is one of the dozens of least developed countries of the WTO that did not notify any SPS measures in the sample discussed in Chapters 2 and 3. While Uganda was an original member of the WTO since the GATT, they notified their first SPS measure in 2013 (a notification pertaining to regulations on imports of maize and maize-derived products).[101] They only began to set up an SPS National Enquiry Portal in 2013 with funding from Abi Trust (Kimbowa, 2013). With a lack of institutional capacity to control the border and lack of transparent import policies to foreign exporters, it is likely that the SPS issues within Uganda (and similar countries) are less controlled than more active participants in the WTO SPS system.

[101] Document number G/SPS/N/UGA/2 found in the SPS-IMS. Uganda issued a completely blank notification in 1999, which has not been considered here.

The coffee supply chain in Uganda reflects many of the issues that come from poor SPS controls within a country and at the border. Primarily these are: (1) lower prices received from importers due to rejections and quality issues, and (2) lower yields from foreign pests/diseases, which have become established in the country's production areas. These outcomes feed into and result from decisions made by farmers and traders within the supply chain.

The role of SPS issues in Uganda coffee is further emphasized by the background before the major incursion of CWD in the mid-90s. SPS issues led to both (1) declines in supply and (2) declines in price for the coffee sector. After liberalization of the sector in the first years of the 1990s, producer share of export price rose significantly from a highly variable 20% to 50% throughout the 1970s and 1980s to a steady 75% of export price in the 1990s post-liberalization (World Bank, 2006b).[102] Concurrent with this development were higher prices for coffee in the mid-90s relative to the previous 5-10 years. This lead to a surge in production. The peak in exports shows clearly in Figure 111 in the Appendix (page 420). Arguably, these beneficial conditions led to the incentive to smuggle coffee from the DR Congo into Uganda. By many accounts, coffee planting material, seedlings, and sacks of coffee cherries flowed freely across the porous border with no SPS regulations to control for vectors of pest/disease (Hakiza, DT, Musoli, et al., 2009; Cheyns, Mrema & Sallée, 2006; Rutherford, 2006; Flood, 2009). Due to poor SPS control, Coffee Wilt Disease (CWD) became established within Uganda resulting in massive devastation of farmers' plots in a short amount of time. The decline in export volumes as CWD became established shows markedly (again see Figure 111).

CWD is infamous for the destruction it caused—and continues to cause—to the coffee industry of Uganda. A group of closely related fungal pathogens causes the disease, the most of important of which is *Gibberella* (*Fusarium*) *xylarioides*. The fungus invades the vascular tissue of Robusta coffee (*C. canephora*)—the type of coffee which dominates Ugandan production—eventually killing the tree. Between its successful entry into Uganda from the Democratic Republic of Congo (likely in 1993) to the early 2000s, the disease killed around half of the Robusta coffee trees in Uganda (see more about CWD and its impact in the Appendix, section A.22.1, on page 388). As such, most growers are familiar with the damage

[102] Liberalization of the coffee sector was not universally agreed to be beneficial. Many of the NGO leaders interviewed felt that coffee producers were better organized and controlled quality better pre-liberalization (see Appendix A.26).

that is possible from foreign plant diseases. The Ugandan government has as well instituted policies to improve the production conditions in the industry, which growers may be familiar with or even benefited from directly.

The second effect of SPS issues is on price for coffee. Despite Uganda's contemporary issues with producing quality Robusta coffee, it was previously known for producing some of the highest quality Robusta in the world due to ideal growing conditions for the tree. The country previously maintained a significant price premium for its Robusta (World Bank, 2006b). This has been lost largely due to poor SPS control. Mycotoxins[103] are the primary SPS issue of coffee from the perspective of importers. While Uganda has had only two serious rejections of coffee shipments to Europe due to Ochratoxin A (a type of mycotoxin) in the first decade since the WTO began, the potential for many more is high (World Bank, 2006a). The few rejections are the result of (1) increased investments in sorting machinery by exporters and (2) coffee roasters mixing bad quality with good. Henson, Loader, Swinbank, et al. (2000) found in their case study of Ethiopia and Cameroon coffee supply chains that often roasters will blend coffee affected by quality issues to meet consumer and legal requirements. The World Bank (2006a) concluded in their report on analysing the threats to global trade integration for Uganda that the "Ugandan coffee industry faces a challenge related to compliance with emerging food safety regulation". If the EU were to enforce regulations on Ochratoxin limits, 7-18% of all green coffee imports would be rejected (World Bank, 2006a).[104] Within the Ugandan system, mycotoxin contamination of coffee, along with other major agriculture and food products, is well beyond most developed country limits due to poor handling and knowledge of SPS issues (Kaaya & Warren, 2005).

Rudaheranwa, Guloba & Nabiddo (2007) outline the constraints to Uganda's exports, which have resulted in a growing trade deficit in the 2000s despite the Ugandan government's "export-led growth" policies for the country. They take stock of the SPS capacities and gaps within the public sector export agencies, as well as, the costs of upgrades needed in the private sector. They find there are both supply side issues, as well as, market access constraints. Since

[103] A group of toxic chemicals produced by a variety moulds. The mycotoxins of most concern within food/agricultural exports are Aflatoxins and Ochratoxins, within each of these are several different forms with alphanumeric designations: e.g. Ochratoxin A or Aflatoxin B_1)
[104] Already, the majority of EU rejections of food and agricultural imports every year are due to mycotoxin contamination (see Appendix A.28).

Uganda finds tariff-free and quota-free access to most major economies via preferential trade agreements for least-developed countries, the market access constraints are almost completely due to inadequate quality of production and failure to meet SPS/TBT standards (Rudaheranwa, Guloba & Nabiddo, 2007). For example, as of 2007, the laboratory at the Uganda National Bureau of Standards was the only accredited microbiological laboratory in the country capable of conducting tests of total plate counts of bacteria and presence of yeasts, moulds, and coliforms. Even the one certified laboratory still lacked capacity to analyse a subset of chemical residues to show compliance with SPS limits (Rudaheranwa, Guloba & Nabiddo, 2007).

As the government's coffee industry support arm, the Uganda Coffee Development Authority (UCDA) has a goal of "promoting production" and "controlling the quality" of coffee to support the position of Uganda as a high value source of coffee on the world market (UCDA, 2014). Production and quality have both faced several barriers in Uganda, which will be explored in more detail throughout the following chapters. In order to achieve these production and quality goals, how different actors within the coffee supply chain perceive and act on supply risks (e.g. pests and diseases) needs to be better understood. Previous studies by World Bank (2006a) have found that traders and farmers are generally unaware of how SPS regulations affect the prices they receive for their products. This study will contribute to understanding what factors motivate famers' decisions and investments in coffee production, given the losses they have faced from poor SPS regulations at Uganda's border and low prices from poor SPS quality maintenance within the domestic supply chain.

The Ugandan coffee industry is an ideal case study for exploring the decision-making and responses to pests from farmers in an agricultural industry. Uganda's coffee production is a critical sector of the national economy compromising some 25% of all foreign exchange earnings, 40% of total export value, and providing income for over 500,000 smallholders directly and nearly 3.5 million families that are in some way reliant on the industry (UCDA, 2014; Cheyns, Mrema & Sallée, 2006). Unlike other industries in many countries where larger suppliers dominate production (e.g. wheat in the USA or soybean in Brazil), the vast majority of Uganda's coffee production is supplied by smallholder farmers with less than one hectare of land who must react to conditions, but have little influence over wider policy (Cheyns, Mrema & Sallée, 2006).

While coffee is an important export of Uganda, Uganda is quite a small player on the international market. Uganda has very little power to influence the price of coffee or the conditions of coffee that importers from the major markets demand. The international fluctuations of the market have an influence on the responses that the Ugandan coffee sector makes. When prices are up, farmers may invest more in their coffee crop and devote more time and effort to coffee production. When prices are down farmers may switch effort to alternative crops. Additionally, exporters store coffee in low price years to wait for higher price years—hedging their exposure to an uncertain market with options on the London futures exchange for Robusta. As a result, while it is beyond the scope for this specific case study, some analysis on the global and regional trends for green coffee exports, which influence Ugandan coffee production, is found in Appendix A.24 (pages 405 to 429).

Research discussed in Appendix A.24 examines the changes in the global export market for green coffee from 1961 to 2011 using UN FAO data (FAOSTAT, 2014). Analysis is conducted at the global level (section A.25.1), for the top country exporters (section A.25.2), and at the East Africa regional level (sections A.25.3 and A.25.4). The last section (A.25.5) explores the structure of the export industry using monthly export and import data manually extracted by the author from Uganda Coffee Development Authority (UCDA) monthly reports. These overviews and limited analysis of the coffee export market help to set the context of the survey results in this chapter, Chapter 6, and Chapter 7.

5.2. OVERVIEW OF CHAPTERS OF CASE STUDY

This case study explores the perceived gravity of CWD and other pests. Each of the following three chapters will address various questions, but the two guiding research questions addressed in this case study are:

1) How does pest/disease risk information transfer among stakeholders in the Robusta coffee supply chain in Uganda and do stakeholders agree on the risks?
2) What characteristics of smallholder coffee farmers determine their response to CWD and other coffee pests/diseases?

The case study is divided among three chapters. This chapter introduces the fieldwork that was conducted in Uganda by the author. The organizations that participated in the study along with the methodology of the workshops and the interviews is presented in section 5.3 below. The chapter also discusses the differences among cooperative and non-cooperative coffee growers surveyed. Following the methodology section is the literature review (section 5.3.5) of the relevant studies on farmer decision-making with a focus on the different behaviours and outcomes expected for farmers in cooperatives. Section 5.5 examines organizational characteristics and production outcomes from coffee farmers' associations in the survey in Uganda.

Following Chapter 5, Chapter 6 discusses results measuring farmers' risk tolerance in three different contexts. The first part addresses one of the main questions (question 1, above) of the case study about agreement among stakeholders about priority pests for Robusta coffee. Section 6.4.1 presents and discusses the results of the pest risk survey for different actors in the supply chain. The severity and frequency of five pests are summarized from the 119 surveyed farmers. The second measurement of risk tolerance, section 6.4.2 contains the results from the risk-aversion scores of 119 farmers and 89 traders surveyed in Uganda, using a classic Holt & Laury (2002) experimental design. Lastly, section 6.4.3 describes the results of a coffee trading game developed by the author to elicit a coffee grower groups' willingness to accept stable prices with less market risks through a contract (methodology discussed in section 6.2.1).

Chapter 7 investigates drivers of farmers' decisions and on-farm practices. Particularly of interest to the second research question (above), the characteristics of farmers that are related to their responses pre- and post- disease incident on their plot are examined. One major consideration is the role that social connections play in shaping decisions. Section 7.2.1 explores the impact that farmers' social networks have on their decisions and the prices they receive for their product in the market. Section 7.2.3 assesses the determinants of decisions on the plot. What factors seem to predict beneficial decisions like fertilizing and pruning of the coffee plot are analysed based on data from the household (HH) survey. Section 7.2.4 investigates the other crops and income generating activities that coffee growers are involved in and then section 7.2.5 estimates the probability that a farmer will exit coffee based on different attributes. Since exit is difficult to measure, the lack of planting seedlings while losing trees to serious pest/disease incidents is used as a proxy.

5.3. METHODOLOGY

A survey of Ugandan coffee growers and traders in the districts of Buikwe, Kayunga, and Kumuli was conducted in December 2013 and January 2014 sponsored by a grant from the University of California at Davis (UC-Davis).[105] The author along with a collaborator at UC-Davis, Dr. Neil McRoberts, travelled to Uganda to conduct the survey along with Mr. Ignitius Bwoogi of the Rural Agency for Sustainable Development (RASD).[106] The fieldwork consisted of four components: (1) grower and trader group workshops; (2) individual HH surveys of growers and traders; (3) expert interviews with stakeholders, including cooperative managers, NGO directors, extension agents, and international exporters; and (4) a coffee trading game. The methodologies used for each type of data gathering are covered in separate sections below: section 5.3.2 for the expert interviews, section 5.3.3 for the workshops, and sections 5.3.4 and 5.3.5 for the HH surveys. The methodology for the coffee trading game is discussed in Chapter 6 (section 6.2.1) since the results are presented in that chapter.

5.3.1. Organizations involved with the fieldwork

Below in Table 37 is a list of the organizations that provided data and/or aided with the fieldwork in some way. For every organization—as well as their involvement in the capacity described below—the author conducted semi-structured interviews with one or more members of their staff on a one-on-one basis. These interviews are listed along with additional interview sources in Table 39 of section 5.3.2 on page 162. The decision to anonymize the names of some organizations (e.g. "NGO B" in Table 37 below) is also discussed there, but generally was done to follow best practice survey and interview design guidance to protect confidentiality given by Oppenheim (2000, pp.105, 266).

[105] SEED Grant awarded to Dr. Neil McRoberts and Professor Thomas Gordon in the Department of Plant Pathology of UC-Davis; Lee Pearson in the Centre for Environmental Policy at Imperial College London; and Ignitius Bwoogi at the Rural Agency for Sustainable Development in Nkokonjeru, Uganda.
[106] See section 5.3.1 for more information about the partner Non-Governmental Organization (NGO)

Table 37: List of organizations and their involvement with fieldwork in Uganda

Name	Type	Research Involvement
RASD	NGO	• Partner in household surveys • Partner in Nkokonjeru group workshop
(NGO B)	NGO	• Partner in Kamuli group workshop • Provided producer data • Provided management documents
(Exporter A)	Export Firm	• Provided producer data
NUCAFE – Nkokonjeru	Gov. Association	• Provided producer data

The main partner for the fieldwork in the Nkokonjeru area (including the districts of Buikwe, and Kayunga) was the Rural Agency for Sustainable Development (RASD). The NGO aided with all the HH surveys and offered their facilities to run the coffee group workshop. They helped find willing research assistants from students at local universities who volunteered to help the author conduct the HH surveys. RASD's Executive Director, Ignitius Bwoogi, was a partner on the research grant.

RASD is an NGO, which was founded initially as a CBO (Community Based Organization) in 2000 by a group of concerned citizens of Nkokonjeru Town Council. The RASD Resource Centre is in Nkokonjeru, Buikwe District about halfway between Kampala and Jinja just miles from the shores of Lake Victoria. RASD registered as an NGO with the National NGO Board (Reg no. 5.5914/5544) in 2005. Focusing much of its resources in the Nkokonjeru community, RASD operates in the greater Mukono area districts (Mukono, Kayunga, Buikwe, and Buvuma).[107] Since 2009, RASD has had on-going projects with Engineers Without Borders volunteers from the United Kingdom in the area of improving coffee processing technology.[108]

NGO B is the second NGO that collaborated with the author on this research. NGO B was established in the early 1980s with the original focus on providing scholarships to cover school fees for children to attend secondary school and university. While they still allocate a large component of their charitable endeavours to educational support, the mission of the NGO has

[107] More information about RASD can be found on their website: http://rasd-uganda.org

[108] For full disclosure: the author was the UK-based project manager selecting and coordinating student volunteers for these summer projects at RASD for the summers of 2010, 2011, and 2012. As well, the author was the president of the student chapter of Engineers without Borders at Duke University that started working with RASD in 2006.

changed over time with a greater emphasis on agricultural development. The largest project NGO B has conducted to date was in the coffee export sector. In 2006, NGO B, in partnership with a major coffee export firm based in Kampala, was awarded a 5-year, >€20,000 grant from the EU to help establish an export market for certified coffee with smallholder producer groups in Uganda. As a part of the project, the NGO organized 3,500 farmers into a cooperative that would offer a premium for members' UTZ-certified coffee. NGO B gave each farmer extensive training in Good Agricultural Practices (GAPs) and requirements for maintaining UTZ certification.

NGO B registered a further 1,200 farmers in 2012 with follow-on funding from the EU in an adjacent town just southeast of the main implementation site. NGO B gave the author extensive access to their database on production from their registered farmers as well as documentation on some of the challenges they faced with UTZ certification. These documents and data form the basis of the discussion in sections 5.5.2 and 5.5.5. However, the majority of the data is left for future research, as there was extensive data coverage of growers involved over 5 years, for 12 parishes, and with 20+ villages in each parish. The data can also serve as a fruitful source for comparison against a cooperative with a different training regime to enhance the understanding of the returns to extension support and training at farmer field schools. This important topic is left for future research due to time constraints, but brief comparisons of the production data for ~3,000 farmers to other coffee farming systems is found in section 5.5.4 starting on page 190.

Exporter A from Table 37 is one of the largest exporters of Ugandan green coffee (see analysis of the large exporters of Ugandan coffee in Appendix A.25.5). Like other major export firms in Uganda, Exporter A is working to boost production of coffee—and possibly lock-in smallholder suppliers of quality coffee—by funding the creation of coffee farmer groups and training programs on how to produce quality coffee. In the Buikwe district, Exporter A was in the process of registering farmers at the time of the fieldwork with a goal of registering some 3,000 farmers by the end of April 2014. Their local director, interviewee #4, agreed to release their preliminary data on the 838 farmers they had registered so far for any research purposes. This group of farmers in Buikwe was used to check that the HH survey conducted as a part of this research had not suffered from a selection bias compared to this larger set of the population of coffee farmers in the area.[109]

The National Agricultural Advisory Services (NAADS)[110] is the government's official extension agency that works with farmers on a variety of crops including coffee. The local NAADS office for Buikwe district was based in Nkokonjeru, not far from the resource centre of RASD. NAADS provides technical advice and has formal agreements with government programs and politicians to facilitate the delivery of coffee seedlings locally. The interviewees (#16 and #17)[111] also said that a plant health clinic for coffee happened every Monday.[112] The main activity the NAADS office engaged in—according to the interviewees—was the registration of farming associations as well as training and distribution of free seedlings.

The National Union of Coffee Agribusinesses and Farm Enterprises (NUCAFE)[113] is a national association in Uganda for coffee farmers and traders. In the area covered in this study, NUCAFE mainly functioned as an alternative buyer of coffee that farmers could use besides selling it to a trader or bringing coffee directly to the coffee mill. Farmers could join NUCAFE for a small fee of 5,000 Ugandan Shillings (approximately £1.25 at the time of the survey) and buy shares in the association for 10,000 Uganda Shillings per share.[114] NUCAFE did have a campaign to register farmers within the district as "NUCAFE certified" farmers and the business manager (interviewee #18) said there were trainings on coffee management as well. Farmers who participated in the present HH survey though disagreed: farmers reported there was no training and no subsequent follow-up after paying registration. Several farmers including specifically #45 and #67 from the HH survey claimed they felt NUCAFE just took their money and gave no benefit and as a result, they would never join a co-op again.

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[109] Table 48 on page 230 in section 6.3.1 shows the results of the tests.
[110] More information about NAADS can be found on their website: http://www.naads.or.ug/
[111] See the interview list in Table 39 on page 162
[112] However, the author could not confirm the evidence of a plant health clinic. It did not occur the Monday of the interview since the manager was out of town, but it also was not obvious that there was a plant health clinic either of the previous two weeks that the research team passed by the NAADS offices.
[113] More information about NUCAFE can be found on their website: http://www.nucafe.org/
[114] Currently the shares were not paying a dividend, but there were plans to pay dividends if there are any profits for the farmers according to the business manager (interviewee #18). As a result, there was not currently any benefit to owning shares that the author could discern and the interviewee did not believe there would be a buy back scheme or a limit on the number of shares sold (as a result, it seemed very likely their value would only be diluted in time and, without a dividend, worthless).

Ideally, NUCAFE is meant to buy *kase* (the Luganda[115] word for dried and milled coffee, which is also called FAQ or Fair Average Quality) allowing farmers to add as much value as possible to their product before they sell it. To facilitate this strategy, the NUCAFE office is based at the local processing mill. NUCAFE had registered over a thousand farmers in the Nkokonjeru area, but was not considered an active player by many of the largest traders interviewed in the HH survey (#10, #11, and #12). Several traders claimed that the local NUCAFE operation had not bought a single 60kg sack of coffee in the 2013 season. However, the interview conducted with the local Business Manager of NUCAFE, interviewee #18, disagreed with this perception—though the author did not ask her directly about the discrepancy. She claimed to be very active and gave the author access and free use of her organization's records on production data for further research.

The availability of data collected by the author from all three organizations as well as from the HH survey is summarized in Table 38. Given the variety and sample sizes in the data, several research projects on coffee production in Uganda could be conducted in the future. It would also help to parameterize models of coffee production and investment.

[115] Luganda is the language of the people of Buganda, the central kingdom located in Uganda.

Table 38: Data availability for production data collected in the field from organizations contacted

Category	Variable	EXPORTER A	NUCAFE	NGO B	HH Survey
Location	District	X	X	X	X
	Sub-county	X	X		
	Parish	X	X	X	
	Village	X		X	X
	Co-op group		X	X	
HH	Name	X	X	X	X
	Age	X			X
	Sex	X	X	X	X
	Education	X			X
	Family size	X			X
	Sources of other farm income	X			X
Plot	Total acreage	X		X	X
	Coffee acreage	X	X	X	X
	Spacing of coffee trees	X			
	Number of shade trees	X			
	Number productive trees	X		X	
	Number unproductive trees	X		X	
	Number total coffee trees	X	X	X	X
Production	Yield (kg / tree)	X	C	C	C
	Yield (kg / ha)	C	X	C	X
	Kg sold to co-op			X	
Practices	GAPs implemented	X			X
	UTZ Compliant			X	
Stats.	Number of farmers	838	1,145	3,500	119
	Years	2013	2013	2013 2012 2010 2009 2007	2013

Note: *X: data is recorded*
C: able to calculate

5.3.2. Interviews

Semi-structured, expert interviews with notes recorded were used for interviewing contacts in export firms in Kampala by the author (called “interviews” throughout). These interviews were conducted exclusively in English as the exporters and coffee industry agencies had English as their official language for business. A list of the contacts interviewed by the author is below in Table 39.

Table 39: Uganda coffee industry interview list

ID	Position	Organization Name	Organization Type	Location	Interview Date
1	Executive Director	*(NGO A)*	NGO	Nkokonjeru	18/12/13
2	Project Manager	*(Exporter A)*	Exporter	Kampala	7/01/14
3	Quality Manager	*(Exporter A)*	Exporter	Kampala	7/01/14
4	Field Manager	*(Exporter A)*	Exporter	Nkokonjeru	7/01/14
5	Head of Programs	*(NGO B)*	NGO	Kampala	8/01/14
6	Executive Director	*(NGO B)*	NGO	Kampala	8/01/14
7	Project Officer	*(NGO B)*	NGO	Kisozi	14/01/14
8	Sustainability Manager	*(Exporter B)*	Exporter	Kampala	17/01/14
9	Coffee Agronomist	*(Exporter B)*	Exporter	Kampala	17/01/14
10	Managing Director	*(Exporter B)*	Exporter	Kampala	17/01/14
11	Research Fellow	EPRC	Research	Kampala	10/01/14
12	Research Fellow	EPRC	Research	Kampala	10/01/14
13	Employee	*(Inputs A)*	Inputs store	Nkokonjeru	7/01/14
14	President & CEO	*(Training A)*	Consulting	Kampala	10/01/14
15	Senior Scientist	COREC	Research	Mukono	10/01/14
16	Coordinator	NAADS	Extension	Nkokonjeru	13/01/14
17	Development Officer	NAADS	Extension	Nkokonjeru	13/01/14
18	Business Manager	NUCAFE	Association	Nkokonjeru	13/01/14
19	Founder	*(Start-up A)*	Business	Mukono	10/01/14

Export firms were contacted based on the results from analysing the largest exporters in the Ugandan market (Appendix A.25.5, page 425). The top ten were contacted and then two from the top five were formally interviewed by the author. "NGO B" was selected based on referral from a colleague in the Centre for Environmental Policy who had previously worked on agricultural development in Uganda. The employee interviewed from "Inputs A" was the primary employee for the only inputs supply store in town.[116] The entrepreneur of "Start-up A" was a contact of Ignitius Bwoogi and was the former director of the only washed[117] Robusta focused coffee business in Buikwe district before it failed. Several intuitions have heavy involvement in the coffee industry in Uganda and were obvious targets for interviews. The

[116] Several traders who owned shops selling a variety of household products and trading coffee, would also sell a selected number of pesticides, herbicides, and fertilizers. Inputs A was the only inputs focused shop in the main town of Nkokonjeru though.

[117] There are two basic methods of processing coffee. (1) Natural or "dry" processing means the coffee cherries are harvested, dried, and then milled to extract the coffee bean inside. This is the usual method of processing for Ugandan Robusta coffee. (2) Washed processing involves taking harvested coffee cherries, floating them in tanks of water and then de-pulping the berry from the bean. The sticky mucilage is left to dry on the bean and then extracted as well to produce a coffee bean. This method is common for Arabica coffee production.

Economic Policy Research Centre (EPRC) is the main institution for analysis of the Ugandan government's policies and provides input to policymakers. The EPRC has conducted work on CWD and so two of their research fellows were contacted by the author for interview. Similarly, the National Crops Resources Research Institute (NaCCRI) and the associated Coffee Research Centre (COREC) under NaCCRI is the main government scientific institute for coffee. A Senior Scientist at COREC known by interviewee #19 was contacted and agreed to be interviewed. Representatives from NAADS and NUCAFE (described in the previous section) were also interviewed. The Uganda Coffee Development Authority (UCDA) was one organization that is unfortunately lacking from the interview list. Many attempts were made by the author to set a meeting with someone from the authority in Kampala, but a suitable time could not be arranged during the fieldwork.

Anonymity was important for several interviewees from prominent export firms and NGOs; especially, the managing director of an intentionally known and top five (by annual volume from Uganda) exporter. Additionally, the President and CEO (interview #14) of the organization referred to in Table 39 as "Training A" could easily be identified if the real name of the organization was given as there are few organizations working on connecting supply chain stakeholders, holding training workshops, and producing reports on the coffee industry. As such, the decision was taken not to reference the names or institutions represented by these types of organizations as some of their honest evaluations of other stakeholders in the industry could be perceived as critical. The majority of the interviewees are anonymized following the standard methodology of interviews recommended by Oppenheim (2000, pp.265–66); a highly cited methodology book used widely in Political Science and other fields. The organization names for interview #11, #12, and #15-18 are given as they have many employees in similar roles so they cannot be identified based on job title alone.

The following list of topics was used to guide the semi-structured interviews:

1. Integration in supply chain:
   - How does the organization you work for fit within the supply chain for Robusta coffee in Uganda?
   - What other organizations do you work directly with?
2. Pests in the supply chain:
   - For the following pests, which ones are most damaging to the production of Robusta coffee? (Here the same images were presented from the pest component of the household survey).
   - How are the pests listed best controlled?
3. Barriers in the supply chain:
   - What are the barriers to producing more coffee in Uganda?
   - What are the limitations to improving quality?
4. Advice and connection to farmers:
   - What sort of advice does your organization give farmers?
   - What do you think growers of coffee should do differently?

Questions were adapted to the context of the organization being interviewed as well as topics that arose during conversation. For example, the interviews with NAADS focused more on topics 2 and 4, while the interviews with exporters focused mostly on topic 3.

5.3.3. Workshops

Two workshops were conducted with coffee farmers and traders. The first took place in Nkokonjeru Town Council (Buikwe District) at the RASD's Resource Centre with nearly 100 farmers and traders in attendance throughout the day.[118] The second workshop was a condensed version conducted in Kamuli town (Kamuli District) with 2 staff of NGO B and around 40 members of the cooperative. At the Kamuli workshop, 31 farmers from the cooperative completed the same HH survey that was used in Buikwe and Kayunga districts (see survey methodology below in section 5.3.5). Example photos from each workshop in Figure 28.

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[118] The official count was taken based on the research team paid for 98 meals at lunch counted by the caterers providing the food. Several people arrived after lunch and others left during the day.

Figure 28: Setup for big group discussion at farmer workshops in Nkokonjeru (top) and Kamuli (bottom)

The Nkokonjeru farmer workshop day held at RASD was divided into three parts of about two hours each with a break for lunch. The outline agenda for the day is found in Appendix A.16 on page 375. The first part of the day was about understanding the market and other crop opportunities. The author designed a set of questions, which were loosely followed to discuss in small groups of around 15 people. The survey team from the HH surveys was used to help translate the questions and report on some of the discussion occurring during the workshop. For one of the activities, each group was asked to make a poster representing the answers to the following two prompts:

1. Think about how the coffee supply chain works now. Assuming the final export product is priced at 5,000 Uganda Shillings (USh) per kg[119], what would be the price at each stage of the process from the harvest to export?
2. How do you think the coffee supply chain should work? Again, assume the export price is 5,000 USh per kg.

[119] a high, but realistic price at the time

The results from this part of the exercise are presented and discussed on page 198 in section 5.5.7. In addition to the supply chain questions, groups were asked to discuss damage from coffee pests/diseases and what actions they may take to mitigate these risks or switch effort towards other crops. The results from that part of the workshop is explained and discussed in Chapter 7. The posters created by every group were presented to the entire audience for discussion at the end of each part of the workshop. The research team saved the posters and took notes throughout the sessions to inform the discussions of the results. Some example photos from the workshop discussions are found in Figure 29 below.

Figure 29: Example photos of workshop discussion among grower/trader groups

5.3.4. Special equipment for household surveys

Each interviewer had a Samsung Galaxy Y S5360 smart phone that captured audio, video, photo, and GPS location at each household interviewed. The phone was GPS-enabled such that the photo taken of the grower or trader would allow the researcher to locate them on the map.

The photos were uploaded to Panoramio[120], Google Earth[121], and Picasa[122] (all Google products) which enabled maps to be made with both satellite imagery as well as the location of each interview. The map produced of the farmers surveyed is in section 5.3.5 on page 169.

5.3.5. Surveys

A paper-based survey with a fixed set of questions administered one-on-one at a person's household (or place of work) was used for the growers and traders surveyed. Consent was obtained from participants who were allowed to end participation at any point of the survey and still receive compensation via the risk-aversion game at the end (see methods for risk-aversion game in Chapter 6). Appendix A.17 on page 376 contains an example of the consent page that was given and explained to the participants before agreeing to join in the survey. Smallholders had to confirm that they were actively growing coffee on their plots and had at least ten trees to qualify for involvement in the survey.

A local, bilingual survey team of four people trained by the author conducted these surveys almost exclusively in Luganda with English translation during recording by the member of the survey team.[123] The surveyors (local university students and volunteers at RASD) had previously helped with the field research of Dr. Kate Scow at University of California at Davis (Kearney, Fonte, Salomon, et al., 2012). The team of experienced surveyors was trained as a group by the author, who then did at least three surveys with each member to ensure the surveys were administered as accurately and consistently as possible. Each member of the survey team was paid a base salary of 10,000 Uganda Shillings (USh) per day in addition to a lunch allowance and bonus at the end of the project. This salary was above local standards, similar to what the previous research teams in Nkokonjeru had paid, and suggested as fair by RASD.

Farmers and traders were asked similar questions with some variances to account for their different place in the supply chain. Each was given a 50-question survey that was divided into four sections: (1) Coffee Production, (2) Network Connections, (3) Pest/Disease Survey, and (4) Household Controls. The study was piloted for the first two days of the survey period where

[120] http://www.panoramio.com/
[121] http://www.google.co.uk/intl/en_uk/earth/
[122] http://picasa.google.co.uk/
[123] The survey team, in addition to the author, consisted of Ignitius Bwoogi, Anthony Kisitu, Paul Kisekke, and George Kawa.

the first five farmers were interviewed and the questions were updated based on the feedback from the respondents as well as the survey team. The results were recorded, but had blanks for questions that were not included or were not comparable (the differences between the test and the final survey were minimal and mostly about phrasing and design for easily recording answers). The final survey design used for farmers/growers is in Appendix A.19 (pages 378 - 383) and Appendix A.20 for traders (pages 383 - 387).

The farmer survey was conducted with 119 farmers in Buikwe and Kayunga districts, as well as, with 31 farmers in Kamuli district at the workshop with NGO B. The trader survey was conducted with 89 traders in Buikwe and Kayunga districts only. Using the tools described in section 5.3.4, maps of the farmers' locations and traders' locations were constructed. Figure 30 displays the map of all the farmers surveyed in Buikwe, Kayunga, and Kamuli districts.[124] The majority of farmers were surveyed in Buikwe District around Nkokonjeru Town, which is shown in more detail in Figure 31.

[124] Traders were located in similar areas and so the map is not shown, though the data were recorded.

Note: each image is at the location of the grower, but at this scale just demonstrates the approximate locations of the survey area.

Figure 30: Map of household survey locations among the three districts surveyed

The administration of the survey was done on location at the farmer's house or trader's house. Around half of the surveys were conducted with two people present from the survey team to ensure accuracy of the recording at the beginning of the surveying period. However, in the final weeks of the survey, surveyors went out individually to increase the sample size of the study. The author participated in around half of the surveys to ensure quality control in their administration, as well as, to become more informed for conducting subsequent interviews with stakeholders in Kampala. Notes on perceptions and comments made by the participants were recorded and will be referred to throughout the study by the id number of the participant (e.g. farmer #45, or trader #73). Photos of a few of the surveys being conducted are shown in Figure 32 below for illustrative purposes.

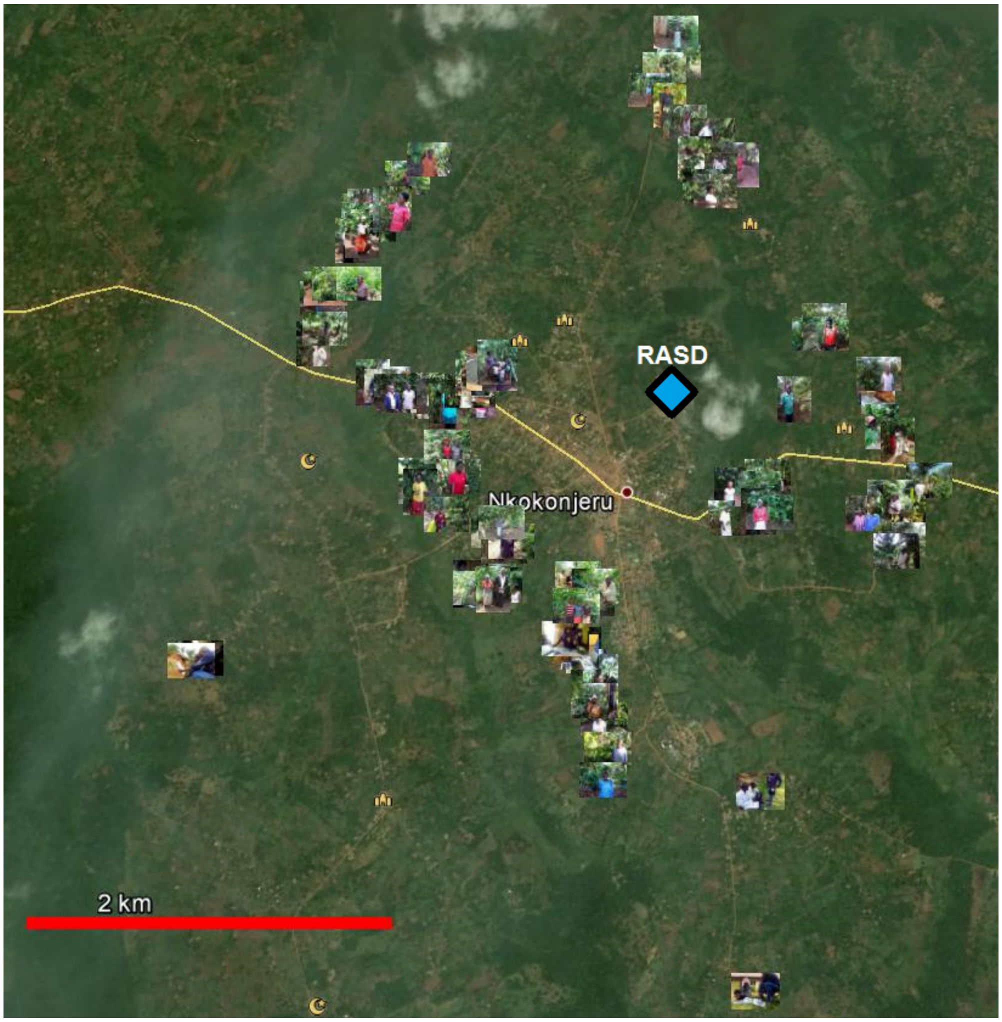

Figure 31: Map of surveyed Buikwe farmers around central town of Nkokonjeru where RASD is based

(a) (b)

(c) (d)

Note: (a) author (left) conducting the interview of the farmer (right) with translator (centre); (b) coffee grower explaining the damage caused by the pest in the image given to her (bottom left of photo); (c) translator (centre) from survey team explains the five pests that are common and gets husband (right) to answer which ones they have seen as his wife (left) looks on; (d) after the survey, if the grower was interested, the surveyor would check the field and demonstrate evidence of different pests/diseases

Figure 32: Examples of survey administration in the field

Non-participation was minimal, but not formally recorded by every surveyor on the team. On the surveys that the author participated in, only two families out of more than 50 reported not wanting to participate after the survey was explained. Indirect methods of not participating could have included parents telling children to say their parents were not home or claiming to not grow any coffee. While not recorded either, based on the author's experience with the surveys, these potential reasons for not participating did not occur very often if at all.

At the mid-point of the survey period, an additional check-in as a team was conducted to discuss any issues that were arising. The only issue was the explanation for the risk-aversion game used as compensation at the end of the interview. Further details are discussed in Chapter 6 methodology section (6.2.3). In short, no changes were made in the administration of the survey at any point during data collection.

5.4. LITERATURE REVIEW

The standard economic models of choice centre on the idea that a rational decision maker, when faced with a series of possible choices, will decide on the one that maximizes their utility (Tversky & Kahneman, 1981). Limitations to this standard approach and alternative theories of choice have been discussed in decades of economic theory on decision-making. The main critiques and subsequent changes to the approach of viewing decisions have been due to observations that real-life economic actors often have (1) time inconsistent preferences, (2) make choices that depend on how the options are framed, and (3) are limited in the degree to which they can process information. These are discussed in more detail with influential papers on each theme below.

A full review of the different, foundational, approaches to study economic decision-making is found in Edwards (1954). In short, Edwards demonstrates that most earlier work focused on theories of "riskless" choices for agents that are completely informed, sensitive to changes in prices, and rational. When moving into the topic of choices under risk or uncertainty, the role of rationality has come under more scrutiny; specifically, whether decision-makers truly have transivity of preferences and maximize expected utility (Edwards, 1954). Farmers, in this case, or decision-makers generally, may be limited both by access to external information as well as ability to process that knowledge. (Simon, 1956) coined the term "bounded rationality" to convey that idea that there are constraints to the objectives, information, and tools that a decision-maker can consider when evaluating and taking action. Simon's work in the 1950s influenced the future fields of psychology and economics by addressing how decisions on allocation of resources are influenced by human cognition (Simon, 1959). Simon described the choice process as:

> A real-life decision involves some goals or values, some facts about the environment, and some inferences drawn from the values and facts...the whole process may be viewed, metaphorically, as a process of "reasoning," where the values and facts serve as premises, and the decision that is finally reached is inferred from the premises. (Simon, 1959)

Gigerenzer & Goldstein (1996) in a highly influential paper extend Simon's original concept of "bounded rationality" with the idea that heuristics lead to better, faster decisions than optimal decision-making procedures under limited information. In short, simple factors in reduced form models led to useful predictions of actual behaviour (Gigerenzer & Goldstein, 1996). The simplification of factors inspires many conceptual models of decision-making.

As well as criticizing the ability of a decision-maker's rationality in terms of perfect information, another shift within the theoretical literature was the assumptions of the utility maximization as the criteria for the choice. There are several lines of inquiry, but perhaps the most influential was Kahneman & Tversky (1979) paper in *Econometrica* for "Prospect Theory". Their paper formalized the observations from psychology that people often overweight low probability events. They showed that decision weights can be used to explain this preference, as well as, incorporating the observations that people overvalue probable outcomes compared to certain outcomes. Their paper also showed that decisions on uncertain choices are reference dependent; gains and losses are only relative to that reference point set by the decision-maker (Kahneman & Tversky, 1979).[125]

Related critiques against the assumptions of economic models for decisions with consequences over time were being made against the discounted utility model (see Frederick, Loewenstein & O'donoghue (2002) for a thorough review). Additionally, criticisms are made for expected utility maximization as the decision criteria by the observation that decision-makers are often influenced by the weight of the consequence of the decision. Rabin (2000) notably developed a theory to calibrate models to account for the fact that decision-makers are risk-averse over decisions of "modest stakes" when most models would predict risk-neutrality. More of the

[125] Kahneman won the Nobel Prize in Economics in 2002 for his work in this area.

literature on the influence of risk-aversion on decision-making is returned to in section 6.1, where the empirical literature and evidence from simulations and games is examined before the presentation of the results from the case study in Uganda. Many of these updates to the economic theory of decision-making are incorporated into the design of conceptual frameworks of the decision-making process.

There are several conceptual models of decision-making applied to agriculture. Errington (1986) categorized the decision process for farmers as happening in three stages: from (1) decision–making, to (2) decision-taking, and finally (3) implementing. Information comes in from internal and external sources in the first step of the decision-making. While the model was similar in nature to Simon (1959), Errington (1986) was ultimately concerned which decisions the farmer delegated, how that was decided, and what factors influenced that decision. Errington builds on much of the organizational studies research of the 1960s and 1970s that were based on decisions taken by leaders on how to organize work (Rantamäki-Lahtinen, 2009). The earliest influence for many studies were Pugh, Hickson, Hinings, et al. (1963), who was ultimately interested in identifying factors that could explain the dimensions of organizational structure (not reviewed in the present study). Another influential work on farm decision-making, Hansson & Ferguson (2011) construct a model with four structures that influence farmer investment behaviour in their dairy farms. They seek to understand which farmers further develop their dairy farms and which ones exit dairy production. The four structures are: decision structure, business structure, cognitive structure, and network structure. The emphasis on networks and factors affecting how farmers' perceive and interpret information will be returned to in section 7.1 with regards to Ugandan coffee growers' social connections and views on the fair price for coffee.

Analogous factors to that basic process that Simon (1959) and Errington (1986) describe can be found in the author's conceptual framework (Figure 33) presented below. The framework is influenced by the farmer decision model used in Mumford & Norton (1984) to explain farmers' decisions to control pests. It is used—with some modifications discussed in section 7.1—to guide the modelling for farmers' decisions to abandon or invest in coffee production (section 7.2.5).

The conceptual framework follows the insights from two systematic reviews of the decision-making literature. The first (1) is the comprehensive review of farming decision models by Öhlmér, Olson & Brehmer (1998). They review the literature from the 1950s to the late 1990s and conclude that the vast majority of conceptual frameworks take six to eight linear steps of decision-making. However, from empirical data the key insight is that there is a non-linear process of observation and searching for information paired with evaluation, decision-making, and post-evaluation (Öhlmér, Olson & Brehmer, 1998). This insight is carried forward in the continuous perception/search, evaluation, and decision loop in Figure 33. The second (2) set of influences comes from the systematic review of theoretical frameworks used in the strategic management literature from the 1970s to 1990s by Rajagopalan, Rasheed & Datta (1993). While several of their factors echo Simon (1959) in terms of access to external information, Rajagopalan, Rasheed & Datta (1993) highlight the role of decision-maker characteristics and environmental factors in the strategic decision process (shown in the red rounded rectangles attached to the characteristics of farmer category in Figure 33).

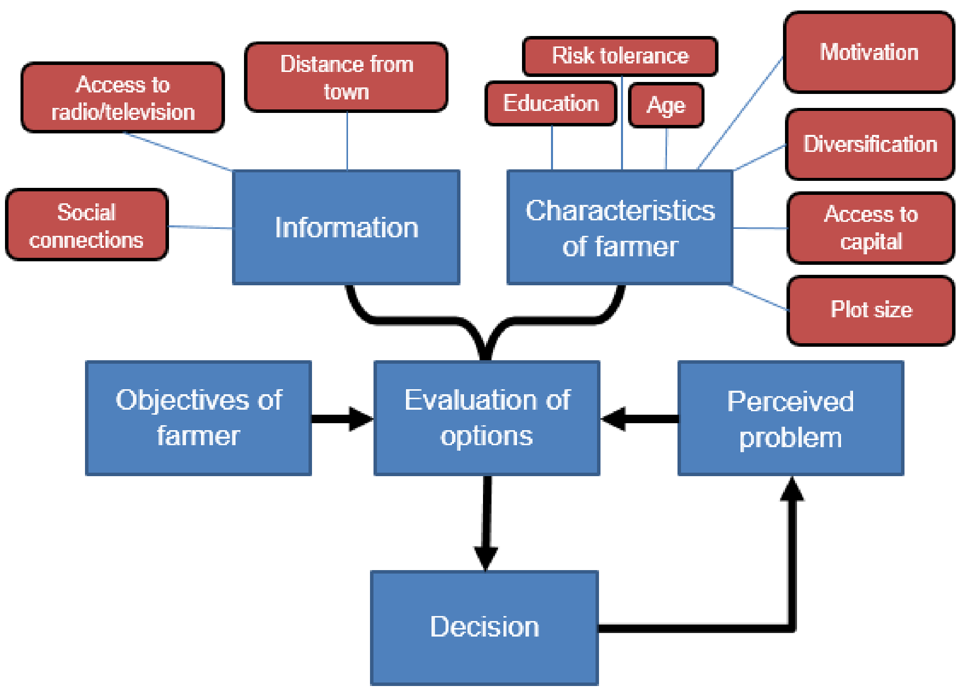

Figure 33: Conceptual diagram of decision-making for farmers

As shown in Figure 33, the basic structure of the decision-making process is in blue rectangles with the farmers' evaluation of options at the centre. The farmer perceives a problem, which leads to the need for evaluation. The problem perception, evaluation, and decision taking is conducted in a loop with subsequent perception to see if the results of the decision are achieved according to the farmer's objectives. This loop follows the work of Öhlmér, Olson & Brehmer (1998). The evaluation to decide how to act is a complex process with many influencing factors. Like Rajagopalan, Rasheed & Datta (1993), the characteristics of the farmer in shaping the evaluation is important. In this model, the variables used to measure directly (or approximate indirectly) these factors are not included, but are shown in the specific application to Ugandan coffee growing (see section 7.1). One implication of the concept of bounded rationality is the limitations imposed by access to information and processing ability of a farmer. Many empirical results have confirmed the importance of social networks both (1) to find external information and (2) to provide interpretation to help make decisions (Inkpen & Tsang, 2005; Conley & Udry, 2001; Tsai & Ghoshal, 1998; Chloupkova, Svendsen & Svendsen, 2003; Fafchamps & Lund, 2003; Sutherland & Burton, 2011; Conley & Udry, 2010). A brief review of some empirical literature on how a decision-maker's social network influences her decision-making and the theories of social capital are discussed in section 7.1 and briefly below.

Studies of the decision-making and farmers' perceptions are important areas of research both for ensuring food security and for improving economic development. These topics are often called farmers' "knowledge, perceptions, and practices" or KPP in the literature (Van Mele, Cuc & Van Huis, 2001; Heong & Escalada, 1999). There are many studies on annual crops and perennial crops in a variety of contexts, but a noticeable gap on tropical crops like coffee where the amount of studies do not match the economic importance of the commodity (Segura, Barrera, Morales, et al., 2004). While the literature is too vast for complete review, a good review of the KPP that influence the adoption of good farming practices can be found in Knowler & Bradshaw (2007). Relevant studies on risk-aversion among farmers and factors that influence decision-making are discussed in brief below. More thorough literature reviews can be found on each topic in Chapter 6 and Chapter 7 respectively. The primary literature for this chapter is the outcomes from cooperative farming as compared to independent growers.

5.4.1. Introduction to farmers' decision-making and behaviour on the plot

Improving understanding of how farmers make decisions is a critical area in order to improve implementation of Integrated Pest Management (IPM) as well as designing effective policies that incentivise farmers appropriately (Williamson, Little, Ali, et al., 2003). Often surveys have found that farmers beliefs and practices, such as spraying of pesticides, directly contradict the best practices recommended by research findings of agricultural extension organizations (Sinzogan, Van Mele & Vayssieres, 2008; Van Mele, Cuc & Van Huis, 2001; Ntow, Gijzen, Kelderman, et al., 2006; Heong & Escalada, 1999; Storehouse, Gbongboui, De Groot, et al., 1997; Escalada & Heong, 2004; Heong, Escalada, Sengsoulivong, et al., 2002). One review finds that risk preferences play a major role in practice adoption; an important characteristic is a farmers' ability to interpret information and the farmers' perceptions of likelihood of different outcomes (Just, Wolf & Zilberman, 2003). However, there does not seem to be universal characteristics of farmers that predict decision-making on the plot and following of best practices (Knowler & Bradshaw, 2007).

Knowler & Bradshaw (2007) recommend that policy needs to be tailored to the local experience, as their review of adoption rates of practices from 31 papers found no universal characteristics that could predict behaviour. Part of the divergence may be due to different beliefs on how the ecosystem system works for their crop. Even stakeholders, only one-step away from each other in a supply chain, may have disparate beliefs on what affects quality and quantity of the final product. Sinzogan, Van Mele & Vayssieres (2008) find that mango growers and mango pickers on the same farms in Benin had very different beliefs on the importance of weaver ants (*Oecophylla longinoda*) to control fruit flies (*Diptera: Tephritidae*) in mango production. The pickers had learned that the ants were important to improve mango quality via controlling fruit fly infestations. Meanwhile, more than 75% of the growers not involved in picking thought the ants had no value and considered them a nuisance (Sinzogan, Van Mele & Vayssieres, 2008). If farmers and traders have different different beliefs about what affects quality, it is likely they will make sub-optimal choices for end-point quality. The agreement on pest risks among coffee stakeholders in Uganda are examined in Chapter 6, while further discussion of factors affecting decision-making on the farm is found in Chapter 7.

5.4.2. The impacts of cooperative organizations

There are several studies that analyse the differences in production and livelihood outcomes from farmers who choose to join cooperatives. Zheng, Wang & Song (2011) use a Heckman selection framework to study the factors that influence behavioural decisions (in a probit model) and subsequently the factors that affect farmer economic outcomes (in an OLS model) for cooperatives in China. They found that farmers that were more highly educated, had smaller planting areas, were growing cash crops, and had a lack of labour were more likely to join cooperatives. Those in the cooperatives on average had higher production and incomes than a sample of farmers that were not in cooperatives (Zheng, Wang & Song, 2011). Similarly, Valkila & Nygren (2010) find that incomes are higher for cooperatives (those in Fairtrade schemes schemes) in Nicaragua when international prices are low. Although, Mendez, Bacon, Olson, et al. (2010) show for a large sample of Mexican cooperative and non-cooperative coffee growers, the higher incomes of cooperative farmers do not translate robustly to higher social-economic indicators like education and health. The extra income is often spent on other activities not measured in development outcomes (Mendez, Bacon, Olson, et al., 2010). The extra income is also quite marginal, especially for small-scale farmers producing minor volumes of coffee (Valkila, 2009). The extra income found in cooperatives may also be due to a selection bias (i.e. more able or more productive farmers may be more likely to join a cooperative) more so than from premiums or training received from the cooperative (Ruben & Fort, 2012). Additionally, many studies find that often the management of cooperatives or the Fairtrade buyers in a region are unable to buy all of the coffee at the premium prices (Sick, 2008; Mendez, Bacon, Olson, et al., 2010; Wollni & Zeller, 2007; Valkila & Nygren, 2010).

Valkila & Nygren (2010) overall question many of the benefits of Fairtrade, but do note that the social development projects did bring together particularly active members of the cooperative who were well aware of the community building projects that premiums were spent on. Their study suggests that cooperatives may be effective at building community engagement among coffee farmers, which could help build collective action towards solving problems as well as information sharing on best practices. Social capital—defined as level of trust among people—is expected to be higher among people in cooperatives (Chloupkova, Svendsen & Svendsen, 2003). Farmers in cooperatives might also be more willing to devote effort towards production of a premium crop. Wollni & Zeller (2007) study of cooperative farmers in Costa Rica finds that cooperative farmers were more likely to choose to grow specialty coffee, reflecting a decision to invest in their plot and put effort towards production of a premium crop.

While the focus of the literature on cooperatives and Fairtrade is on price premiums and enhanced production, few authors have analysed the issue of the effect of farmers' perceptions of a fair price on the decisions they make. Sick (2008) studied Costa Rican coffee farmers' perceptions of Fairtrade. Of the many concerns, chief among them was the feeling that the farmers who were aware of the final price paid per cup by consumers in the North, felt they were not getting a fair share of the profits. Many farmers in Sarapiqui had converted the lower elevation parts of the plots to dairy cattle instead of coffee, and they were trying to get income from coffee tourism as opposed to focusing on selling to the export market (Sick, 2008). Ruben & Fort (2012) find that cooperative farmers in Peru are more satisfied in terms of extension services and market management services than their non-cooperative counterparts. Cooperative group members selling Fairtrade also consulted their spouse more often for decisions, but statistically were no more likely to use fertilizer or follow environmental practices. They also found that cooperative farmers selling organic, Fairtrade coffee were more risk accepting than other groups (Ruben & Fort, 2012). Building on the work of these two studies, the following analysis looks at farmers' views on a fair price for coffee and the differences in production and social connections among cooperative vs. non-cooperative organized farmers.

5.5. COFFEE CERTIFICATIONS AND PRODUCTION SYSTEMS

As mentioned at the beginning of this chapter, coffee provides the main source of income for over 500,000 households in Uganda, with the vast majority of coffee farmers being low-input intensity smallholders with less than 2.5 ha of coffee and many with fewer than 50 coffee trees on less than 0.5 ha (UCDA, 2014; Cheyns, Mrema & Sallée, 2006). The vast majority of Uganda's coffee supply comes from very small farms, but there are a few larger ones producing for the export market. The first set of large farms range from 20-100 hectares of coffee and there are possibly a maximum of a dozen of these in the country (personal conversation, interviewee #14). The next largest set of coffee farms are just over 100 hectares. One is owned by a group called KDS based in Mpigi, which has between 120-200 hectares (personal conversation, interviewee #14). The second is a private farm in Masaka with perhaps 120 ha (personal conversation, interviewee #14). There is only one very large coffee farm in Uganda with an enormous amount of land (several thousand hectares) devoted to coffee; the German coffee giant, the Neumann Kaffee Group, owns it.

The Neumann Kaffee Group's Kaweri farm has 2,500 ha of coffee devoted to producing washed Robusta. They own nearly a whole sub-county and control some 10,000 acres in addition to the washed Robusta operation, according to interviewee #15 from NaCCRI/COREC (personal conversation). The price premium for their washed Robusta is thought to be rather good; interviewee # 14 believes they get around +600 USh premium over the London exchange market price (personal conversation).[126] This allows them to offer a premium to farmers of 150-200 USh per kg for quality red cherries (personal conversation, interviewee #14). This premium was in line with the premium that the founder of the washed Robusta start-up company in Mukono District was planning to offer, but could not make viable in the 2012 season (personal conversation, interviewee #19). While only anecdotal, the narrow premiums that could be offered even when a company like Neumann has extreme scale highlights the narrow margins that are present throughout the coffee industry in Uganda. As the MD of Exporter B stated plainly "there is no unexplored fortune here in coffee" (personal conversation, interviewee #10). Price discovery is excellent in Uganda and newcomers find a very competitive market. The margins at every step are not well out of line with the risks and capital required to be in business at that stage (personal conversation, interviewee #10).

The effects of narrow margins on the industry structure are explored in more detail below. The following sections discuss some of the characteristics of the beginning of the supply chain for coffee in Uganda, specifically focusing on the data collected both in surveys and interviews about cooperatives.[127] Sections 5.5.1 and 5.5.2 introduce the structure of a coffee cooperative in Uganda and give an overview of the supply chain for coffee from field to export. Sections 5.5.3 and 5.5.4 compare the (1) social connections of cooperative vs. non-cooperative farmers and (2) the yield (in kgs coffee berries per coffee tree) of coffee between farmers in a cooperative with training, a cooperative without training, and a non-cooperative surveyed sample. From the literature review, the expectation is that cooperative growers should have better yields and thus, higher production. Section 5.5.5 discusses the challenges faced by NGO B, the NGO that organized the cooperative studied in this survey (see methodology section 5.3.1 for details of the NGO). Section 5.5.6 introduces the certification schemes for coffee in the Ugandan market that were common among farmers' groups. Section 5.5.7 analyses the results from the question on fair prices from the survey of coffee farmers in combination with the results on fair prices and ideal supply chain structure discussed by farmers at the workshop held in Nkokonjeru. The conclusions from this part of the research and some suggestions for future work end the chapter in section 5.6.

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[126] See page 192 for explanation of London exchange market for coffee which generates the international price that Robusta coffee is compared to in the Ugandan domestic market.
[127] Cooperative, farmer group, and farmers' association will all be used synonymously in the following sections

5.5.1. Ugandan coffee industry structure overview

Farmers grow coffee and must then choose whom to sell it to and at what stage of processing. They can sell coffee at one of three stages of processing: (1) ripe berry right off the tree (*mwanyi mbisi* in Luganda), (2) dried coffee cherry (*kiboko* or *mwanyi nkalu* in Luganda) [128], or (3) process/hull the coffee to remove the husk and sell Fair-Average Quality (FAQ) coffee (*kase* in Luganda). The look and name of the coffee in Luganda and English at each stage are presented in Figure 34. There is a significant weight loss (around 50% of the mass) of the product at each of the first two stages of production (i.e. from drying *mwanyi mbisi* to *kiboko*, and from hulling *kiboko* to *kase*). This mitigates some of the gains in price per kg that the products in the latter stages of production command (see section 5.5.7).

[128] Mwanyi generally refers to the coffee berry and so it can either be ripe/wet (*mbisi*) or dry (nkalu). Kiboko was another name given to dried coffee supposedly during the pre-liberalisation period of the Uganda coffee market when a farmer could expect to be whipped or hit (termed a kiboko) by authorities when they did not follow the correct procedure for drying coffee. The dried coffee thus received the metonym kiboko due to its association with this harsh punishment (personal conversation, interviewee #1). See interviewees' perspectives on liberalisation of the coffee industry in Appendix A.26 starting on page 423.

Mbisi or Wet Cherry
(a)

Nkalu / *Kiboko* or Dried Cherry
(b)

Kase or FAQ
(c)

Kawa or Screen 15/18/etc.
(d)

Note: Processing transforms the product from (a) to (b) to (c) and finally (d) for export. (a) red, ripe cherries from tree; (b) *kiboko* is prepared by drying coffee outside for several weeks on tarps or the ground; (c) *kase* is prepared by hulling coffee at a milling machine to remove the husk from the *kiboko*, however black beans, chaff, and many sized beans remain in the batch; (d) *kawa* is made from *kase* screened at an export facility to a consistent size and free from defects, like insect damage or black beans from harvesting unripe coffee. *Kawa* can also refer to roasted coffee. (All photos by author).

Figure 34: Images of coffee at each major stage of natural/dried processing along with the associated names for the coffee at the given stage

Growers also must decide who to sell to. Either to the cooperative they are a member of, to a trader for whatever quality coffee they produce, or perhaps directly to a processor who will do the hulling of the coffee (assuming it is dry/natural processed). There are many types of traders at different points in the supply chain. Some will focus just on dried beans (*kiboko*) to sell to a processor, and others specialize on taking a finished product (i.e. *kase*) from a processor to an exporter. The nature of the product a trader buys and sells is largely dependent on the trader's operating capital.[129] Cooperatives can choose to sell to a trader or do their own processing in-house before going to an exporter. A simplified diagram of the basic structure of the coffee supply chain in Uganda from production to export is given below in Figure 35.

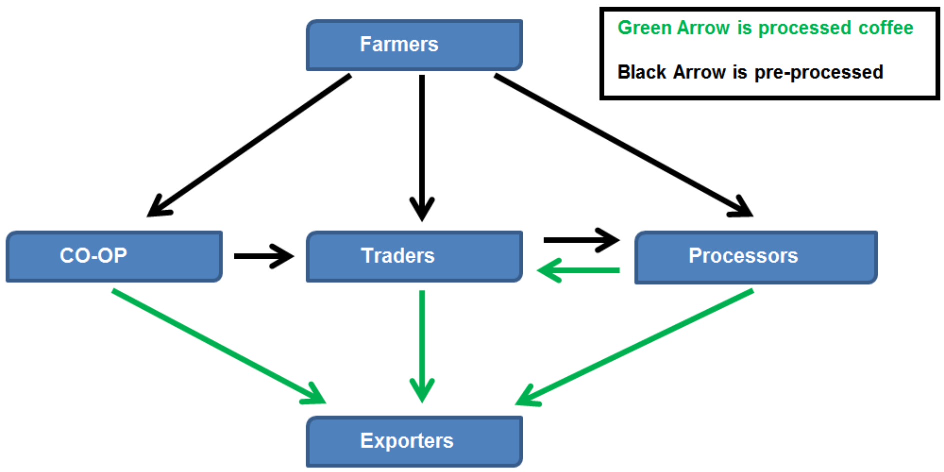


Figure 35: Conceptual model of simplified coffee industry structure in Uganda

The average farmer is selling around 200 kg of coffee in a year (median from HH survey), while the average trader is buying around 7 tonnes of *kiboko* or 6 tonnes of *mwanyi mbisi* (medians from HH survey). The trader is typically travelling as far as 5km (median) from his or her house to reach the approximately 70 farmers (median) from which the typical trader buys coffee. While the largest traders employ 20 other traders to purchase on their behalf, the typical trader has only 1 other employee (median) that the trader pays to purchase coffee on their behalf or works with them to source coffee in some way. The typical delivery to a major exporter (like Exporter A) is around 6 tonnes at a time—however, they accept anything as small as one bag (60 kg) of FAQ coffee (personal conversation, interviewee #3).

All coffee leaving Uganda has to go through a UCDA certified exporter (personal conversation, interviewee #10). The exporter screens the coffee firstly to remove defects and impurities like stones which are often mixed in with coffee (either accidentally or to add weight to the load). The next level of screening is to sort the coffee by the size of the bean. The beans are screened

[129] Analysis of the traders in the survey is found in section 6.3.2 in Chapter 6

by a large machine, which has progressively smaller holes that smaller beans can slip through to the next screen-size level.

There are four common screen sizes for coffee in the Ugandan market and four sizes that are traded on the international Robusta commodity exchange market based in London (LIFFE). Table 40 has the measurements for the different screen sizes; a larger screen size (e.g. Screen #18) is a larger bean and commands a higher price than smaller screen sizes (e.g. Screen #12). Uganda also exports what are called "undergrades" (i.e. beans smaller than the smallest screen size) to importers in China and Sudan who cater to a low-price segment of the market (personal conversation, interviewee #3). The existence of demand for a very low-quality bean influences the incentives for growers and traders to produce quality coffee.[130]

Table 40: Screen sizes used for quality measurements of Robusta Coffee

Screen	Size (inch) of round apertures for the sieve	Traded on LIFFE	Common Ugandan Export
<12			X
12	12/64	X	X
13	13/64	X	
14	14/64	X	
15	15/64	X	X
18	18/64		X

5.5.2. Example structure of a coffee cooperative in Uganda

The proposed benefits of joining an association are often cited to be the training and price premium received. The individual farmer may grow quality coffee that is not appreciated by the roaming bicycle trader who pays an average price to every grower. However, an association will know that all members are complying with a certain practice and so the trader involved with the associated group would be expected to pay a higher price (personal conversation, interviewee #6). Cost savings can also be realized by spreading the costs of drying coffee among many farmers (e.g. bulk purchasing of tarps and labour sharing). Interviewee #14

[130] Discussion on the low quality coffee issue in the context of changes after liberalization of the coffee market can be found in Appendix A.26.1, page 425.

mentioned cooperatives skip many of the small intermediaries between the farmers and the big merchant traders. The premium from organizing like this is somewhere in the range of 50-100 USh per kg of *mwanyi mbisi* (personal conversation, interviewee #14). Figure 36 shows the basic structure of the cooperative that was organized by NGO B.

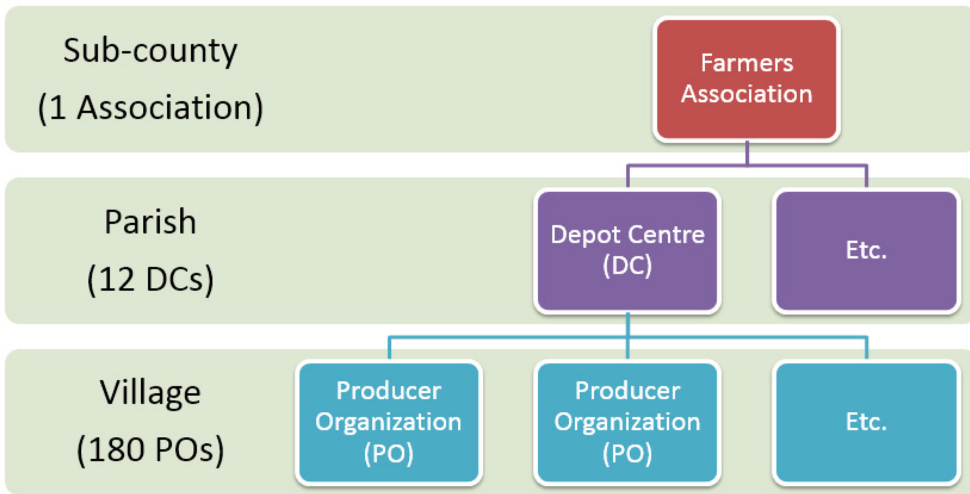


Figure 36: Diagram of basic structure of the cooperative organized by NGO B in Kamuli District

In each village, there would be a Producer Organization (PO) that would have around 20 growers as members. Each PO had a lead farmer who was the most experienced and trained by the NGO. The lead farmer would communicate best practices and ensure that everyone in the organization was following certification standards. The lead farmer also served as a communication point between the Depot Centre (DC) and the members of the PO.

At the DC level, there would be quality control with officially appointed quality inspectors and chemical experts that could be consulted by the PO for advice on how to improve their operations. POs would organize to bring their *kiboko* to the DC where a moisture sample and spot checks[131] for bean quality were conducted before the delivery would be accepted. Messages would be relayed about quality from the experts often through the lead farmer; however, other members of the PO also brought their coffee independently to the DC and could

[131] It is difficult, if not impossible, to tell the quality of dried coffee by simply looking at it. The method that NGO B encouraged was to select a sample of dried cherries and then cut them open with scissors to inspect the quality of the bean inside as well as to look for mould or insect damage.

consult the experts. The DCs would deliver to the farmers association's central hub at the sub-county level, where there was a machine to process the dried coffee to *kase*.

NUCAFE had a similar structure with POs, however, there was not a Depot Centre level of organization. Based on the conversation with the Business Manager (interviewee #18) as well as the structure of their internal production dataset, the NUCAFE office at the processing mill in Nkokonjeru served as the main point of contact for each PO. There was a lead farmer for each PO similar to the structure of NGO B.

Exporter B also sponsored schemes to develop coffee farmer associations. The structure they used for the cooperatives was analogous to that of NGO B, but they focused on washed Robusta production. The POs had around 25-30 growers each and members were allowed to sell to anyone, however, Exporter B sponsored these schemes in the hope that they choose to sell to Exporter B. Farmers sold wet cherry and the PO would have a trader in a truck drive around every day during the harvest season to collect ripe cherries from farmers. Each of the 110 POs had a washing (pulping) station to wet process Robusta into a washed Robusta bean. The daily price would be issued by the MD (interviewee #10) which would be used by the trader employed to collect from farmers to bring to the pulping station for the PO; farmers would be paid cash on delivery of their ripe berries. Farmers needed to sort their coffee ahead of time as unripe or overripe berries would not be purchased.

The Buikwe District field office for Exporter A was conducting a farmer registration with the hopes of setting up a farmers' association equivalent to that of Exporter B. Exporter A had finished establishing several farmers' associations in Masaka and was looking to expand into Central/East Uganda using the same structure. Based on the interview with their field manager (interviewee #4), Exporter A plan to register around 3,000 farmers into a washed Robusta producing cooperative. Analogously to Exporter B, Exporter A planned for weekly truck collections in the village and for the members of their cooperative to deliver to central wet-processing facilities at the PO level.

Surprisingly, despite the differences between NGOs and Exporters, the structure they used for a farming cooperative were strikingly similar. The main difference with NGO B was the direct links to extension experts who would offer growing, pest, and treatment advice to growers.

However, the Regional Sustainability Manager for Exporter B (interviewee #8) did travel several times per year out to their various farmers' associations to check-in and provide training programs if needed.[132]

The structure of a cooperative like that of NGO B, with more direct points of contact between farmers, traders, and extension agents, could potentially allow for better communication of pest and disease threats. It also could allow for better information transfer of best practices from the experts to the members of the association. These expected outcomes of being in a cooperative were confirmed in the survey (see following section).

5.5.3. Comparison of social connections and practices between farming systems

As shown in Figure 37, Kamuli farmers in an association were much more likely on average to fertilize their plots as compared to the Buikwe and Kayunga District farmers in the HH survey. Given a two-sample test of proportions: 87% ± 6.0% of Kamuli cooperative farmers fertilized, while only 53% ± 4.6% of independent farmers in Buikwe and Kayunga fertilized their coffee plots ($z = -3.4575, p = 0.0005$). The cooperative farmers also appeared to implement spraying of pesticides and fungicides more often than the other group of farmers in the surveys. Given a two-sample test of proportions: 37% ± 8.8% of cooperative farmers fertilized, while only 10% ± 2.8% of independent farmers fertilized their coffee plots ($z = -3.601, p = 0.0003$). Meanwhile, while Figure 37 seems to indicate a difference in implementation of Good Agricultural Practices (GAPs), the results were not significantly different. Kamuli farmers in NGO B's cooperative implemented GAP practices such as pruning and eliminating dead branches from their trees just as often on average as farmers from Buikwe and Kayunga (results from two-sample test of proportions: $z = 1.1185, p = 0.2634$).

[132] The coffee agronomist (interviewee #9) worked closely with the Regional Sustainability Manger (interviewee #8) and was in fact working on materials for a new training program that would be taking place the following month after the author conducted the interview.

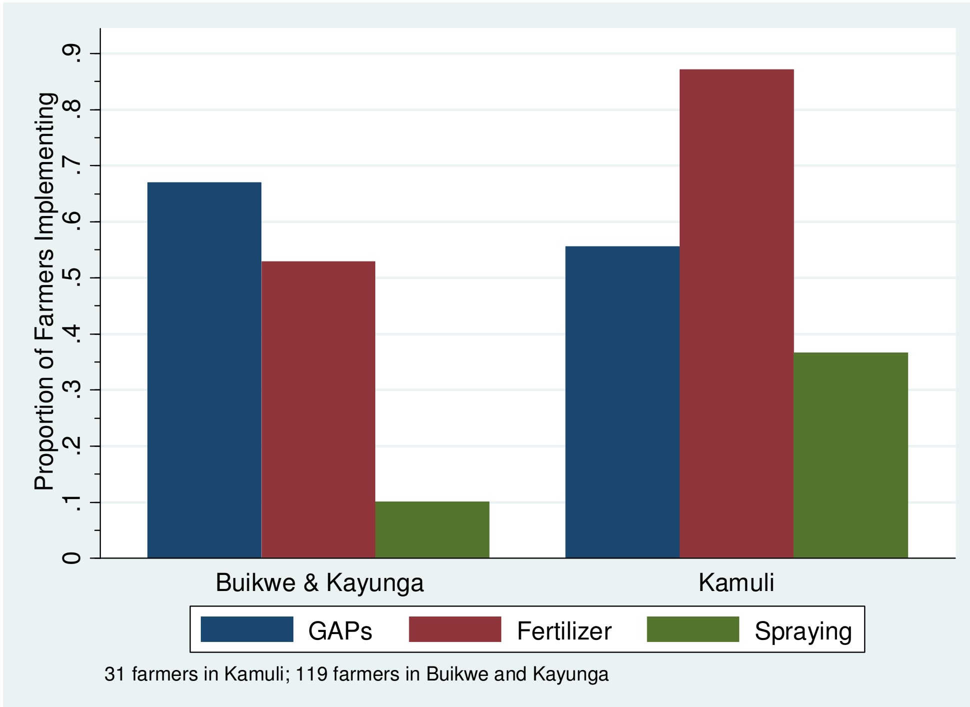
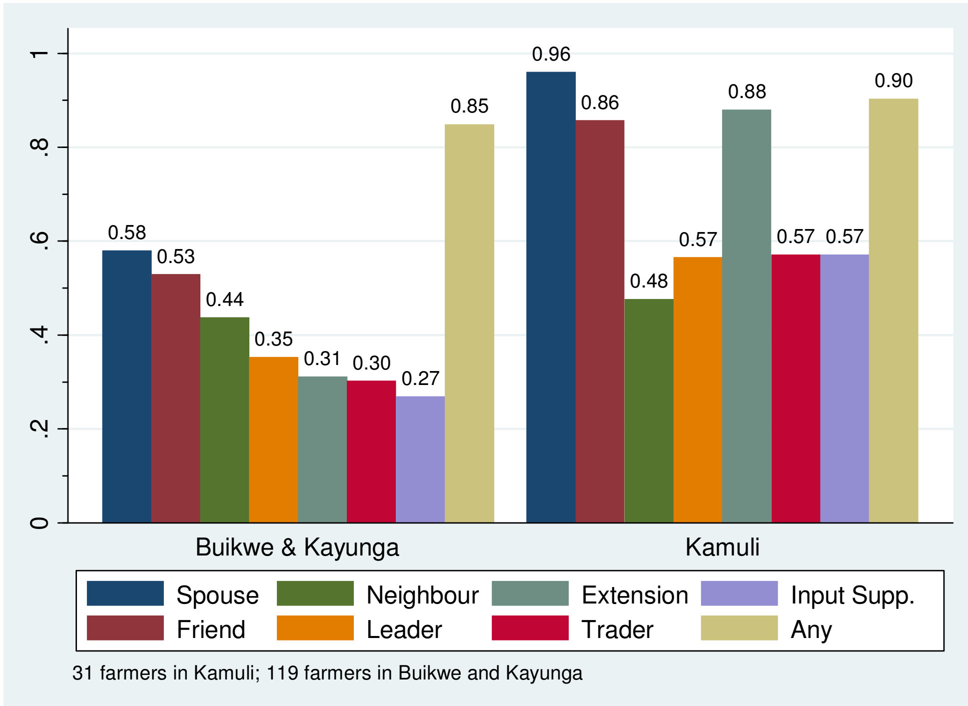


Figure 37: Proportion of cooperative farmers in Kamuli who responded that they followed each practice compared to baseline farmers in Buikwe and Kayunga

Kamuli farmers in the cooperative were more connected to other social connections than the independent farmers surveyed in Kayunga and Buikwe. The average Kamuli farmer in the cooperative had 3.5 ± 0.39 out of 7 social connections that they consulted on a regular basis for decisions on their coffee plot. Buikwe and Kayunga farmers who were not organized into a cooperative of any sort, responded that they consulted fewer social connections. The average Buikwe and Kayunga farmer in the survey reported consulting 2.78 ± 0.20 out of 7 social connections.[133] The means were different at the 10% level by a two-sample T-test with equal variances ($t = -1.8095, p = 0.0724$).[134] While not only reporting contacting more people on average to make decisions, Kamuli cooperative farmers contacted certain types of social connections at different rates than the farmers in Buikwe and Kayunga (see Figure 38).

[133] The full results of the survey on social connections for the Buikwe and Kayunga farmers are found in section 7.2.1 starting on page 272.
[134] Levene's test could not reject the hypothesis of equal variances



Note: Response percentage to each question was not 100% in the survey in Kamuli. Non-responses were left blank and excluded for analysis for that social category. For example, this explains how the proportion of "yes" for the spouse category can be higher than the proportion of consulting "any" social connection since some respondents may have said "no" to several categories, but left the spouse question blank.

Figure 38: Proportion of farmers consulting social connections in Kamuli compared to Buikwe/Kayunga

For the cooperative group, there is a large jump in the number of farmers that claimed to consult an extension worker (see Figure 38). This is likely attributed to the placement of experts at the DC level that farmers could consult for advice on pests, inputs, and coffee growing methods. In many ways, though, the most surprising change is that Kamuli farmers were more likely to consult others not connected to the social infrastructure put in place by the cooperative as well. It appears that the availability of people to consult for advice on crop management encouraged farmers to consult their own social network more often as well. Farmers in Kamuli reported consulting their spouses, friends, neighbours, and input suppliers more often. While the boost in the social connectivity to extension workers, leaders, and traders could be attributed to the infrastructure put in place by the NGO, the other connections likely cannot.

These differences between the proportions that responded "yes" to consulting different social connections were tested for significance using a two-sample proportion test. The results are reported with significance signs in Table 41. The only social categories with non-significant differences were the proportion that consulted at least one social connection when making decisions on the plot (i.e. the "Any" category in Table 41 and Figure 38) and the proportion that consulted a neighbour. The proportion that consulted a leader in the community was also only marginally significant ($p = 0.056$).

Table 41: Differences between proportions of Kamuli vs. Buikwe/Kayunga growers' social connections

CATEGORY	b	se0	z	p-value	
Spouse	-.3801681	.1052209	-3.613049	.0003026	***
Friend	-.3277311	.1168749	-2.804118	.0050454	***
Neighbour	-.0392157	.1175699	-.3335522	.7387175	
Leader	-.2122762	.1109582	-1.913119	.0557328	*
Extension	-.5690756	.1081959	-5.259679	1.44e-07	***
Trader	-.2689076	.1123485	-2.393512	.0166879	**
Input Supp.	-.3025210	.1098790	-2.753219	.0059012	***
Any	-.0544863	.0699688	-.7787227	.4361431	
N	150				

Note: *** for p<0.01, ** for p<0.05, and * for p<0.10
b is the differences in proportions between Kamuli as compared to Buikwe/Kayunga as the baseline; se0 is the standard error under the null hypothesis H_0 of equivalent proportions between the groups.

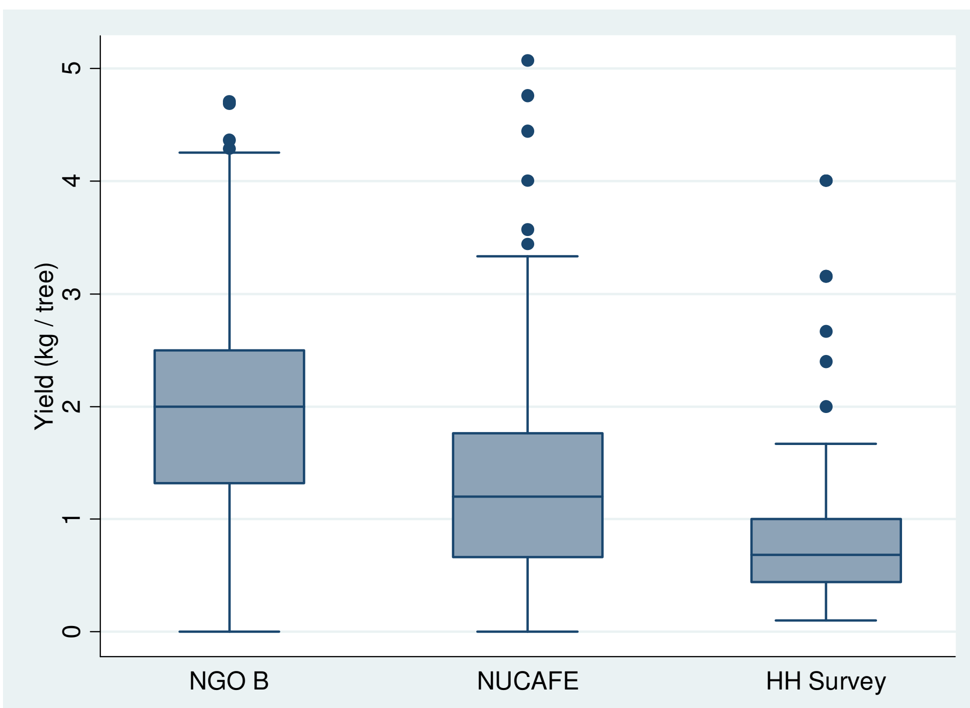
5.5.4. Comparison of production between farming systems

The HH survey only allows comparison between the Kamuli cooperative farmers who participated in the workshop and the Buikwe/Kayunga farmers for many pest, socio-economic, and social questions. However, production and yield data for farmers in other organizations can be exploited for comparison (review the organizations in section 5.3.1 on page 156). Three groups of farmers can be compared:

1. NGO B had some 3,000 farmers that both were interested in joining a cooperative as well as receiving extensive training and ongoing extension service.
2. NUCAFE had registered 1,145 farmers in Buikwe and Mukono Districts. As mentioned previously, NUCAFE had a group of farmers that were interested in being in a cooperative and had joined, but they had not received any formal training and interventions based on interviews.
3. The HH survey had 119 farmers who participated in Buikwe and Kayunga Districts, but were not members of any official cooperatives.

The results are shown in Figure 39 comparing yields for the three farming systems. The three groups are compared just in terms of yield of coffee cherries (kg) per tree on their plot. This is the most appropriate measure of yield to use. Yield (kg/ha/year) is difficult to interpret in a mixed farming plot where one hectare of land could be either 100% devoted to coffee or 10% devoted to coffee.

The variance of the yields within each group are quite high, likely due to the difficulty of both accurately estimating the number of trees on a plot, as well as, keeping good records of sales of coffee cherries throughout the year. Based on the research team's experience in the HH survey, farmers have difficulty knowing how many productive and unproductive trees they have because pests often decrease their number of live trees each season. Additionally, some of the poorest farmers do not keep records of how many kg of coffee they sell each season, and as a result, make a rough estimate during the survey.



Note: NGO B data taken from 3,004 farmers with data for 2012/13 coffee year; NUCAFE data is taken from 1,143 with data from 2012; HH Survey was from 119 farmers interviewed at the end of 2013. Outliers above 6 kg/tree/year are kept in the analysis of group means below, but were removed from the plot area for ease of display.

Figure 39: Comparison of coffee yields (kg/tree/year) for 2012/13 across three different farming systems

Despite the limitations of the data, it appears that the farmers in the HH survey had the lowest yield. However, NGO B and NUCAFE had significantly different yields as well. The average cooperative farmer in NGO B produced 1.96 ± 0.013 kg/tree/year, while the average farmer in NUCAFE produced 1.23 ± 0.025 kg/tree/year.[135] A difference of 0.73 kg/tree might seem quite small, but that is nearly a 60% increase over NUCAFE's mean yield per tree. For the average farmer with around 400 trees, this results annually in an extra 292 kg of *mwanyi mbisi*, which—assuming it were sold at the lowest level of processing at a modest 600 USh/kg—would generate around 175,000 USh/year extra income. Although the data suggests the yields were higher, there were many challenges that came with running the cooperative.

5.5.5. Challenges to cooperative organization

Given the benefits to communication, encouraging best practices like fertilizing, and possibly improving yields per tree, what were the downsides to associations like the one in Kamuli?

The biggest problem that the farmers' association with NGO B faced was a cash-flow issue stemmed by market price fluctuations (personal conversation, interviewee #5). The association would need to give cash out to the DCs such that each could buy coffee from POs when farmers produced it. The main harvest came for all DCs during the months of November and December. As a result, all of the money would need to go out to each DC at the same time creating a lack of working capital. The association at the top of the supply chain could not always sell the coffee fast enough to exporters to recover the cash they had loaned out to the DCs for purchasing coffee. Sometimes the price on the market was quite low and so the association wanted to store the FAQ for later sale. Because of the time taken while storing/bulking coffee, the cooperative would often run out of cash within the first two weeks of the main harvest season (personal conversation, interviewee #5). This forced them to turn away members with coffee. The farmers would then sell to traders outside the system and perhaps feel that their extra effort for committing to UTZ certification was not worth the energy (personal conversation, interviewee #5).

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[135] Mean difference determined by two-sample T-test with unequal variances ($\mathbf{t = 26.23}$, $\mathbf{p = 0.0000}$) after confirmation from Shapiro-Wilk W-test for normal data and Levene's test rejected the hypothesis of equal variances.

The Regional Sustainability Manger of Exporter B (interviewee #8) mentioned these cash-flow constraints as well based on the interviewee's experience in examining other cooperatives. Many farmers associations do not have enough capital to buy all the coffee from the member growers in the good years, as a result the growers lose trust in the association. Additionally, farmers are impatient when it comes to changing practices. If the association does a training and the following year there is a large pest incident, farmers lose faith quickly in the new practices, even when they are told it could take years for the new practices to show results (personal conversation, interviewee #8).

According to the Executive Director of NGO B (interviewee #6), internal inspections every year for UTZ certification cost around 10 M USh (approximately £2,500 at the time of the survey) and the NGO lacked the money to maintain the certification inspections, especially given the failure rate for several growers. The official external inspection for the final certification had a similar price. As a result, when the EU grant ended in 2012, the farmers' association sold without certification, as the conventional coffee price was relatively high compared to recent years anyway. The year at the time of the survey, 2013, had been a challenge. The year had lower prices and in general, there was not much of a premium at all for UTZ so they did not find it worth investing in the certifications. They also faced the issue that farmers were often going to middlemen, as the cooperative could not afford to buy all the coffee the farmers were delivering (personal conversation, interviewee #6). The director was interested in moving towards Fairtrade as the director had heard the premiums would be higher, but NGO B felt that they had already committed to UTZ. The training they gave was also based on UTZ practices, so to some extent NGO B felt locked-in to the scheme (personal conversation, interviewee #6). Interestingly, the lock-in was felt even when not currently meeting the standard and maintaining certification.

Another challenge that was developing in the market in Uganda was that exporters and NGOs were competing for grants to register farmers into associations. The initial exporter partner for NGO B was Exporter B. However, NGO B's Executive Director did express some concern that Exporter B was recently applying for funds to register farmers in the Kamuli District into a new farmers' association. The director was unclear how the partnership would work and felt that Exporter B was overstepping their purpose and could not do as good of a job with farmer training as NGO B did with their group (personal conversation, interviewee #6). As a result, the cooperative had switched exporters. Similarly, in Buikwe district, NUCAFE had registered some 1,200 farmers into an association, but Exporter A's field office was likely re-registering many of them into the new association. The Business Manager of NUCAFE (interviewee #18) was unaware of the activities of Exporter A.

An interesting problem that Exporter B ran into at first when organizing a farmers' association was the pricing for *kase*. They used to pay farmers for the final product's weight at the *kase* prices such that farmers had added all the value to the final product (personal conversation, interviewee #8). The farmers however accused Exporter B of cheating on the weight of the coffee since the exporter was not paying for the husks (although they were paying a higher price). As a result, many farmers started selling to a nearby processing mill which purchased the *kiboko* at the dried coffee price and then did the processing themselves before selling on to an exporter. The Exporter B team had to change their strategy as the factory started losing volumes as farmers sold to the other mill in the area. It was unclear whether this was completely irrational behaviour, or if some farmers knew that they were harvesting poor quality cherries and that the *kiboko* price with the added weight of the husk was better for them, than getting a high price for their lot which would contain many lighter, black beans. Without a controlled measurement, the driver of this behaviour could not be determined. However, this anecdote did point to a potentially interesting research area in the beliefs of traders on what drives their profits and their strategy to maximize value from coffee trading.

5.5.6. Certifications and adding value to coffee

Many of the farmers associations mentioned above were involved with external certification schemes. Among the organizations encountered in the fieldwork, the most prevalent schemes were 4C and UTZ. Others interviewed often mentioned Fairtrade though none of the stakeholders had been active in the scheme. The majority of the stakeholders discussed the issues with certification schemes generally and specifically focused discussion on UTZ as it was the most prevalent of the schemes.[136]

[136] Certification schemes are explored in more detail by many authors (e.g. Rueda & Lambin (2012) and Taylor (2005)). Relevant examples for Uganda can be found in Bolwig & You (2007).

Exporter B had farmer associations in several certification schemes. For Arabica they had one group in the Mt. Elgon region doing UTZ, 4C, and Rainforest Alliance certification (personal conversation, interviewee #8). The exporter had started doing UTZ certified only recently in 2011. The interviewee (#8) felt that UTZ was the simplest to maintain compliance. Rainforest Alliance had not sold yet for the exporter and they believe the audits would be too expensive to justify for smallholders, given the small premium offered. The premium they were able to get in the market for UTZ certified was around 50 USh/kg. This was an extremely small premium, and likely, this is why NGO B often said that UTZ had no premium.[137] The research fellows based at the EPRC of Makerere University in Kampala also confirmed that there was little premium available for making a high quality, certified Robusta coffee (personal conversations, interviewees #11 and #12). One Research Fellow suggested that there are benefits to moving up the supply chain in terms of processing from conventional farming, but there is little benefit to going for higher quality coffee through certification schemes (personal conversation, interviewee #11). Exporter B did manage a small premium though and passed at least some of it on to the farmers in their associations.

Exporter B had an innovative system for giving out the premium to the farmers' associations they worked with. Instead of paying the farmers a premium at the time of selling, when they are most cash-rich, the exporter would keep records of the bonus the farmer had earned (based on production targets). These records would then be used to administer a bonus in the non-harvest season when the grower would be most cash poor and needing cash to invest back into their plot or for other household expenses. The bonus was paid in cash or inputs depending on what the grower said they would like to receive (personal conversation, interview #8).

The Sustainability Manager of Exporter B (interviewee #8) said that premiums have been squeezed on certifications and only getting worse. Roasters are pulling out of their commitments to giving a premium (personal conversation, interviewee #8). UTZ has gained traction in the international market, and as a result there are many origins with UTZ certification. UTZ buyers say their price that they are willing to pay and there is little room to negotiate for a higher price (personal conversation, interviewee #10). Rainforest Alliance

[137] It is also likely the exporter absorbed some of the premium as well so what NGO B's association got was an even smaller cut, and what the top level of the farmers' association passed on to each grower was likely diluted even further.

allows their label to be used with as little as 30% certified coffee in the blend, as a result the premium for producing Rainforest Certified coffee has been more robust since the end price of a bag sold by the roaster is not driven as much by the premium paid for the certified label. The reason 4C does not offer a premium or allow a label on a bag is because they want to be the standard of the industry. The 4C brand did not view the practices[138] they require as above what "should" be standard within the industry (personal conversation, interviewee #8). Exporter B has found that 4C is gaining a lot of traction in the market and enough roasters are demanding it that most exporters carry at least some (personal conversation, interviewee #10).

The lack of a strong premium for certified Robusta relates directly to the lack of strong demand for quality Robusta in developed markets. Pricing at the export market is determined by the Robusta price on the London-based LIFFE exchange (London International Financial Futures and Options Exchange); however, it is actually the spread difference between Robusta on the LIFFE and Arabica on the Intercontinental Exchange (ICE) in New York that drives demand (personal conversation, interviewee #10). Due to the nature of the ability of Robusta to serve as a poorer, but "blendable" substitute for Arabica hurts the viability of a strong, consistent market for washed Robusta or certified Robusta. When the price spread between Robusta and Arabica is very narrow, washed Robusta cannot compete. As stated simply by the Managing Director of Exporter B: "why would a roaster buy a washed Ugandan Robusta when they can get a Guatemalan Arabica for a similar price?" The substitution effect between Arabica and Robusta was confirmed by the Program Manager for Exporter A (interviewee #2) as well. Around 2010, when Arabica prices rose sharply, blenders that interviewee #2 knew switched from a blend of about 80% Arabica (20% Robusta) to a blend of 60% Arabica (40% Robusta). As the gap narrowed, the blends tended to return to the baseline levels (personal conversation, interviewee #2).

Despite Exporter B's success in selling UTZ certified coffee, the Regional Sustainability Manager (interviewee #8) was critical of many of the requirements. The issue with UTZ certification is that some of the requirements do not fit well in the context of the Ugandan farm. As an example, the chemical storehouse is required to have a tin roof, which is often more advanced than the main household of the coffee grower (personal conversation, interviewee

[138] The main requirement of 4C is avoiding 10 unacceptable practices in production of coffee.

#8). The failure checklist of the data given to the author from NGO B's cooperative confirmed this as a major constraint for farmers to maintain certification. Exporter B did mention though that UTZ is currently revising its standards to be more context appropriate. To address the concerns about context appropriate standards, Uganda is developing a code of conduct as well which could form a type of national certification (personal conversation, interviewee #10). However, the issue with this will be trust and most importers will not recognize a national certification (personal conversation, interviewee #10).

Given the limitations of certification schemes in terms of price premium and difficulty to adapt to the local context, the Sustainability Manager (interviewee #8) echoed what the MD (interviewee #10) conveyed as well: certification schemes are never going to improve the lives at scale for the millions of coffee growers in Uganda. The demand is not large enough for it. Exporter B used to convince farmers to join certification schemes in their associations based on premiums, but the strategy now has shifted to talking about volume increases. Improving productivity seems to appeal to farmers, but it is difficult to convince them that the practices will work (personal conversations, interviewees #8 and #9).

Outside of certification, another method of adding value often mentioned in the popular press (e.g. Thiemann (2012)) or with NGOs is that of roasting coffee in country before export. Roasting accounts for much of the value addition of the final coffee purchased by consumers (Cheyns, Mrema & Sallée, 2006). While the World Bank and other organizations promote farmers "adding value" to agricultural products before they are exported, there are many challenges associated with doing this for coffee. The difficulties in maintaining quality of roasted coffee during transport as well as the higher tariffs most developed countries maintain on roasted (but not green) coffee, make the economics of selling roasted coffee more difficult (personal conversation, interviewee #10). As well, developing the market relationships may be difficult due to a lack of trust in the quality of the product coming from a new roaster in a developing country context (personal conversation, interviewee #10). As such, many of the major players in the industry in Uganda do not see roasted coffee as a solution that will help the any significant number of coffee growers in the region (personal conversation, interviewee #14).

The overall message from many interviews was that certification systems had limited benefit for Robusta coffee farmers despite how well they might work for Arabica coffee systems. Uganda has many smallholder farmers with little land, making the costs of certification per plot quite high. They have limited capital to afford the improvements to maintain the safety levels required for some schemes (e.g. tin roof for chemical storage under the UTZ certification). Additionally, many farmers self-reported in the HH survey that they liked working independently. Roasting in country as another way to move farmers further up the value chain seemed like an unrealistic goal to two industry experts with over 30 years of experience each (interviewees #10 and #14). The majority of solutions to improve livelihoods for the average farmer will need to focus on stable prices, increasing yields, and encouraging GAPs like pruning, which help maintain production and resilience to pests (personal conversation, interviewee #10). Relatedly, the next two sections will examine the results from the farmers' workshop and household surveys with respect to the supply chain and pricing.

5.5.7. Fair prices and ideal supply chains

The farmers that the research team worked with had well-formed opinions on how the supply chain could be better and what they believe a fair price is for coffee. The motivation for asking about prices was to help understand the issue of a lack of investment in coffee. Farmers that are receiving substantially below what they consider a fair price likely will not be motivated to invest time and resources into coffee production. At the extreme, the consistent under-pricing of coffee may cause farmers to exit coffee for alternative crops. For example, Sick (2008) reported growers in Costa Rica reported switching to dairy cattle on part of their plots after becoming disappointed with the lack of premium for Fairtrade coffee.

The magnitude of the difference between a farmer's view on a fair price and the price she has been offered is useful for two reasons. (1) It can be used to determine the level of subsidy/premium that would be required for a cooperative that wanted to meet the expectations of its growers.[139] Additionally, (2) given the constraints of the system in terms of a final export price (determined by the international market) and the weight loses that are inevitable from drying and hulling, one can determine the maximum price a farmer and trader could ever hope

[139] The largest premium found during the survey for UTZ certified coffee was only 50-100 USh, and perhaps this is far too low to change behaviour; the grower may still find the price well below her threshold value of a "fair" price that is required for action.

to attain even in a frictionless system with zero transport costs. If the price that the farmer or trader considers fair is above this point, this could suggest that she may be more likely to exit coffee production when other opportunities are available. While it was not possible to test this hypothesis in the period of this project, some preliminary results are presented below on the views of farmers on pricing and their ideal supply chain. It is shown that farmers' views on what a fair price should be for their products have an influence on their investment behaviour as measured by planting seedlings in the past five years.

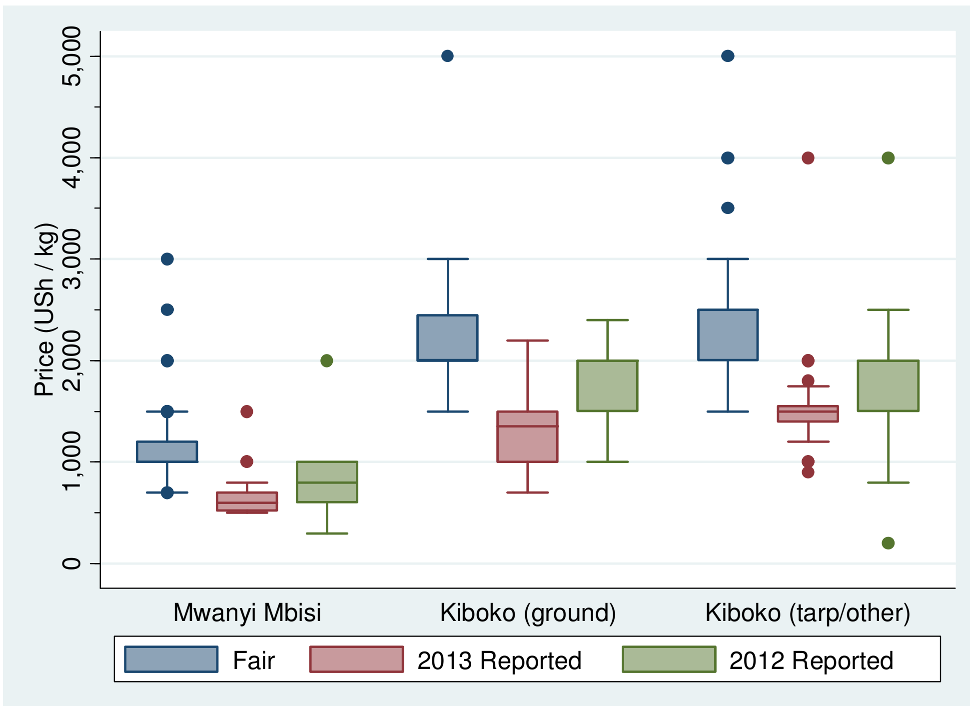
There are constraints on prices determined by weight losses that are inevitable as coffee is processed to a more refined product. On the day of the interview, interviewee #8 from Exporter B had just finished conducting tests on coffee berry weight losses. Their tests showed that drying 10 kg of red, ripe coffee cherry produces 5.6 kg of *kiboko*, but drying 10 kg of green, unripe cherry yields only 4.2 kg of *kiboko* (personal conversation, interviewee #8). This confirmed what the traders reported in the HH survey that they lose about 50% of the weight of the coffee when drying. Similarly, interviewee #14 reported that the weight loss from *mbisi* to export is perhaps 80%: half is lost from drying to *kiboko*, another 50% reduction when hulling to *kase*, and then a bit more (5%) lost to broken beans and losses throughout processing. The trader is then penalized twice by buying unripe coffee cherries: the weight is less after drying and the bean is usually smaller resulting in a lower grade of coffee and thus lower price.

At a basic level just using the loses and not accounting for transaction and transport costs, Table 42 below tabulates the highest, ideal prices from a set of possible export prices. The factors are based on the weight loses discussed above. These ideal prices can be used as a gauge to compare against the outcomes for both the fair price question from the HH survey, as well as, the prices the groups at the workshop reported in their ideal supply chains.

Table 42: Ideal prices (USh/kg) for coffee, based on export price and weight loses from processing

	Export	***Kase***	***Kiboko***	***Mbisi***
Factor	1	0.95	0.5	0.25
Price A	5,000	4,750	2,500	1,250
Price B	10,000	9,500	5,000	2,500
Price C	15,000	14,250	7,500	3,750

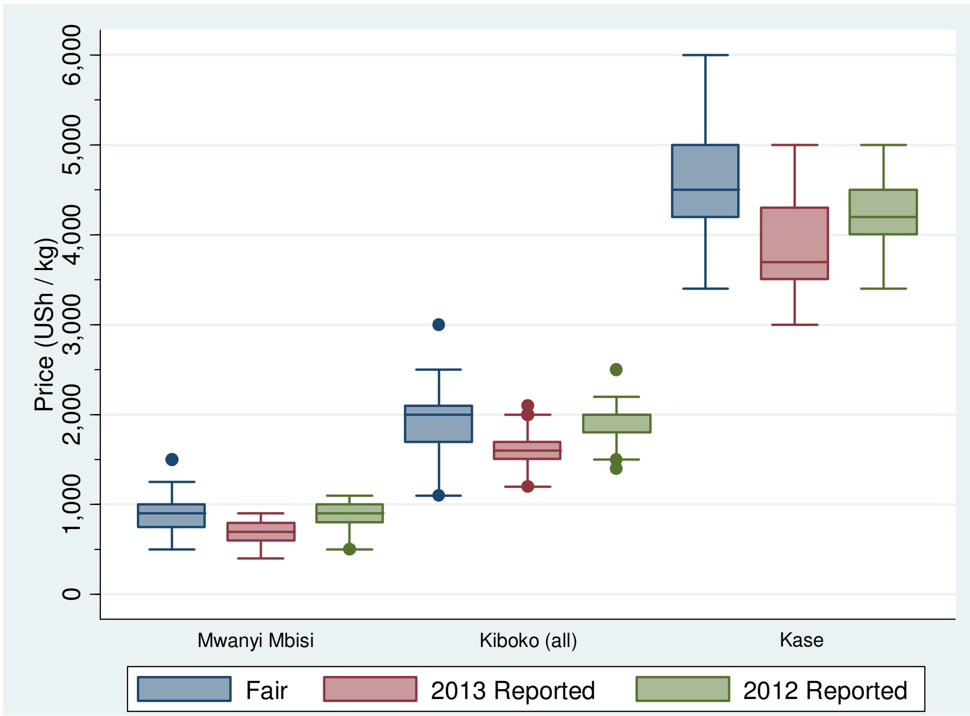
As a part of the HH survey for traders and growers, they were asked the prices they got for the products they bought and sold, as well as, the price that they believed to be a "fair" or "adequate" price (see survey forms in Appendices A.19 and A.20). While some farmers reported unrealistic price expectations (see the outliers plotted as dots in Figure 40), many reported prices that, while high, were within the 75th percentile range of reported 2012 prices. The 75th percentile answers for "fair" prices were also below the ideal prices for *kiboko* and *mbisi* for a realistic export price of 5,000 USh (Table 42).



Note: Data from farmers HH survey question 12 (see Appendix A.19). Farmers' who sold both *mbisi* and *kiboko* were asked for prices of both products so there will be a bit more weight given to their answers in the figure.

Figure 40: Box plots of farmers' opinions on fair price for their product vs. the prices they reported receiving in 2012 and 2013

Farmers believe that the fair price for their product is much higher than they have received in 2013 or even 2012, a good year for Robusta coffee prices. As shown in Figure 40 above, on average farmers' thought the fair price for *mwanyi mbisi* (fresh coffee cherries) was around twice the price they got for it in 2013. Similarly for *kiboko* (dried coffee cherries), the actual price they reported being offered in 2013 was around half on average the price that they thought was fair. The median fair prices by process were: 1,000 USh/kg for *mwanyi mbisi*; 2,000 for *kiboko*; and 2,500 for *kiboko* dried on a tarp.[140] The fair price expectation difference between *kiboko* dried on the ground and *kiboko* dried on a tarp was not significantly different (by a two-sample T-test); only some farmers felt a higher price expectation from the expended effort on drying properly.



Note: prices for *mwanyi mbisi* (fresh coffee cherries) and *kiboko* (dried cherries) are taken from questions to traders about what they pay growers and believe a fair price to be (question 13 in HH survey in Appendix A.20 on page 383). Prices for *kase* are taken from question 8 in the trader HH survey for those that sell *kase*.

Figure 41: Traders' reported fair price and actual prices for different coffee products

Traders viewed the prices they received for *kase* to be on average below what was considered a fair price to them in both 2012 and 2013 (see Figure 41 above). They reported being underpaid by an average of 548 USh/kg in 2012 and 892 USh/kg in 2013. They view their prices to farmers for either *mwanyi mbisi* or *kiboko* as mostly "fair". In 2012, the prices for *kiboko* and *mbisi* offered by traders were on average fair in their opinion (differences not significantly different from 0 by a T-test). However, in 2013, the price they offered to farmers was on

[140] Since many farmers and traders respond with the same price, the median often falls on the same value as the 25th or 75th percentile values as well which is why they are not drawn distinctly in these boxplots (e.g. Figure 40)

average around 220 USh less per kg than what they considered to be a fair price for *mbisi*.[141] The average difference between the fair price and the 2013 reported price for *kiboko* was 345 USh per kg.[142]

One would expect that those farmers who are less content with the price, might be less willing to invest in coffee and more likely to exit coffee growing to pursue other crops. While this is not rigorously tested here, a two-sample T-test with equal variance confirms this result for investment in coffee (using a binary proxy variable of whether or not the farmer has planted seedlings in the last 5 years). Farmers that have not invested in coffee on average thought a "fair" price for their product (*mbisi* or *kiboko*) was 1.95 ± 0.11 times higher than the 2013 price, while those that have planted thought a fair price was only 1.72 ± 0.06 times higher than the 2013 price ($t = 1.9872, p = 0.0489$). Although both groups of farmers thought the 2013 price was too low compared to their perception of fair, those that have stopped planting seedlings to replace their old and dead trees believe that the price should be significantly higher. This belief likely leads them to choose not to invest as much in their coffee plot.

Just to confirm the impact of the farmer's opinion on a fair price on their actual behaviour, a logistic model is estimated to predict the probability (p) of investing in coffee (i.e. planting seedlings). The simple model estimated is given in equation (1). In the model, $\%\ plot\ in\ coffee$ is the portion of the farmer's total plot devoted to coffee (ranging from 0 to 1); $fair\ price\ factor$ is the multiple of the 2013 reported price the fair price was for the farmer (continuous from 0.75 to 5 times as much in the data); and $coffee\ plot\ size$ is the hectares of coffee the farmer has devoted to coffee (continuous from 0.1 to 14 in the data).

$$\log \frac{p}{1-p} = b_0 + b_1 * coffeeland + b_2 * fairfactor + b_3 * perc\_coffee \quad \textbf{(1)}$$

Controlling for the size of the farmers plot, the model is clear that magnitude of the difference between the farmers' view of a fair price and the reported price received in 2013 for *kiboko* or *mbisi* had an impact on their likelihood of investing in seedlings. The results in terms of the

141 One-sample t-test confirmed that the mean for the difference between fair price and reported 2013 price for *mbisi* was significantly different from 0 ($t = 6.2315$, $p = 0.0000$)

142 One-sample t-test confirmed that the mean for the difference between fair price and reported 2013 price for kiboko was significantly different from 0 ($t = 4.1618$, $p = 0.0001$)

odds-ratio (i.e. exponentiated log-odds coefficients) in Table 43 below show that for a 1 ha increase in the amount of land devoted to coffee, there is a 54% increase in the odds of investing in coffee. However, the coefficient is more difficult to interpret for $fair\ price\ factor$ since the odds-ratio is less than one, other than to say farmers that have higher fair price expectations are less likely to invest in planting seedlings. The results for the percentage of plot devoted to coffee were surprisingly insignificant; $coffee\ plot\ size$ likely explained a lot of the variation.

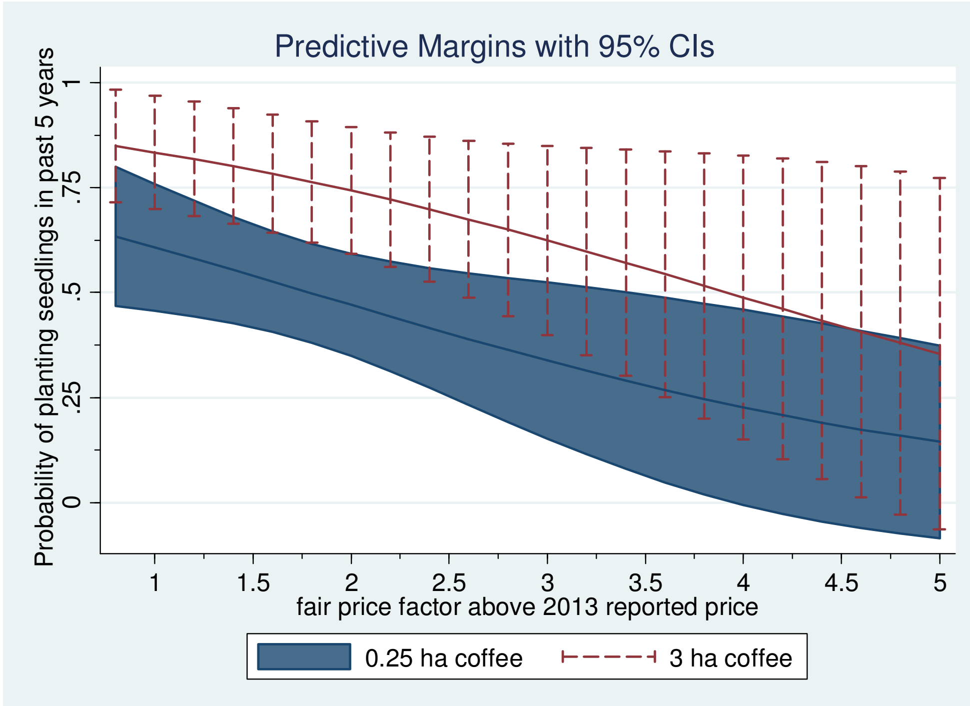
Table 43: Results of logistic model estimation for probability of planting seedlings

	(1)
coffee plot size	1.536**
	(0.293)
fair price factor	0.574**
	(0.162)
% plot in coffee	0.993
	(0.874)
Observations	136

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Exponentiated coefficients; Standard errors in brackets; there are 136 observations because of the 119 farmers, 17 of them sell both *kiboko* and *mwanyi mbisi*. As a result, those that sell both are included twice since they reported the prices they sold these products at and their fair price for each.

It is much easier to interpret the results of the logistic model using a plot of the predicted probabilities from the model. The impact of increasing expectations on the fair price for coffee is plotted in Figure 42, holding the hectares devoted to coffee at two different constants.

It is clear that farmers with less land devoted to coffee are more likely to stop investing in new seedlings, especially if they think the price they receive for their coffee is much less than what they consider to be fair. For farmers with more land devoted to coffee, the higher their view of the fair price is as compared to what they were paid in 2013, the more likely they were to stop investing in coffee as well. Other factors that may help predict investment or exit from coffee growing are studied further in Chapter 7.



Note: 0.25 ha of coffee is the 10th percentile size of plot, while 3 ha is the 90th percentile size of plot for farmers surveyed.

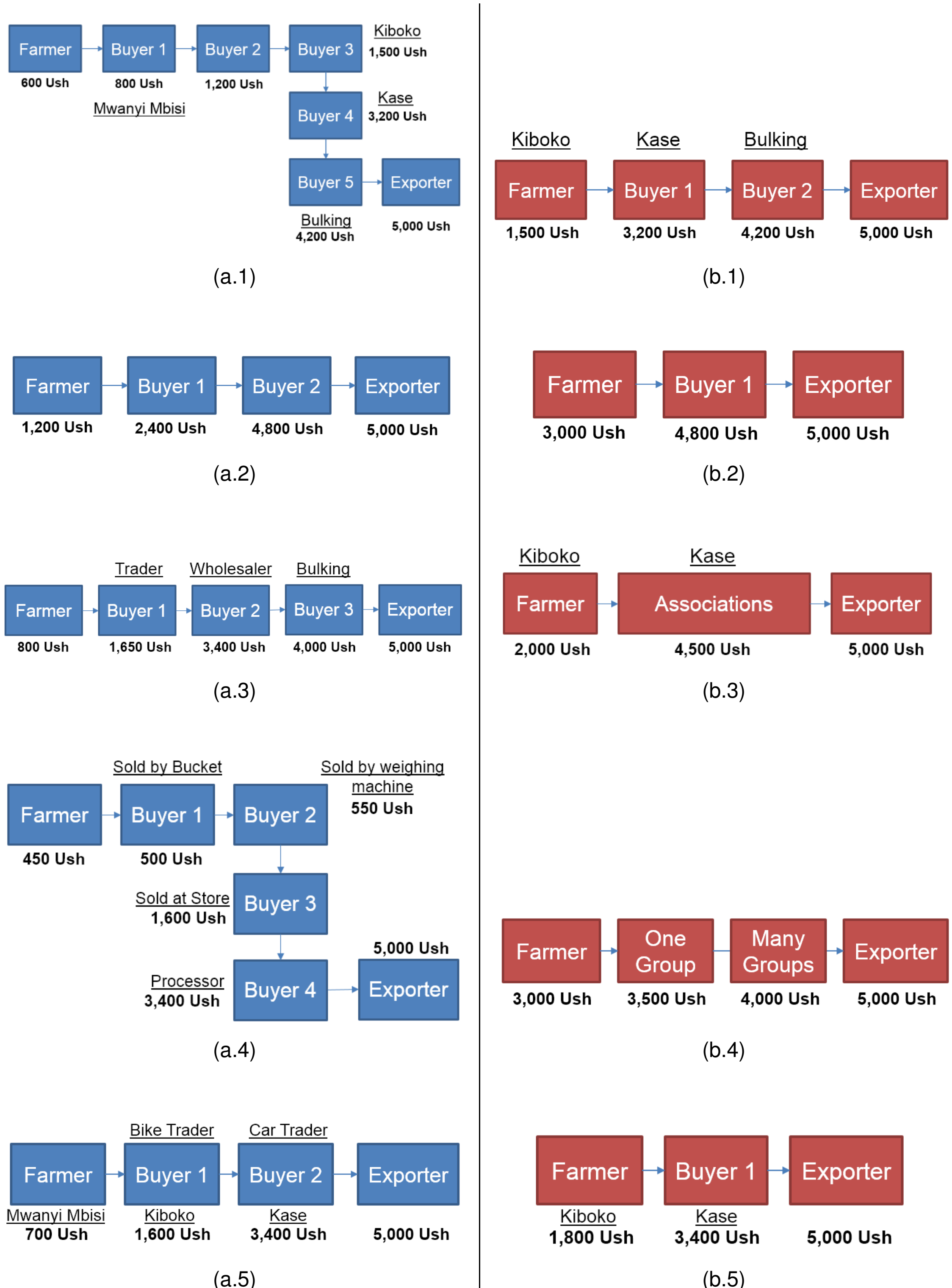
Figure 42: Predicted probability of planting seedlings against the fair price expectations of the farmer for two different plot sizes

Considering the importance of the fair price factor in keeping coffee growers investing in future production, closing the gap between what the farmer views as a fair price and that of the current market prices is an area worth exploring further. There are three ways that a farmer could potentially earn closer to the fair price for coffee: (1) increase the final export price by serving a higher value market, (2) improve quality such that the price offered might be higher for the product, and (3) eliminate intermediaries such that profits flow back towards the beginning of the supply chain. As discussed in the previous section (5.5.6), many experts did not believe there was much opportunity in (1). Additionally with the inability to tell quality by visual inspection of *kiboko*, (2) has limited potential to affect the price offered in the conventional supply chain. The last option (3) may have potential to bring the prices in the market closer to what farmers and traders view as fair for the coffee product they sell. Farmers in the workshop in Nkokonjeru also suggested the ideal supply chain would have less intermediaries.

Coffee farmers and traders at the workshop in Nkokonjeru were asked to draw the current supply chain and what they thought an ideal supply chain looks like. They were told that they should assume that the export price for coffee is 5,000 Ush/kg (a reasonable value at the time) and then to write what each stakeholder at each part of the supply chain receives for their product. The results of the diagrams for five groups are shown in Figure 43 on the next page.

The ideal supply chains suggested by some groups such as #5 were more realistic than those proposed by other groups such as #3 and #4, which did not have a clear description of what processing would happen at each stage. Without any prompting by the research team, all the farmer groups agreed that the way to get more value back to the farmer was to eliminate intermediaries and shorten the supply chain. Perhaps they were well informed from previous experience at NGO or UCDA workshops that forming associations and eliminating the levels of intermediary traders is the way for the farmer to make more money.

Group #1 and #4 suggested that the current supply chain had a major issue of farmers selling their product in small amounts with several intermediaries before it reached a major trader and was dried to *kiboko*. This was certainly true of a few of the farmers in the HH survey, who reported selling *mwanyi mbisi* by buckets or bowls (improvised from discarded materials and holding perhaps 3-10kg depending on the size). The reason the farmers in the HH survey mentioned doing this was out of a need for quick cash and either not having time for drying the coffee or being too old to handle the labour. The farmers selling in small quantities like this though were relatively rare, so groups #1 and #4 are likely reporting the worst-case scenario for old farmers with small plots.



Note: Diagrams made from original posters drawn by groups independently during the workshop. Photos taken from the original drawings before translation by a member of the research team are given in Appendix A.22 on page 388

Figure 43: Groups (1-5) responses to what the "current" (a, on left) and "ideal" (b, on right) supply chain should look like

The proposed ideal supply chain of group #1 is very similar to the supply chain made by the cooperative with NGO B. Farmers dry their coffee and only sell *kiboko* to a processor who sells *kase* to another party who bulks it before export. The difference for NGO B is that they both processed coffee to *kase* and bulked it for export. Intermediaries are not always disadvantageous. NGO B's cash flow issues largely occurred from the time spent bulking *kase*. These could possibly have been ameliorated if they sold to a 3rd party that did the bulking before taking to an exporter. The cooperative would have lost some of the profit, but would have greatly increased the speed at which they turned coffee into liquid assets.

Groups #2 and #3 propose very similar solutions to the current supply chain. They both suggest that the only issue is eliminating some of the buyers that are in-between the farmers and the exporters. In group #2's ideal supply chain, it is unclear what the buyer in-between would be doing (similarly for the ideal chain for group #4). A price of 3,000 USh for *kiboko* would likely be impossible to achieve given the weight loss from that stage to final export (assuming the final export price is only 5,000 Ush/kg). However, if the farmer is selling *kase*, the price is a bit low and the buyer in-between is taking a large profit for bulking the coffee. Group #3's ideal supply chain is perhaps the most interesting as it has aggressive, but realistic prices and processing levels for each stage. A price of 2,000 USh/kg of *kiboko* is close to the fair price quoted by many farmers for *kiboko* (see beginning of this section). Moreover, the price for *kase* considers the 50% weight loss from processing and an extra 500 USh/kg to cover additional costs and profit, while still maintaining a final margin of 500 USh/kg for the exporter.

From this activity, a few conclusions can be drawn with several suggestions for future research directions. (1) Farmers are well informed about the shape of the current supply chain and that there are several buyers in-between which are currently doing processing of coffee and that this takes a certain amount of capital to accomplish. (2) Some farmers have high expectations for what the farmer should receive for his/her product in an ideal supply chain, but 3 out of 5 groups have feasible supply chains that involve the farmers selling *kiboko* to a larger group or trader that would process to *kase*. (3) All the groups knew that eliminating the sale of *mwanyi mbisi* would allow them to extract more value from the supply chain. (4) Farmers are well informed about the supposed benefits of farmers associations. Since they are informed, it suggests that it is not a lack of information that is preventing them from forming groups and attempting to process coffee to further stages.

Future research should follow up with farmers in a similar workshop format to address the reasons why they do not form associations given the systems in place at each district via NAADS to register and their knowledge of the benefits of associations to process coffee in bulk. Additionally, given the constraints of the system in terms of the costs and weight losses at each stage, a model can be developed for the financial management of a cooperative. The model would help design a cooperative that meets the views of farmers' visions of fairness and incorporates their ideas of what the supply chain could look like. The model could take historic prices of coffee and calculate the premium that could be maintained for farmers while remaining sustainably profitable over a 20-year period for example. Given coffee prices are so volatile, in the high price years, profits could be saved to cover the subsidy in the low price years. Looking at the constraints of the system in terms of managing processing loses and the volatility of the final export price for coffee could inform the design of a cooperative that helps to meet the needs of the farmers.

5.6. DISCUSSION AND FUTURE WORK

This chapter introduced the fieldwork in Uganda to study the perceptions of pest risk and factors that impact decision-making among coffee growers. Sections 5.5.1 introduced the stages of processing that harvested coffee is typically sold at in Uganda and the industry structure. Section 5.5.2 examined the typical structure of a cooperative with the example from NGO B and informed by interviewees from Exporter B and NUCAFE who have worked with their own cooperatives.

The analysis in section 5.5.3 found that farmers in cooperatives consulted more social connections when making decisions on the farm. Cooperative farmers are also more likely to engage with each type of stakeholder as compared to independent farmers. Only 31% of independent farmers reported consulting extension services for advice, but 88% of cooperative farmers reported consulting extension services when making decisions on their coffee plots. Given the role of training and placement of agricultural experts by NGO B at coffee collection points in the parish, the boost in consulting extension services is expected. However, cooperative farmers were more likely to consult social connections outside the cooperative institutions as well. A full 96% of cooperative farmers reported consulting their spouses and

86% their friends, as compared to 58% and 53% respectively for independent growers. Comparable to the findings of Chloupkova, Svendsen & Svendsen (2003) for developed countries, social capital seems to be higher among cooperative groups in developing countries as well. The cooperative farmers also were more likely to fertilize and use pesticides on occasion (section 5.5.3). This could be driven by the training received by NGO B or reflect that cooperative groups are more likely to invest in premium production methods (Wollni & Zeller, 2007).

Section 5.5.4 found that cooperative groups from NUCAFE and NGO B reported having higher yields in terms of kg coffee per tree compared to coffee farmers in the HH survey. Although it is unclear if the higher yields are due to training received, the nature of being in a cooperative, or a selection bias among farmers who choose to join cooperatives (Ruben & Fort, 2012). NGO B had the highest yield of the three groups producing some 0.73 kg/tree/year more than NUCAFE (the next highest group). However, NGO B's high yields were not uniform across the parishes that they operated in, and were not improving universally year-on-year. Further research with NGO B is needed to understand what drives the differences between years and parishes for production outcomes.

While the data from NGO B, NUCAFE, and the HH survey was used to compare yields from different farming systems, future work could analyse other differences. Given that the 838 Buikwe farmers from Exporter A had not received any special intervention to date, they could also serve as a good field control for analysis comparing the impact of training in NGO B's intervention in Kamuli. Both registered farmers in Buikwe as well as the ones in Kamuli likely represent similar types of farmers who self-select into registering to join a group of farmers. The Buikwe group would just be several years behind the Kamuli farmers and thus could serve as a good control to measure against. This analysis could be useful to compare the costs of intervention against the benefits to farmers' production.

Section 5.5.5 discusses the two primary challenges faced by the cooperative of NGO B. The first of which was a cash-flow issue. The crop was harvested at the same time across the region and their capital was not sufficient to buy all of their members' coffee before selling it on to an exporter. The second challenge they faced was the high costs of inspections to maintain UTZ certification. These challenges are not uncommon for coffee cooperatives. Valkila & Nygren

(2010) found that Nicaraguan cooperatives studied were selling 40-70% of their coffee through conventional market channels instead of Fairtrade. Certification costs keep out some of the most vulnerable coffee farmers and form a significant barrier to production in other coffee growing areas as well (Valkila, 2009; Sick, 2008). Some of these challenges faced by NGO B's cooperative could be potentially diminished for cooperatives organized by major exporters. Exporters such as Exporter B have access to many different sales channels, are less capital constrained, and can afford certification costs since part of the benefit to them is for corporate social responsibility targets and public relations (section 5.5.6).

Section 5.5.7 finds that farmers have established prices that they consider a fair offering for the product they produce. These prices are much higher than the prices they received in 2013 for *mbisi* and *kiboko* coffee. The difference between their fair price and the offered price is a robust predictor of coffee investment behaviour. A farmer with 0.25 ha of coffee who thinks the price is fair is about 60% likely to plant seedlings, but a farmer who thinks the price should be 100% higher (factor of 2) is only around 40% likely to plant. Farmers with more land devoted to coffee were more likely to invest in planting seedlings as well, but were also influenced by their view on the fair price for coffee. Farmers who are dissatisfied with coffee pricing are more likely to switch to alternative activities (Sick, 2008). However, the likelihood that a farmer switches from coffee to another crop is also likely dependent on their risk taking behaviour. Measurements of risk-aversion are examined next in Chapter 6.

Chapter 6. Risk-aversion of Coffee Farmers and Traders

Agricultural production is inherently full of uncertainty. Smallholder farmers in rural Uganda need to deal with many risks in their lives. However, focusing just on the sale of one agricultural commodity, intuitively there are two major categories of risks: (1) variability in output and (2) fluctuation in output prices. Unlike their developed country counterparts, poor farmers lack access to formal insurance and credit markets to mitigate against production risks. While they do have informal mechanisms to cope with income shocks, relying on family and friends is limited in scale (Dercon, 2002; Fafchamps & Lund, 2003) and lack of insurance often results in selling of income generating tools and equipment (Udry, 1995). Risk-aversion and lack of income smoothing also inhibit investing in opportunities with future benefits like new technology and education for children (Dercon, 2008). The importance of agriculture to the economy in developing countries makes the study of risk preferences among farmers an important area with policy relevance.

Three areas of risk preferences are examined in this chapter. First (1) in section 6.4.1 the agreement of priorities among stakeholders in the Robusta supply chain for five major pests and disease are examined. Data comes from the HH survey for growers/traders and from interviews with other supply chain actors.[143] If parties at different levels of the supply chain have different views on which pests are most important, they may act with counter priorities to each other—spending more resource preventing a disease or pest that may not really be a significant issue in the opinion of the farmers. The choices of the pests included in the survey are discussed in section 6.2.1.

Next, (2) results are presented and discussed from measurements of risk-aversion for coffee farmers and traders using a Holt & Laury (2002) design (hereafter abbreviated: HL) adapted from the work of Tanaka & Munro (2014) in Uganda. The methodology and design of the risk-aversion game used at the end of the HH survey is discussed in section 6.2.3. There are thousands of experimental studies with an experimental methodology based on HL; some important and relevant studies are reviewed in section 6.1. The risk-aversion results for traders and growers are compared in section 6.4.2.

[143] See Table 39 on page 162 for the interview list

Lastly, (3) the results of a coffee market game that allowed farmers to choose to take a stable, risk-free price for their coffee instead of a variable market price are examined. The methodological design of the game is explained in section 6.2.1. The game was developed by the author and piloted at the workshop held at RASD in Nkokonjeru. The game simulates market swings that occur from year-to-year within the coffee market of which the farmers are accustomed to responding. The usefulness of the pilot and future development to improve the simulation are discussed in the conclusion.

This chapter as well as Chapter 7 report the results for many of the questions asked in the HH survey of farmers and traders. As a result, the summary statistics of characteristics of the participants are presented in section 6.3.1 for farmers and section 6.3.2 for traders. Section 6.5 concludes and discusses the limitations of the risk measurements presented along with future lines of inquiry.

6.1. THE ROLE OF RISK IN SMALLHOLDER AGRICULTURE

The majority of smallholders in the developing world grow a variety of crops on their plots and often produce in mixed crop-livestock systems (Herrero, Thornton, Notenbaert, et al., 2010). They must choose into which agricultural products to invest both effort and money. Ideally, the farmer would choose crops that have high and consistent output prices, high and consistent yields, and invest in a portfolio of crops/livestock with uncorrelated market prices and uncorrelated loss characteristics (e.g. drought/flood tolerance, different pests, different harvest times, etc.). Optimizing based on these goals would likely reduce risk of large income loses and keep a more consistent level of revenue for the farmer. Farming however faces many risks and constraints beyond a pure financial investment, which are discussed below.

Soil as well as climate characteristics will determine which crops are viable and which grow best in combination with each other. The plot of a smallholder is likely fixed, thus not allowing her to benefit from spatial diversification, which is often the best method of stabilizing farm income (Anderson, 1971; Trebeck, 1971). Additionally, some crops will take more time/effort than others take and require more or less experience to achieve results. Despite the challenges of modelling farm choices under uncertainty, there have been numerous examples in the literature of mathematical programming models. These models often calculate a measure of risk-aversion based on actual economic behaviour against a theoretical model of utility maximization. The deviance of the measured utility function is expected to tell the researcher something about the economic agent's risk preferences, assuming the model is a good fit for the real agent (Arrow, 1971; Austin, Willock, Deary, et al., 1998; Avelino, Zelaya, Merlo, et al., 2006; Bar-Sliira, Just & Zilberman, 1997; Elamin & Rogers, 1992; Hill, 2010, 2006).

Given the diversity of risks and possible responses, some researchers like Anderson (2003) of the World Bank have suggested more qualitative frameworks for matching risk mitigation measures to types of risks as a more effective, practical strategy compared to mathematical models of optimal farming behaviour. The framework by Anderson (2003) allows for alternative strategies in response to risk including prevention and coping, as well as, mitigating risks in the informal sector instead of the usual government policy and market-based mechanisms (Anderson, 2003). The majority of the literature takes a more formal quantitative approach based on economic models developed first by Knight (1921). This was later improved in subsequent decades with the use of von Neumann & Morgenstern (1947) concept of "expected utility".[144] Their expected utility theory then formed the foundations on which Pratt (1964) and Arrow (1971) developed two common measures of risk-aversion that influenced decades of empirical research.[145]

Original measures of risk aversion found in Pratt and Arrow's work in the 1960s and 1970s stand out as guiding future theoretical and empirical literature about the effect of wealth on risk aversion (Pratt, 1964; Arrow, 1971). Arrow (1971) showed that with higher wealth there should be decreasing absolute risk-aversion (i.e. a smaller portion of total assets in risky investments), but higher relative risk aversion (i.e. the wealthier one becomes, the more likely she will take risk with at least some portion of her wealth). Subsequent empirical work often looks for evidence of one or both of these effects.

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[144] Though expected utility dates back to thought experiments of Bernouli in the mid-1700s, von Neumann and Morgenstern are credited with deriving it into a rational decision model (Schoemaker, 1982)
[145] A thorough review of the development of risk-aversion is found in Just, Khantachavana & Just (2010). A related field of research on the subject of risk-aversion centres on "Prospect Theory" first developed by Kahneman & Tversky (1979). Prospect Theory helped to explain empirical results showing people make decisions based on potential gains and losses, overweighting low probability events in both cases. The literature on Prospect Theory is not covered in this chapter.

Bar-Sliira, Just & Zilberman (1997) use econometric estimation and re-work the model of Arrow (1971) to account for changes in wealth and the elasticity of absolute risk aversion among Israeli farmers. Mainly, their results confirm the hypothesis of Arrow (1971): wealthier Israeli famers are more likely to adopt risk-seeking behaviours such as adopting new technology in their farming practices. Similarly, but in a developing world context, Elamin & Rogers (1992) model the traditional, mostly subsistence farm plot in Sudan incorporating a measure of risk-aversion in farming activity choices for three sizes of model farms. The imputed risk-aversion coefficients from the data collected were quite high, demonstrating the importance of incorporating risk-aversion measures. In their study, the sacrificed potential farm income from less risky cropping choices was nearly 10% as compared to optimal choices in the model (Elamin & Rogers, 1992).

Eswaran & Kotwal (1990) show risk aversion—driven not necessarily by risk preferences, but by lack of access to credit—leads to under investment in risky production, as the poor are unable to pool risks over time. Similarly, findings of Rosenzweig & Binswanger (1992) provide evidence from India that more risk-averse farmers sacrifice potential income in order to secure a more stable, lower income as compared to wealthier farmers. As such, risk-aversion may prevent farmers from investing in high-return, higher-risk activities in favour of lower-risk, low-return poverty traps (Yesuf & Bluffstone, 2009). Knight, Weir & Woldehanna (2003) show that risk-aversion decreases with further education and that both have an impact on technology adoption in Ethiopia (risk-aversion decreases probability of adoption, education increases adoption probability). There is great interest in the social situation and external factors beyond pure risk preferences that seem to drive risk-aversion. Feinerman & Finkelshtain (1996) found on a survey of 180 farmers in Israel that socio-economic characteristics such as family size, measures of wealth, and type of crop planted were correlated with level of risk-aversion and influenced production decisions.

An alternative to the use of econometric techniques to study risk aversion based on real decisions made in the past, there is the experimental method where a game or survey is used to elicit the risk preferences of respondents. The most famous and important of such games is found in the seminal paper of Holt & Laury (2002). Their framework is further discussed in reference to the risk-aversion game used in the HH survey in section 6.2.3. The literature based on the HL design is vast; over 2,500 subsequent papers have cited the experiment.[146] A few papers stand out and are discussed in brief below.

Tanaka & Munro (2014) use a HL game to elicit the risk preferences of 1,289 people among a randomly drawn sample of the Ugandan population in 94 villages, covering six out of the seven climate zones of the country. They find that agro-climatic conditions seem to influence the time and risk preferences of farmers as there are significant differences in preferences between regions of the country. However, they did not find significant impacts of individual or household characteristics on risk-aversion except the effect of gender (women were more risk-averse than men) (Tanaka & Munro, 2014).[147]

Herberich & List (2012) discuss the issue of background risks which influence real decisions in ways that are not accounted for in the economic theory established by Pratt (1964) and Arrow (1971) or subsequent HL experiments. They are among the first to incorporate background risks into a HL experiment with farmers and students. Background risks are incorporated by giving ranges of (1) pay-out sizes and (2) a lack of information about the probabilities of different pay-outs occurring in a set of four designs. They expected to find that farmers were more risk-seeking in the experiments than students as farmers are more accustomed to making decisions with high-levels of background risks. Despite this, their results found that farmers were slightly more risk-averse, but the study suffered from low sample sizes (n<20) and the results were not significantly different (Herberich & List, 2012).

In a developing world context, Yesuf & Bluffstone (2009) find strong evidence of risk-aversion among rain-fed agriculture and livestock producers in 262 farm households in the highlands of Ethiopia, especially when the game involved a chance of loss. They also confirm, like many studies, that wealthier farmers were more risk-accepting than poorer counterparts (Yesuf & Bluffstone, 2009). Possibly, because of a high degree of risk aversion, survey results as well find that farmers in developing countries tend to overestimate both the severity and the likelihood of the worst-case scenario pest events (Heong & Escalada, 1999).[148]

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[146] According to metrics from Google Scholar <http://scholar.google.co.uk/>
[147] Individual characteristics included age, education, and head of household status. Household characteristics included land size, asset value, and percentage of household members under age 15 (called the dependency ratio in the study). Several of these variables were collected in the present survey (see methodology in section 5.3.5).
[148] This result is explored in the context of the present survey on risks and pests in section 6.4.1 on page 235.

In Uganda, Hill (2009) finds evidence that risk preferences do have an impact on investment decisions for poor coffee-producing households in Uganda. She uses a survey of 300 households with questions on hypothetical risks, which give her a measure of the farmers' risk-aversion. She then divides out poor and rich farmers using a socioeconomic survey and using regression analysis, finds that wealthier farmers devote more land to coffee and get a higher share of their income from coffee (Hill, 2009). Vargas argues that this affect is significant because poor farmers are less likely to allocate time and effort into coffee production, which, though riskier, has a higher average return than other crops like *matooke*[149] that they devote farming effort too. This factor is one of many that contribute to poverty traps (Hill, 2009). These results also confirm the theoretical predictions of decreasing absolute risk aversion and increasing relative risk aversion of Arrow (1971). Bauer & Chytilová (2010) also find strong evidence that a better understanding of risk-aversion and discounting can help guide policy makers' understanding of Ugandan farmers' investment decisions. Also in Uganda, Humphrey & Verschoor (2004) find that households in Eastern Uganda affected by shocks and long-term poverty are more risk-averse than their less afflicted counterparts.

In general, the evidence base in the literature is quite mixed on whether risk aversion is a useful tool for understanding behaviour, leading to strong critiques even from authors that previously had published widely in the field (Just, Khantachavana & Just, 2010). However, as Just, Khantachavana & Just (2010) document, the majority of the compelling and justified critiques centre on the difficulty of accurately estimating a form of the utility function using econometric techniques.[150] A more modest goal of "simply characterizing risk preferences into broad categories of behaviour" can still prove to provide useful insights (Just, Khantachavana & Just, 2010). Following this suggestion, the risk-aversion experiment used in the present survey was inspired by the simple methodology used by Tanaka & Munro (2014).

[149] A type of plantain that is a staple food in Uganda
[150] For a thorough review of the history of the literature on the interaction between risk preferences and agricultural management, see Just, Khantachavana, & Just (2010).

6.2. METHODOLOGY

The main explanation of the design of the surveys and format of the workshop in Nkokonjeru have been explained previously in Chapter 5 (see section 5.3, pages 164 to 172). The methods for the pest risk component of the survey (section 6.2.1), the coffee trading game at the workshop (section 6.2.2), and the risk-aversion game at the end of the survey (section 6.2.3) are all discussed below.

At the mid-point of the survey period, an additional check-in as a survey team was conducted to discuss any issues that were arising from the fieldwork. The most significant issue was the explanation for the risk-aversion game. Many farmers were responding with irrational answers and so the team discussed how each team member was explaining the game to see if they could come up with tips for each other to help boost understanding. There was no significant change in the administration of the survey, only alternative ways to answer questions that interviewees had were discussed. Despite this, the percentage of illogical responses remained quite high compared to the literature (see results of risk-aversion game in section 6.4.2).

6.2.1. Pest risk survey

The pest risk part of the survey was based on the methodology of Van Mele, Cuc & Van Huis (2001) who worked with mango growers in Vietnam. To record pest perceptions among Vietnamese mango growers, Van Mele, Cuc & Van Huis (2001) first asked farmers what their most important pest problems were. Getting this list, for each pest they subsequently asked farmers to report the incidence, severity, and estimated yield loss on a ranked scale of low, moderate, and high (Van Mele, Cuc & Van Huis, 2001). Similarly, in this survey growers were asked to identify five common pests/diseases of Robusta coffee. Subsequently, for the pests/diseases they claimed to know, they reported the incidence and severity of each pest/disease on their plot.[151] While some growers struggled to give an answer to a typical season since pest severity can vary significantly annually, the majority could settle on an "average" season answer quite readily. The response detail was considered granular enough

[151] The questions used for the pest risk part of the survey are found for farmers in Appendix A.19 questions 23 to 33 and in Appendix A.20 questions 26 to 34 for traders.

for these purposes of comparing different groups since it was beyond the scope of this analysis to identify seasonal variations or impact of factors like weather on disease/pest incidence.

While coffee diseases and pests are found throughout East Africa, there is country level variation. For instance in Ethiopia, the three major fungal pathogens of coffee are Coffee Leaf Rust (CLR), Coffee Berry Disease (CBD), and Coffee Wilt Disease (CWD) (Hindorf & Omondi, 2011). However, in Uganda since the primary coffee crop is Robusta, the top pests are different. The top pests explored in the present survey correspond to the highest risk pests as decided in a small group[152] format by an East African Regional Workshop held by the Coffee Research Network (CORNET) in 2004 as discussed in the technical manual by Rutherford & Phiri (2006). Of the five pests and diseases in the present survey, Coffee Berry Borer (CBB), Red Blister Disease (RBD), and CWD ranked equally as the worst pests/diseases for Uganda by the 2004 panel with a score of 3 out of 3 (Rutherford & Phiri, 2006). Root Mealybugs (RMBs) also made the list of priorities with a slightly lower score (2/3). As such, these four pests were included with the addition of a fifth pest, Coffee (Black) Twig Borer (CTB/BTB), which has only recently been found in Uganda (Egonyu, Kucel, Kangire, et al., 2009). The present survey complements the rankings discussed by Rutherford & Phiri (2006) in several ways. Firstly, (1) their study did not distinguish between the priorities of different stakeholders in the workshop. (2) The metric they used did not distinguish between severity and frequency. (3) The score out of three provided poor resolution to distinguish between pests. Additionally, (4) since the workshop was conducted in 2004, there was a clear need to update the knowledge base for the current list of priority pests for Uganda Robusta coffee production including BTB.

In Table 44 below, a brief description is given of each of the five pests and diseases used in the survey. Each pest/disease also has a small section with further descriptions in the Appendix (sections A.22.1 through A.22.6 starting on page 388). The main pests/diseases of concern are BTB and CWD, so these sections have more thorough explanations of their biology and impact on Robusta production in Uganda. The section on BTB (page 390) also includes a discussion of different stakeholders' opinions on how best to control the pest.

[152] The group consisted of coffee farmers, processors, marketers, regulatory bodies, development agency representatives, and civil society from eight East African countries including Uganda.

Table 44: Five common diseases and pests of Robusta Coffee in Uganda

Pest/Disease	Brief Description
Note: images included for examiners' copies, but removed for the online, publically available version on Imperial College Spiral due to copyright regulations.	**(a) Coffee Wilt Disease**[153] ***Fusarium xylarioides*** **(see page 388)** A soil fungal pathogen causing extensive damage to yields as the entire tree dies once infected. It is the most famous and devastating historically of Uganda's Robusta production.
Note: images included for examiners' copies, but removed for the online, publically available version on Imperial College Spiral due to copyright regulations.	**(b) Black Twig Borer**[154] ***Xyleborus ferrugineus*** **(see page 390)** A beetle that burrows into the smaller branches of the coffee tree. Once inside it helps establish a fungus on which it feeds, but also which kills the branch, and potentially, the entire tree.
Note: images included for examiners' copies, but removed for the online, publically available version on Imperial College Spiral due to copyright regulations.	**(c) Coffee Berry Borer**[155] ***Hypothenemus hampei*** **(see page 395)** A beetle that burrows into the coffee berry causing it to fail to ripen and ruining the quality of the bean inside.
Note: images included for examiners' copies, but removed for the online, publically available version on Imperial College Spiral due to copyright regulations.	**(d) Red Blister Disease**[156] ***Cercospora coffeicola*** **(see page 396)** A fungal pathogen which causes damage to the leaves, weakening the tree as well as damaging berries, which reduces the quality and yields of the resulting coffee.
Note: images included for examiners' copies, but removed for the online, publically available version on Imperial College Spiral due to copyright regulations.	**(e) Root Mealybug**[155] ***Planococcus fungicola*** **(see page 398)** A sucking pest that causes nutrient loss and stress to the coffee tree by affecting the uptake of nutrients through the roots. This can result in yield loss and in extreme cases, the death of the tree.

[153] Image credits: Rutherford & Phiri (2006) and Rutherford (2006)
[154] Image credits: http://www.forestryimages.org/browse/subthumb.cfm?sub=426
[155] Image credits: Rutherford & Phiri (2006)
[156] Image credits: https://www.plantvillage.com/en/topics/coffee/

6.2.2. Coffee market game

A simulation exercise was developed by the author to use with groups of farmers and traders to elicit their responses to price fluctuations in the coffee market, and to find their response to the opportunity to take a contract with a stable price. The objective was to examine to what extent farmers would accept and stay with a contracted stable price when opportunities existed to cheat the contract and make more money in "good" price years.

The game was designed such that the expected earnings if a team stayed with any one trader were approximately the same (see Table 45). As shown in the last row of Table 45, only those that stayed with Trader B for every round would receive 95% compared to staying with Trader A or Trader C, which were equivalent over the simulated 10-season period. The factors in columns 3 and 4 are what Trader A's prices were multiplied by to get Trader B and Trader C prices. The factors reflected the type of year (last column) the simulated season reflected. The "market price" that was announced to the teams was the simple mean of what Trader B and Trader C would later offer to the farmers as they walked around buying coffee.

Table 45: Design and payments for coffee market trading game

		Factors		Prices (USh / Kg)			
Season	TRADER A	TRADER B	TRADER C	B	C	"MARKET" (Mean B & C)	Type of Year
1	1,800	1.1	1.3	1,980	2,340	2,160	Good
2	1,800	0.8	0.7	1,440	1,260	1,350	Bad
3	1,800	0.8	0.7	1,440	1,260	1,350	Bad
4	1,800	1.3	1.4	2,340	2,520	2,430	Great
5	1,800	1.1	1.3	1,980	2,340	2,160	Good
6	1,800	1.1	1.3	1,980	2,340	2,160	Good
7	1,800	0.8	0.7	1,440	1,260	1,350	Bad
8	1,800	0.7	0.7	1,260	1,260	1,260	Bad
9	1,800	0.7	0.6	1,260	1,080	1,170	Horrible
10	1,800	1.1	1.3	1,980	2,340	2,160	Good
MEAN:	1,800	0.95	1	1,710	1,800	1,755	

To simplify the process of production, each team was told that they produced 100 kg of dried coffee (*kiboko*) each year. The team would be able to store any coffee from a given year until the next year, but storage beyond one season was not allowed. Some traders do store their dried coffee while waiting for better prices, so this was a reasonable allowance in the game. This decision on constant production limited the power of the simulation to highlight investment decisions and pest treatment choices farmers make. However, the simplification seemed necessary at the time in order to facilitate game play. It also made the game more focused on farmers' responses to the opportunity for price stability in an uncertain market.

The contract of Trader A guaranteed a constant price and purchase of at least half of the team's annual production of coffee (i.e. 50 kg). The official contract gave each team the option to sell half their coffee (i.e. 50 kg) on the open market (to Trader B or C) without violating the contract, but Trader A would try to convince the team to sell Trader A the entire lot (i.e. 100 kg) ostensibly to meet the company's volume targets. Trader A used tactics like speaking of establishing good will and relationships between the company and the team when they sell the entire lot. If a team were to violate their contract during any season, it was explained that Trader A would refuse to deal with them for the remaining seasons of the game.

At the end of season 5 (i.e. the mid-point of the game), teams were asked if they would like to re-sign the contract for the next 5 seasons. Teams that had not previously been on contract would also be able to sign-up for a contract for the remaining 5 seasons. The price and conditions offered by Trader A remained the same as they did at the first offer in the beginning of season 1. No teams were allowed to join Trader A at any season between the sign up points and the teams were notified of the sign-up points before the game began.

The setup of the game was as follows (see Figure 44). Farmers and traders were split into six teams.[157] One person from the research team was deemed the "market maker" with a laptop that was used to record sales from each team as well as to announce the yearly coffee market information. The "mobile team" consisted of three traders from the research team. Each trader was given a translator/assistant who would move with them to help assist with questions from the participant teams.

[157] Since they would need to be able to discuss amongst their team, the survey team let participants self-select into approximately equal groups to allow for any cultural norms or previous friendships to be respected and to increase the chance that the team worked well together.

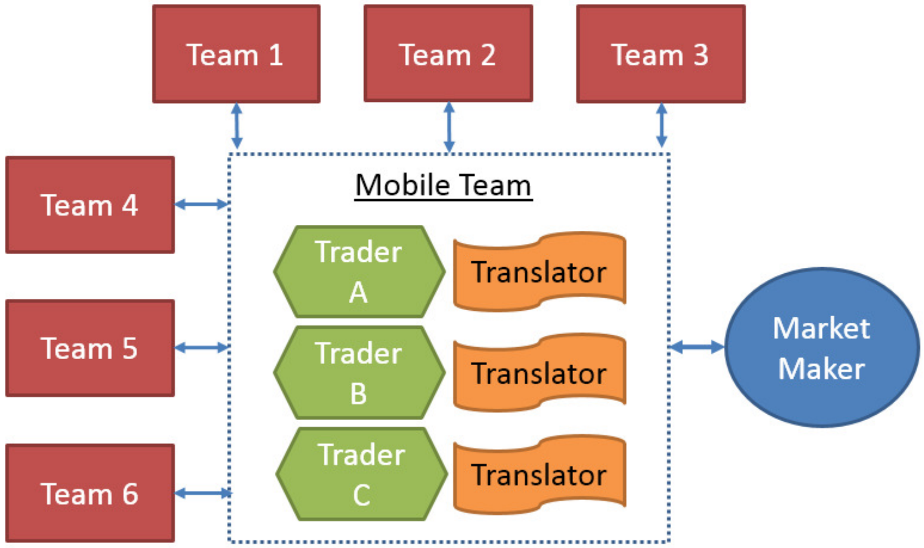


Figure 44: Diagram of game setup of coffee trading game

The game began with the start of season 1. At the beginning of each season, the market maker would announce the type of year that was expected (e.g. good, bad, horrible etc.) and the market price for coffee (last two columns of Table 45). The traders would move between the market maker and each team in order to "buy" coffee from each team for the simulated season. Traders were allowed to try to persuade the participant teams to sell—just as a trader in the real supply chain may pressure farmers to accept the trader's price. At the end of the season, traders would stop moving around and would record all sales from each team with the market maker. The next season would begin by the market maker announcing the next season number, the type of year, and the market price.

Teams were incentivized to perform to their potential with an award of a cash prize of 7,000 USh (approximately £1.75) for each member of the winning team.[158] The score for each team was simply the money they made over the course of the game (i.e. the sum of each team's revenue from selling their 100kg for each season). The prize and points system was announced with the rules before the game play began.

Figure 45 shows some images from the game play at the workshop in Nkokonjeru conducted with RASD. The game was played as the last activity of the workshop as the high-energy nature

[158] In this community, this cash prize would be more than a day's wages for a typical person.

of the game kept interest among the participants. The main issue that the researchers encountered was the author underestimated the amount of time teams would spend discussing strategy and then negotiating with the traders. The game was cut short in the interest of time at the end of the farmer workshop. As such, teams did not play rounds 7, 8, and 9. However, the results were still useful and the research team felt they learned much of what could be discerned from the game by that point of play. The results are discussed in section 6.4.3, page 262.

(a) (b)

(c) (d)

Note: (a) trader interacts with team in top left, (b) trader sits down to negotiate with team, (c) market maker (centre with laptop) announces prices while two traders look on, (d) trader reports sales to market maker

Figure 45: Images from coffee trading game at workshop in Nkokonjeru

6.2.3. Multiple price list design

There are four common methods of measuring risk aversion in the field, all of which have been applied to some extent in a developing country context: Ordered Lottery Selection, Multiple

Price List (MPL), Titration Procedure, and simple investment games.[159] The point of each method is to elicit the deviance of the respondents' utility function from that which would be expected by Expected Utility Theory (von Neumann & Morgenstern, 1947). Respondents who are risk-averse will have a certainty equivalent value (CEV) below the expected monetary value (EMV) of an option and conversely, those that are risk-seeking will have a CEV above the EMV. As an example, if the choice is between having a fixed amount of money or a 50% chance at £10: someone who is risk neutral would demand exactly £5 to take the fixed amount option (CEV=EMV=£5), someone who is risk-averse would demand less than £5 (CEV<EMV) to forgo the 50% chance at £10, and someone who is risk-seeking would only accept more than £5 (CEV>EMV) to take that fixed amount over the 50% chance at £10.

The Multiple Price List (MPL) design is promising because it allows for a more accurate measure of Constant Relative Risk Aversion (CRRA) than Ordered Lottery Selection, is more robust than Titration, might be less perceived as gambling as compared to simple investment games, and has been successfully piloted in field trials in Uganda (Tanaka & Munro, 2014). The original design of the MPL is discussed in detail in Andersen, Harrison, Lau, et al. (2006), but was made famous in a seminal paper of Holt & Laury (2002). All of these subsequent experiments are similar in nature to the original HL design with modifications to allow for time-variance, loss-aversion, and other modified characteristics of the utility function that may be relevant for the given research question.

For simplicity and in order to make the survey results more comparable to the literature, a version of the design of Tanaka & Munro (2014) was used and is based on the original MPL design of HL. The main differences between the design used and that of HL are that the probabilities remained the same between rounds and different payments were used; in contrast, Holt & Laury (2002) varied probabilities with a constant payment.

[159] Methods informed by conversation with Dr. Ben D'Exelle of University of East Anglia (UEA) at a Methods in the Field Course conducted by UEA London, 18 May, 2013.

#	Bag A	Bag B		Pick a marble from A or B?
	4 red marbles ● ● ● ●	3 red marbles ● ● ●	1 white marble ○	
1	4,000	4,000	2,000	
2	4,000	4,500	2,000	
3	4,000	5,000	2,000	
4	4,000	5,500	2,000	
5	4,000	6,000	2,000	
6	4,000	7,000	2,000	
7	4,000	7,000	3,000	
8	4,000	7,000	4,000	

Note: Pay-outs are in Ugandan Shillings (conversion rate at the time of survey: 4,000 USh ≅ £1 British Pound Sterling).

Figure 46: MPL design used for farmer HH survey, based on Tanaka & Munro (2014)

As shown in Figure 46, respondents chose between option A or option B in eight different rounds. This design was used in the survey administered to all of the coffee growers. A shortened version was used for the coffee traders, who the local survey team thought would not have the patience after taking a long survey to participate in the version that was used on the growers. The modified MPL design for the traders is shown in Figure 47. The main difference is that three rows (# 2, #4, and #6) were eliminated to create a shortened game.

In both of the MPL designs (i.e. Figure 46 and Figure 47), option A is the safe option with a 4/4 (100% probability) of yielding 4,000 USh. Option B is the chance option with ¾ (75% probability) of the left hand value and ¼ (25% probability) of the right hand value. The respondent starts at the top and chooses each round between option A or option B. Respondents were told ahead of time they needed to make selections for each row, but then would randomly play one row for "real" where a payment would be made. They were told they would not have the option to change their answer. This followed the methodology of the original HL experiments. Option A should always be chosen in row #1. Option B is the only rational choice in row #8. The switch point, where the respondent "switches" from only answering A to only answering B, allows the researcher to calculate the respondent's risk aversion.

#	Bag A	Bag B		Pick a marble from A or B?
	4 red marbles	3 red marbles	1 white marble	
1	4,000	4,000	2,000	
2	4,000	5,000	2,000	
3	4,000	6,000	2,000	
4	4,000	7,000	3,000	
5	4,000	7,000	4,000	

Note: Pay-outs are in Ugandan Shillings (conversion rate at the time of survey: 4,000 USh ≅ £1 British Pound Sterling).

Figure 47: MPL design used for trader HH survey, based on Tanaka & Munro (2014).

In measuring the degree of a respondent's risk-aversion or risk-seeking, a common choice in the literature is the CRRA measure (Herberich & List, 2012; Tanaka & Munro, 2014; Hellerstein, Higgins & Horowitz, 2013). This is the value of r in the utility function[160] $U(x) = \frac{x^{1-r}}{1-r}$ for $x > 0$ for which the probability-weighted sum of utility outcomes is maximized (i.e. $\max(\sum p_i * U(x_i))$; where x_i is the pay-out to the individual (i) with probability p_i . For $r = 0$, the respondent is risk neutral. For $r < 0$, the respondent is some degree of risk-

[160] Holt & Laury (2002) use a utility function of $\mathbf{U(x) = x^{1-r}}$, but for high levels of risk aversion (i.e. $\mathbf{r > 1}$) it is necessary to divide by $\mathbf{(1-r)}$ to get increasing utility.

seeking. Finally, for $r > 0$, the respondent is risk-averse. Based on the researchers' experimental design, they can elicit different ranges of the CRRA for which the respondent's choice in the experiment was optimal—assuming expected utility theory is true. It is easiest to demonstrate the methodology and results given in column 2 of Table 46 below with an example calculation.

Assume a farmer is playing the risk-aversion game given in Figure 46. She answers A for all choices until row 6, where she switches to B for that row through the rest of the game (rows 6, 7, 8 see Figure 46). For row 5, she chose the safe option of a guaranteed (i.e. 100% probability of) 4,000 USh, which by revealed preference she must have preferred that to the 75% chance of 6,000 USh (see equation (2)). However, for row 6 she preferred the probabilistic option of 75% chance of 7,000 USh and 25% probability of 2,000 USh to the safe choice (see equation (3)). Her risk preference can then be calculated as the interval between the solutions for r given the two equations (2) and (3) shown below:

$$\frac{4000^{1-r}}{1-r} > 0.75 * \frac{6000^{1-r}}{1-r} + 0.25 * \frac{2000^{1-r}}{1-r} \tag{2}$$

$$\frac{4000^{1-r}}{1-r} \leq 0.75 * \frac{7000^{1-r}}{1-r} + 0.25 * \frac{2000^{1-r}}{1-r} \tag{3}$$

Solving (2) yields $r > 2$ and solving (3) yields $r \leq 2.391$. As such, the interval for the actual risk aversion parameter is given by $2.00 < r \leq\ 2.39$ (as shown in Table 46 for switching to B at row 6).

Table 46: Risk aversion classification based on lottery choices for design in Figure 46 above

Row of first B (switching point)	Range of relative risk aversion for $U(x) = \frac{x^{1-r}}{1-r}$	Expected value difference at switch point $(E[A] - E[B])$	Risk preference classification*
ALL B	-	500	Irrational
2	$-\infty < r \leq -0.82$	125	Very risk-seeking
3	$-0.82 < r \leq 0.92$	-250	Risk-seeking to risk neutral
4	$0.92 < r \leq 1.62$	-625	Slightly risk-averse
5	$1.62 < r \leq 2.00$	-1,000	Moderately risk-averse
6	$2.00 < r \leq 2.39$	-1,750	Intermediate risk-averse
7	$2.39 < r \leq 3.79$	-2,000	Highly risk-averse
8	$3.79 < r \leq \infty$	-2,250	Very risk-averse
ALL A	-	-	Irrational
MULTIPLE	-	-	Irrational

* Terminology based on Tanaka & Munro (2014)

It is also trivial to calculate the expected value difference between choice A and choice B at her switching point of row 6 (see equations (4) and (5) below). In equation (4), p_a is the probability of the payout x_a occurring, and analogously for the two possible payouts for option B. The expected value of choosing the safe option of 4,000 USh is 1,750 USh less than what would be expected by taking the probabilistic option in B for row 6 (as shown in equation (5) and Table 46 as well).

$$E(A) - E(B) = p_a * x_a - (p_{b1} * x_{b1} + p_{b2} * x_{b2}),\quad where: p_{b1} + p_{b2} = 1 \tag{4}$$

$$E(A) - E(B) = [1.00 * (4{,}000)] - [0.75 * 7{,}000 + 0.25 * 2{,}000] = -1{,}750 \tag{5}$$

To enhance understanding of the experimental design, Tanaka & Munro (2014) had each row of the game (like Figure 46) presented at a different table in the experiment room. Thus, when a participant came in, she would physically sit at a different location to make each choice. She was also making each choice in isolation without knowledge of the next option, although, the order of the choices was preserved. Tanaka & Munro (2014) argue this allows the participant—who might be illiterate, elderly, and with no formal education—to focus on the decision and not get confused by the structure of the game. Given the low levels of education in impoverished, rural areas, even a simple game like this requires a great degree of attention and thought to understand fully. Likely, this simplified and focused setup allowed them to get relatively low irrational response rates in their experiments (Tanaka & Munro, 2014).

The game was conducted at the end of every household survey for growers (following the design in Figure 46) and for traders (following the design in Figure 47). The game was administered as shown in Figure 48. Each participant was given the option to participate in the game for a cash prize. All survey participants elected to participate in the game, so there was no selection bias due to participation in the risk-aversion game results.

(a) (b)

Note: (a) surveyor from team (left) prepares to record responses while another from survey team (right) demonstrates the choice A and B from different sides of two-part bag; (b) grower (left) contemplates whether to go with bag A or bag B

Figure 48: Administration of the risk-aversion game in the field

To the extent that was feasible, the author attempted to control for biases in the explanations from different surveyors administering the survey. The instructions were standardized and written on the back of every sheet to remind the surveyors of the methodology (see the text of the instruction sheet in Appendix A.18 on page 377). Additionally, training of the survey team at the beginning as well as the mid-point check-in covered how to administer the game.

Additionally, for a point of comparison and to confirm the viability of the risk-aversion protocol, the results from a survey of 138 adult visitors to the Imperial Festival is shown as well. The Imperial College Festival is an annual, two-day event where research is put on display to the public. The setup of the author's research station is shown in Figure 49 below.

Figure 49: Setup of research station on coffee pests and diseases at Imperial Festival (May 2014)

The format followed the survey for growers, but was modified to be in British Pounds (see Appendix A.21 on page 387). The game was explained following the same guidelines that were used in the field. While explanations in the field could take over ten minutes, festival participants claimed to understand the game after a brief explanation of a few minutes. Responses from participants over age 18 were recorded. Certainly, this sample is by no means representative. The researcher did not record any characteristics beyond the risk-aversion score. Given the large sample size (138) though, it is useful to confirm the methodology and provide a snapshot comparison. Results are presented in section 6.4.2.

6.3. SUMMARY STATISTICS OF SURVEYED FARMERS AND TRADERS

The summary statistics for characteristics of the farmers and traders surveyed in Uganda are presented below. For the full description of the survey methodology, refer back to Chapter 5 in section 5.3.5 staring on page 167.

6.3.1. Household characteristics of growers

The farmers in the survey were quite diverse in their activities on their plots, family size, age, and experience in farming. Summary statistics for collected data about the 119 farmers in Buikwe and Kayunga districts are shown below in Table 47.

Table 47: Summary statistics for coffee growers surveyed in Buikwe and Kayunga

	MEAN[161]	SD	MIN	MAX	OBS.
Age	50.94	17.58	18	90	118
Num. Children	5.97	5.03	0	42	119
Household Size	6.96	3.89	1	22	119
Income (USh)	2132964	2292693	96000	1.20e+07	110
Num. Meals/Day	2.82	.43	1	4	119
Any Education?	.90	.30	0	1	119
Married?	.66	.48	0	1	119
Own Mobile Phone?	.70	.46	0	1	119
Own Vehicle?	.18	.38	0	1	119
Have Electricity?	.12	.32	0	1	119
Own Plot?	.91	.29	0	1	119
Own Clock?	.71	.46	0	1	119

In line with trends across the agriculture sector in Uganda, producers with coffee on their plot are on average above 50 years old—and as old as 90 for one farmer surveyed. Growers had several children (average of six children) and often had older relatives or other family members living at home with them as well (average household size was seven people). Several coffee growers and others in the village had numerous children. One grower surveyed had 42 children and there was a wealthy store owner in the village who was famous in Nkokonjeru Town for having at least 75 children (personal conversation, interviewee #1).

[161] For binary variables like "Married?" the mean indicates the percentage of the sample for which the question was true; as an example, 66% of growers surveyed were married and 91% owned their plot that they farmed.

Poverty was pervasive for those in rural areas growing coffee and other crops. A mean income of just over 2-million Ugandan Shillings (USh) reported in Table 47 is around £475 or just over £1.3 per day. Many growers were far below this average, with the poorest grower living just a subsistence existence and reporting surviving on a meagre 96,000 USh (£23) per year.[162] Many of the other collected metrics were an attempt to get a better proxy for income given the difficulty in accurately reporting income when the vast majority of growers keep few—if any—records. These alternative metrics confirm the general level of poverty. Only 12% of growers had access to electricity at their home and only 18% owned a motorcycle or automobile (refer back to summary statistics in Table 47). With the wide penetration of mobile phones throughout Eastern Africa[163], 70% of farmers had access to a cell phone from at least one member in the family. Given the fertility of the soil and diversification into food crops, though, more farmers reported eating more than three meals a day than the number eating only one meal per day. While acute hunger or malnutrition may be issues during the dry season, starvation or clinical malnourishment were not present (personal conversation, interviewee #1).

Compared to a larger sample from Exporter A's registration of 838 coffee farmers in the Buikwe district, the author's sample was 8 years older on average and owned slightly more land (though it was not significant at the 5% level). Otherwise, they were not significantly different in terms of whether they had education, were married, and how many hectares they devoted to coffee. While a robust check against the general population was not feasible, this at least confirmed that the 119 farmers that were surveyed were not severely different from a much larger population of 838 coffee growers in the district.[164] A two-sample T-test was used with unequal variances for comparing age and total land, and with equal variances for coffee

[162] All values are self-reported and surveyors did their best to question and confirm extreme values, however, as with any survey, this one is susceptible to underreporting by interviewees. They may have perceived that underreporting something like income would lead to a larger reward for participating or generate charity from the survey team member conducting the interview. However, given the fertility of the soil and growing conditions throughout the year, it is possible for a subsistence farmer to survive without access to much cash except to purchase sugar, oil, and salt from the shops in town. Also many farmers use *matooke* (the plantain staple of the Ugandan diet) to barter for other products and so poor farmers may underreport income since many transactions for household items do not occur in cash.

[163] See Aker & Mbiti (2010)

[164] It could be that comparing to Exporter A is not a fair metric of a population sample. Younger or more cooperative farmers may self-select into registering with an exporter that is looking to organize farmers and provide training and support. However, it was the best that could be done in the field at the time.

land.[165] A two-sample test of proportions was used for the binary variables "married" and "any education". The results are reported below in Table 48.

Table 48: Comparisons of means between Exporter A's 838 newly registered coffee growers in Buikwe and the HH survey sample of 119 growers

Variable	Exporter A	Grower HH Survey	p-value	
Age (years)	42.8 ± 0.5	50.9 ± 1.6	<0.0000	***
Total Land (ha)	3.4 ± 0.2	4.5 ± 0.6	0.0587	*
Coffee Land (ha)	1.4 ± 0.7	1.3 ± 0.2	0.577	
Married (Y/N)	0.69 ± 0.02	0.66 ± 0.04	0.501	
Education (Y/N)	0.84 ± 0.01	0.89 ± 0.03	0.110	

Note: significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Likely due to the prevalence of universal primary education, the vast majority of farmers (90% in Table 47) had at least a primary school education. Of those that had at least some education, over 50% had just primary school education (see Figure 50). The next largest category was secondary education, followed by those that had no formal education, and closely following those that had at least some higher education beyond secondary school. Higher education also included teaching programs and vocational schools that were beyond secondary school, in addition to four-year university courses.

[165] Levene's test rejected the hypothesis of equal variances for age and total land, but not for coffee land size; results not reported.

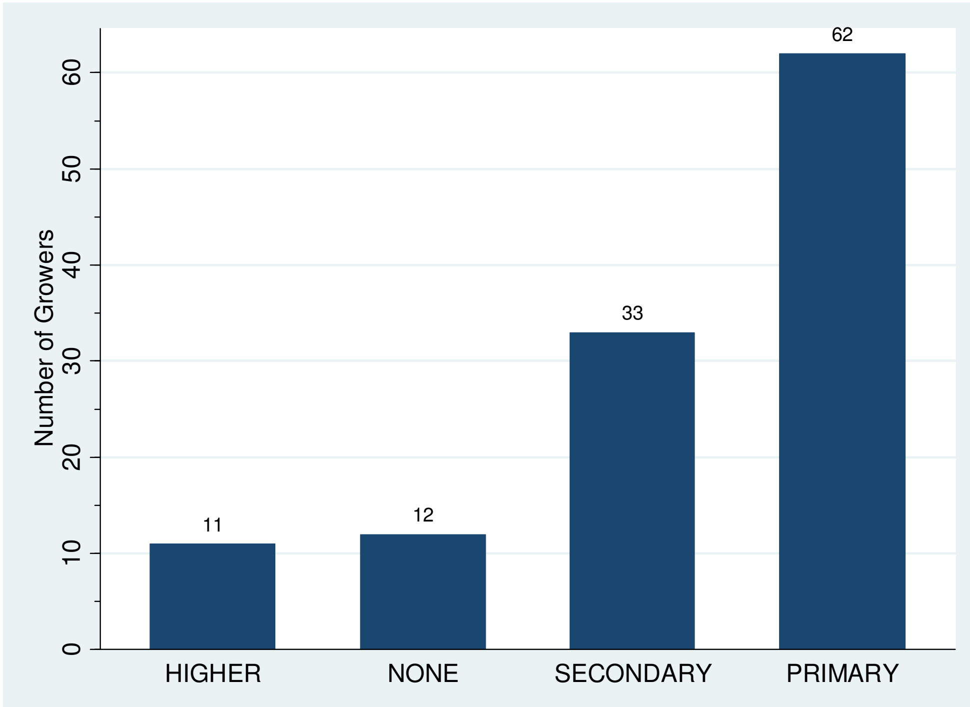


Figure 50: Reported education levels of growers in HH survey

6.3.2. Household characteristics of traders

Traders were a more heterogeneous group than growers due to their differentiated role in the marketplace. Richer traders owned motorcycles or trucks and focused on buying from smaller traders and selling to an exporter. Traders with less wealth and working capital worked from their bicycle buying directly from farmers. This differential role in the market was recognized by growers and other stakeholders interviewed. Traders were often referred to as "bicycle traders" or "motorcycle traders" to differentiate the type of trader the person was. In addition, many shop owners would also function as coffee traders. Epitomized images of each type of trader are shown below in Figure 51.

(a)

(b)

(c)

(d)

Note: Trader types in order of increasing wealth and specialization in the coffee industry (a) trader on bicycles are the most common and poorest; (b) traders on motorbikes have more income than those on bicycles, but often are involved in other jobs as well which require the motorcycle like working as a "boda-boda" or motorcycle taxi; (c) wealthier traders may work from their retail shop where they will sell a variety of products as well as buying and selling coffee; (d) the man pictured here was thought by interviewee #1 to be the 3rd richest man in Nkokonjeru. His main activity was coffee trading, working closely with the milling factory owner. All photos by author.

Figure 51: Coffee trader types from household survey in Buikwe and Kayunga

Interviewee #14 from the coffee industry training and research organization explained that big merchants like traders with pickup trucks (see panel (d) of Figure 51) are near the end of the supply chain, interfacing directly with exporters (personal conversation). They provide much of the liquidity and make the market for smaller traders. Bigger merchants often give out capital for smaller traders to go into villages to make purchases from farmers on their behalf, on either foot, bicycle, or motorcycle (personal conversation, interviewee #14). As a result, one question traders were asked in the HH survey in addition to their working capital was how many other traders they had working for them.

All traders were asked why the got involved in coffee trading. While the results of this question (number 23 in Appendix A.20) are not fully explored, it is interesting to note the patterns that emerged as to why each trader got into coffee and who they consulted about the decision. Many traders mentioned that they started trading coffee to earn additional income and that coffee was a product that they understood. Two traders specifically (trader #78 and trader #15) mentioned their personal stories of moving from a small plot farmer, to a farmer who processed their coffee to *kase*, to eventually a trader who bought *kiboko* and sold *kase*. One trader started with working capital of only 100,000 USh (approximately £24) and built up a trading business from there.

Table 49 below has the summary statistics for the 89 traders surveyed in Buikwe and Kayunga as part of the household survey. The vast majority of traders (>90%) had a mobile phone, their own land, some level of education, and a clock.

Table 49: Summary statistics for coffee traders surveyed in Buikwe and Kayunga

	MEAN	SD	MIN	MAX	OBS.
Age	37.55	9.42	20	70	87
Num. Children	5.31	3.59	0	17	88
Household Size	6.67	4.15	1	30	89
Income (USh)	6059318	1.33e+07	360000	1.00e+08	88
Num. Meals/Day	3.03	.38	1	4	89
Any Education?	.97	.18	0	1	89
Married?	.83	.38	0	1	89
Own Mobile Phone?	.93	.25	0	1	88
Own Vehicle?	.53	.50	0	1	81
Have Electricity?	.24	.43	0	1	89
Own Plot?	.91	.29	0	1	88
Own Clock?	.96	.21	0	1	89

Traders' socio-economic status is most useful to examine in reference to the community of growers. In Table 50 below, the results of mean comparison tests between growers and traders in the HH survey are reported. Two-sample T-tests of unequal variances were used to compare age, $income$, and $number\ of\ meals$ variables after the results of a Levine Test rejected the hypothesis of equal variances. Two-sample T-tests of equal variances were used for variables: $number\ of\ children$ and $household\ size$. Two-sample test of proportions were used for the binary variables. Results are reported in Table 50.

Table 50: Comparisons of means between growers (n=119) and traders (n=89) in HH Survey

Variable	Grower HH Survey	Trader HH Survey	p-value	
Age	51 ± 1.6	38 ± 1.0	<0.0000	***
Num. Children	6 ± 0.5	5 ± 0.4	0.2899	
Household Size	7 ± 0.4	7 ± 0.4	0.6170	
Income (M USh)	2.1 ± 0.2	6.1 ± 1.4	0.0074	***
Num. Meals/Day	2.8 ± 0.04	3.0 ± 0.04	0.0002	***
Any Education?	0.90 ± 0.028	0.97 ± 0.020	0.0640	*
Married?	0.66 ± 0.044	0.83 ± 0.040	0.0046	***
Own Mobile Phone?	0.70 ± 0.042	0.93 ± 0.027	<0.0000	***
Own Vehicle?	0.18 ± 0.035	0.53 ± 0.055	<0.0000	***
Have Electricity?	0.12 ± 0.030	0.24 ± 0.045	0.0240	**
Own Plot?	0.91 ± 0.027	0.91 ± 0.031	0.9700	
Own Clock?	0.71 ± 0.042	0.96 ± 0.022	<0.0000	***

Note: significance indicated by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

As shown in Table 50, traders were on average wealthier than farmers were. The average farmer earned just over 2M USh per year, but the average trader earned some 6M USh annually, with the richest trader earning an order of magnitude (10x) more than the wealthiest farmer (compare max values in Table 47 and Table 49). Traders also more often owned a mobile phone and a vehicle. The vehicle ownership levels were not surprising considering many traders use a motorcycle or truck to conduct their business, likely they are more in need of a mobile phone as well to get current market prices. While electricity penetration in traders' households was still low at only 24% of those surveyed, it was still significantly greater than the 12% on average that had electricity among the growers. Traders were also more often married than among the growers surveyed, however, they were also much younger on average than the growers were. The age result confirms the statement from NGO B's Head of Programs that it is easier to engage youth in coffee business side of the supply chain rather than agricultural production (personal conversation, interviewee #5).

Compared to farmers, traders were not only more likely to be educated, but also to have gone to secondary instead of just primary school. As shown in Figure 52 below, nearly half (49%) of the traders surveyed had gone to secondary school or higher. Traders and growers are indeed in distinct socio-economic classes, but may or may not have different views on risks in the supply chain. As such, the comparison between traders and farmers for the three contexts of risk measurement are presented throughout the next section (6.4).

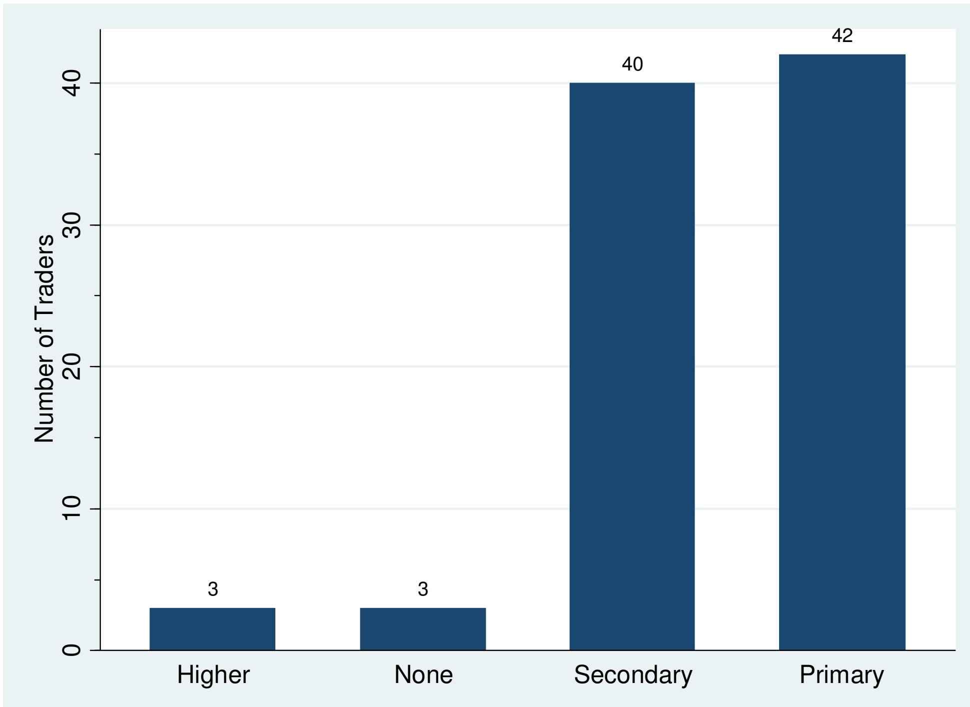


Figure 52: Reported education levels of traders in HH survey

6.4. RESULTS

6.4.1. Prevalence and severity of pests/disease

There are five main pests and diseases of Robusta coffee as discussed in section 6.2.1. The research team was interested in the extent to which stakeholders at different points in the supply chain agree about the pest/disease priorities and severity. Particularly of interest were the foreign pest (Black Twig Borer) and foreign disease (Coffee Wilt Disease) which have impacted Uganda's coffee production.

Coffee Wilt Disease (CWD) is one of the most widespread and important diseases in the history of the Ugandan coffee production system. There were minor outbreaks of the disease before 1997 with reports in isolated fields, but these early incidences did not have a major effect on coffee production in the country. Beyond a few farms, there was little impact or knowledge about this disease among coffee farmers in the country (Flood, 2009). This all changed in the late 1990s. The war that took place in the Democratic Republic of Congo resulted in a porous border between the countries which allowed for the flow of people, goods, and coffee. It was not just green coffee ready for export that came through, but ripe and unripe berries as well which served as effective vectors for fungal spores. It is all but certain that CWD came into western Uganda from the DRC during this period (Hakiza, DT, Musoli, et al., 2009; Cheyns, Mrema & Sallée, 2006; Rutherford, 2006; Flood, 2009). More about the history of the fungus and its impact on production is found in the appendix (A.22.1, starting on page 388).

An emerging pest hitting the southern regions of Uganda in the past few years is the Black Twig Borer (BTB). The BTB causes extensive yield loss (over 50% of "normal" year yield in some cases) (Egonyu, Kucel, Kangire, et al., 2009). Just as an example, one farmer interviewed in 2013 in a Ugandan national newspaper article had lost his entire 10-acre field to the borer (Aliga, 2013). The Ugandan Coffee Development Authority (UCDA) estimates that in the southern Ugandan districts of Rakai, Lwengo, Kalungu, Bukomansimbi, and Masaka the prevalence of BTB is almost certainly 100% (Aliga, 2013). More about the views of stakeholders interviewed and history of the pest is found in the appendix (A.22.2, starting on page 390).

Table 51 contains the results of asking the interviewees to identify the pests/diseases and ranking them from (1) worst to (5) least concern. Several people interviewed simply stated that only a few diseases or pests were priorities and the rest were minor problems not worth mentioning (e.g. interviewee #2, #8, #18). Unfortunately, the sample size of those interviewees who took the pest ranking survey was very small. Nevertheless, there are a few suggestive conclusions it makes. (1) All stakeholders agreed that BTB (pest B in the survey) was a top priority pest for Robusta coffee production in Uganda. For all the reasons described in section A.22.2, the beetle causes extensive damage and is difficult to prevent or treat. (2) The stakeholders agreed that Mealybugs (pest E) were quite unimportant to the production of Robusta currently. (3) There was disagreement about the importance of CBB (pest C) and RBD (disease D). While the person (interviewee #13) selling inputs to farmers thought CBB was quite an important pest, exporters (interviewees #4, #2, and #8) ranked it a very low priority. It was interesting that the NAADS employee ranked CWD (disease A) so low. Likely, the interviewee was influenced by the fact that NAADS had given out so many wilt resistant seedlings that should address the problem.

The mean value of the ranking for each pest is given at the bottom of Table 51. These priorities are then compared to the rankings from the survey of farmers conducted after the workshop in Kamuli District. Traders as well from Buikwe and Kayunga ranked the pests/diseases in the order of priority as they saw it on the supply chain. Finally, both measures can be compared to the more detailed severity and frequency measures that farmers in Buikwe and Kayunga reported on the HH surveys. In general, the stakeholders besides traders and farmers viewed BTB (B) as the worst pest, followed by CWD (A) and then RBD (D), CBB (C), and finally, RMBs (E) as the pest of least concern.

Table 51: Results of pest/disease ranking during interviews with supply chain stakeholders

Group	Interview #	A	B	C	D	E
Exporter	4	1	2	5	4	3
	2	2	1	x	x	x
	8	2	1	x	x	x
NGO	5	2	1	x	x	x
	1	2	1	4	3	5
Extension	16	3	1	x	2	x
Cooperative	18	1	2	x	x	x
Inputs	13	x	1	2	3	4
	MEAN:	*1.8*	*1.3*	*3.7*	*3.0*	*4.0*

Note: 1 worst in red, to 5 least concern in green

Traders in the HH survey were quite familiar with the pests common on the plots of coffee growers. One reason for this is that many traders were previously coffee growers and 97% still reported growing at least some coffee on their own land. As a result, it was expected that traders would be well informed on the diseases and pests of Robusta coffee—though their priorities might differ from farmers due to their place in the supply chain. These expectations were largely confirmed.

As shown in Figure 53 below, traders were very familiar with the pests and diseases common in Uganda for Robusta coffee. It was only Mealybugs that had a low recognition rate (58%), but the rate was also the lowest for growers as the pest is not that common on Robusta coffee in this region (see in Figure 54 for growers on page 243). CWD (A) and BTB (B) were recognized by all 89 traders in the survey, with RBD (D) recognized by all but one trader.

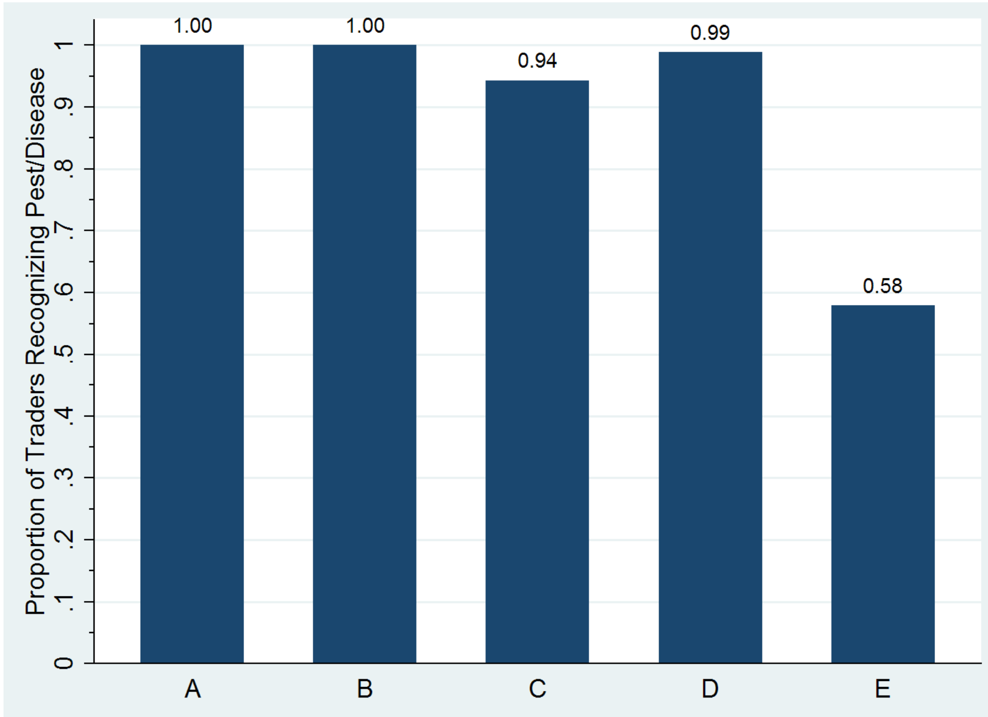


Figure 53: Proportion of traders in HH survey that confirmed they had previously seen the pest/disease

Two methods were used to generate an average pest ranking for the traders. The most common ranking for each pest summarizes for each category of severity 1 to 5, which pest/disease had the most votes from traders. The second method takes the sum of the votes by traders multiplied by the ranking from 1 to 5 for each pest/disease. The latter method will weight a pests' rank by the category of severity it was originally ranked in. For example, assume pest Z was considered the worst (rank 1) by 5 farmers and the least concern (rank 5) by 5 farmers. Also, assume pest X was considered the worst (rank 1) by 4 farmers and medium concern (rank 3) by 6 farmers. By most common rank pest Z would be considered worse than pest X since it had 5 votes versus pest X's 4 votes in the rank 1 category. However, by average ranking pest X would be considered worse than pest Z since pest X's average score would be $\frac{1*4 + 3*6}{10} = 2.2$ while pest Z's average score would be $\frac{1*5 + 5*5}{10} = 3.0$, weighed down by the five farmers who did not think it was a serious problem.

Measured by either method, traders viewed the CWD (A) as the worst disease issue for Robusta coffee as shown in Table 52. This was followed closely by BTB (B) which the majority agreed was the 2nd most significant pest, however, 34% had put it as the worst pest of the five.

There was a significant drop in the priority for the next two pests/diseases. RBD (D) was cited by many traders to be a concern for the impact that it had on the weight and quality of the coffee they took to process at the mill into *kase*. Similarly, the next priority pest was CBB (C), which also affects the final bean since it becomes damaged from the insect. For around 10% of traders, they viewed either C or D as the top pest likely due to the impact that disease and pest have on their profits. C and D tend to affect traders more than growers as it is difficult to tell CBB or RBD damage from *kiboko*, especially if it is in a large sack sold by a farmer to a trader. As a result, the trader would only notice the impact by the shrivelled and insect-damaged beans that result from processing the husk off the *kiboko* at a mill when turning it into *kase*.

Table 52: Tabulation of traders' responses for pest/disease priority rankings

	1	2	3	4	5	MEAN RANK BY PEST/DISEASE
A	48	30	7	3	0	1.60
B	30	36	10	9	3	2.08
C	5	4	20	33	19	3.70
D	3	15	38	30	1	3.13
E	2	3	12	9	34	4.17
MOST COMMON PEST/DISEASE BY RANK	A	B	D	C	E	

In agreement with the other stakeholders in the supply chain, the traders largely agreed that RMB (E) was a very low priority pest (42% said they had never seen one nor heard of the pest). They also agreed that RBD (D) causes more damage than CBB (C) as well. Unlike the other stakeholders in the supply chain, traders viewed CWD (A) as a priority over BTB (B).

The growers in the HH survey were also aware of many of the pests and diseases of Robusta coffee and could easily recognize the pest/disease from the survey images and descriptions presented by the research team (see results in Figure 54 below). Like the traders, 100% of the farmers recognized CWD (A). However, for all other pests, the recognition rates by growers were lower than that of traders (see below in Figure 54 for growers and above Figure 53 for traders).

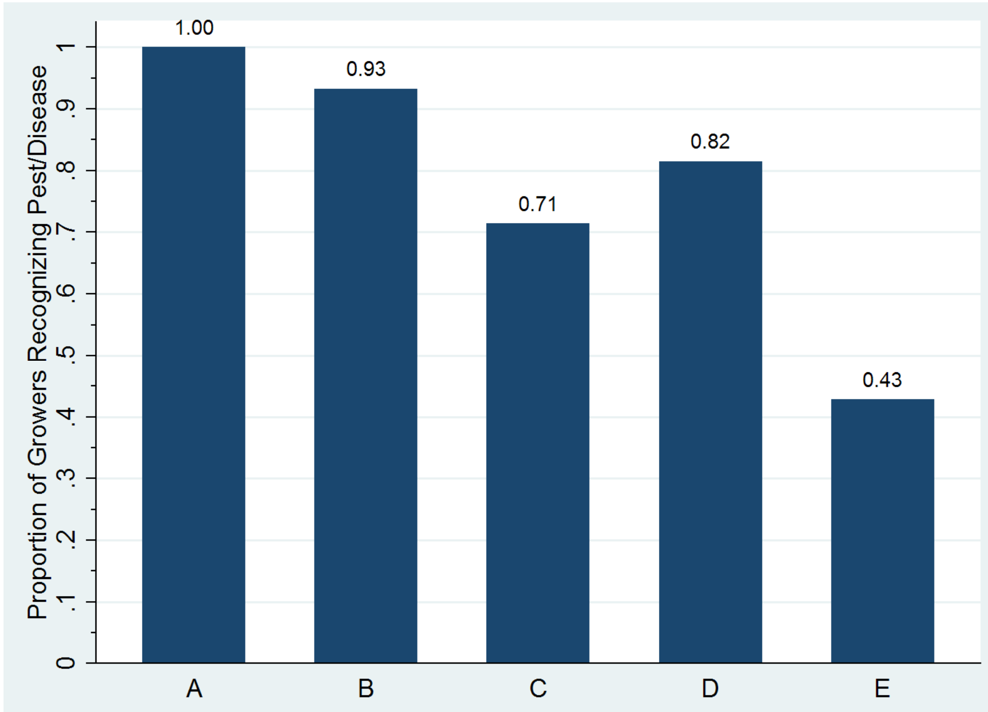


Figure 54: Proportion of growers in HH survey that confirmed they had previously seen the pest/disease

The growers' recognition rate of BTB (B) was only 7% lower (0.93 ± 0.023) than traders' 100% recognition rate, but significantly so by a two-sample test of proportions. Only 71% (0.71 ± 0.041) of growers recognized CBB (C) compared to 94% (0.94 ± 0.025) of traders. As well, RBD (D) was recognized by only 82% (0.82 ± 0.036) of growers, but nearly 100% (0.99 ± 0.011) of traders in the HH survey. While both groups had low recognition rates of RMB (E), growers (0.43 ± 0.045) had significantly lower recognition rates than traders (0.58 ± 0.053).[166]

There are several plausible explanations for why the growers were less knowledgeable about pests/diseases of Ugandan Robusta Coffee. (1) Traders cover a much larger area than farmers, travelling 5.8 km (mean) on average to buy coffee from 102 coffee growers (mean). Given the number of plots they visit, people they potentially talk to, and variations they would observe in farmer output from year-to-year, it is logical that they would be more aware of the pests/disease affecting the supply chain. In addition to being exposed to others farms, the vast majority (97%) grow coffee on their own plots as well, and thus, have exposure to the various problems faced

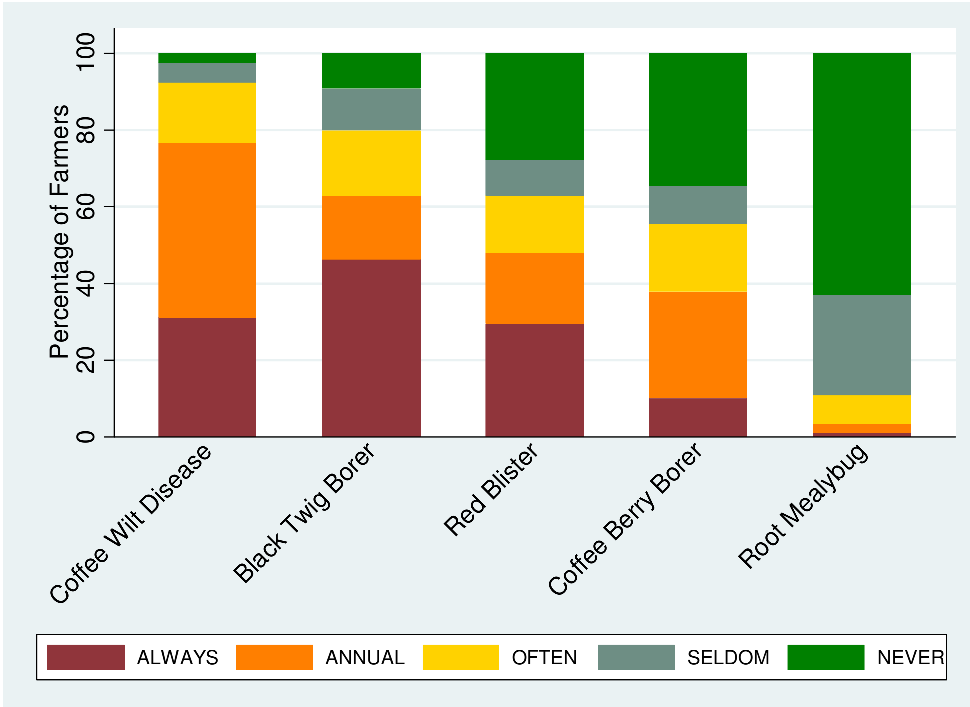
[166] All results confirmed as significant ($p<0.05$) by two-sample test of proportions.

by growers. (2) An alternative explanation is that traders are more susceptible to positive response bias and would want to appear knowledgeable about coffee in a survey. This would lead them to confirming they have seen something in their work, when they in fact have not. (3) Some farmers may have not understood the question completely and may have had knowledge of the pest, but claimed to not recognize it since it was not a large issue for their plot. Of the possible explanations, (1) is quite convincing given the reach of traders and therefore their exposure to various coffee growing conditions.

The growers were asked detailed questions on frequency and severity of the five pests, instead of a simple priority ranking like the other groups (recall methodology in section 6.2.1).[167] Growers in Buikwe and Kayunga rated the frequency with which the five pests/diseases attack their plot in the same order that the traders' ranked the priority of each pest/disease. CWD (A) was most frequent, followed by BTB (B), RBD (D), CBB (C), and finally, (E) RMB. Interestingly, while CWD had the highest frequency of occurrence on average, BTB was said by farmers to be present at all times on their plot (the highest frequency), while CWD by far had the largest annual frequency (2nd highest frequency).[168] The frequency of a pest is important to consider in relation to the severity when it occurs. The growers' views on the severity of each pest are shown in Figure 56.

[167] In retrospect, the traders could have answered these detailed questions as well, but during the survey design, the author was unaware of how knowledgeable traders would be about coffee production.

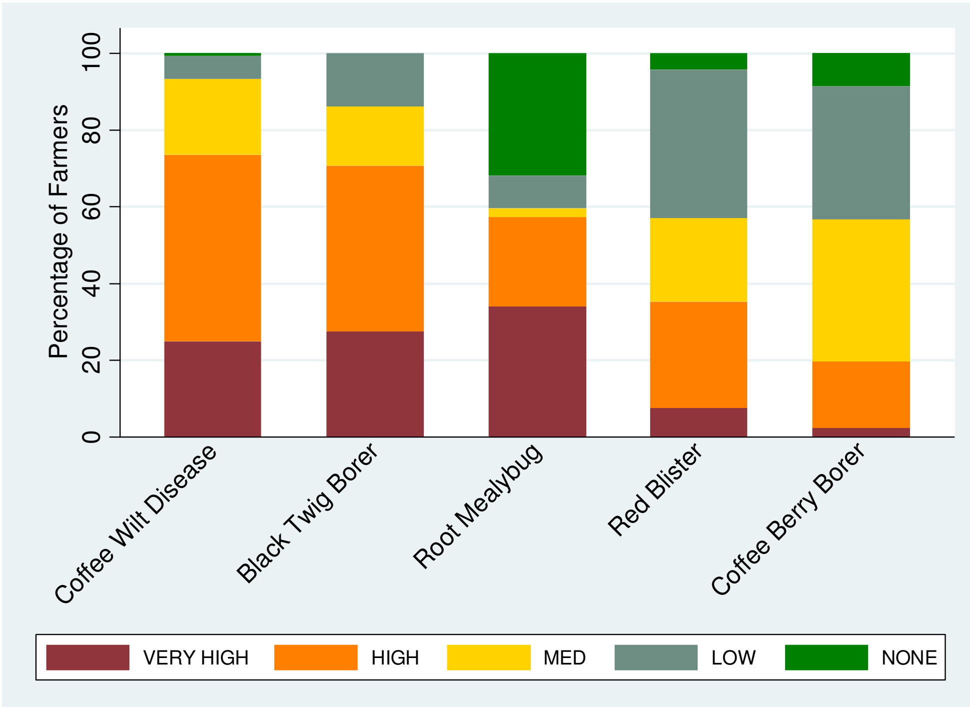
[168] Based on informal conversation during the interview most farmers were clear that there was a distinction between a pest that came at least once a year ("annual" in the survey) and one that seemed to be present throughout the year ("always" in the survey) on their plot, but whether all farmers could distinguish between the two categories could not be confirmed for all the surveys.



Note: The category "never" includes those that responded that they were not familiar with the pest/disease in Question 27 of the farmer survey (Appendix A.19)

Figure 55: Growers ranking of the frequency rating of each of the five Robusta pests/diseases

The severity scores given by farmers' to the five pests revealed interesting differences compared to the consensus of the other stakeholders and traders. Unsurprisingly, CWD (A) and BTB (B) were rated very severe by over 25% of the farmers' surveyed and overall had the highest severity scores. However, the third highest rated pest by severity was actually the RMB (E) with 34% of farmers who experienced them rating them as "very high" severity—higher than that of CWD or BTB for that severity category. Contradicting these farmers, a nearly equal 32% said that the Mealybugs do no damage ("none") when they are present on the plot. Consistent with the other groups, Buikwe and Kayunga growers found that the damage from RBD (D) was more severe than that of CBB (C). Given the number of farmers that rated many pests as very severe and very frequent it is likely that the risk is overstated. Since no samples were taken or fields studied scientifically to confirm the results, it is impossible to know, but other studies have confirmed that farmers often cite worst-case scenario pest events (Heong & Escalada, 1999).



Note: excludes farmers who rated the frequency as “never” or reported that they were not familiar with the pest in Question 27 of the farmer survey (Appendix A.19)

Figure 56: Growers rating of the severity of each of the five Robusta pests/diseases

The discrepancy between farmers’ responses on RMB is difficult to interpret. Given that they are hard to detect until a farmer digs up a tree to expose the roots, it is likely that those that rated it as “very high” have only ever seen them on the trees that have shown strong symptoms of damage for lack of nutrients caused by the Mealybugs. Alternatively, those that have lost trees to BTB for instance and have dug up the tree to burn it may have noticed a few RMB that seemed relatively harmless in comparison. The real answer may be somewhere in between with the bugs causing moderate damage depending on the conditions of the soil. Further research in the area with actual sampling of farmers’ plots could better determine the severity and frequency with which RMB cause issues for the typical coffee plot in Uganda.

The Kamuli District farmers that were organized into a cooperative by NGO B were surveyed for their views on pest/disease priorities as well. The workshop format with the Kamuli farmers did not facilitate explanations of frequency and severity. As a result, they were given the same severity ranking survey (simple ranking from 1 to 5 of the pests/diseases) as the Buikwe traders and other supply chain stakeholders that were interviewed one-on-one. The results of their responses on the priorities of different pests are given below in Table 53.

In agreement with the stakeholders (Table 51), the cooperative farmers in Kamuli thought the BTB (B) was the worst. This was followed by CWD (A) as the next highest priority pest. In 3rd and 4th, CBB (C) and RBD (D) were nearly tied. By the ranking within each category, RBD had the most farmers saying it was the 3rd priority pest, but by the mean of all the rankings it received by farmers CBB had a higher average ranking. In agreement with the interviewed stakeholders as well as the Buikwe traders, the farmers in Kamuli were not concerned about RMB (E).

Table 53: Tabulation of NGO B cooperative Kamuli District farmers' in responses for pest/disease priority rankings

	1	2	3	4	5	MEAN RANK BY PEST/DISEASE
A	7	17	1	1	0	1.85
B	18	4	5	2	0	1.69
C	4	5	7	10	2	3.04
D	0	2	15	10	1	3.36
E	0	1	1	5	20	4.63
MOST COMMON PEST/DISEASE BY RANK	B	A	D	C/D	E	

Overall across all groups, it appeared that there were three distinct groups of pests/diseases in Robusta coffee production. The top two priority pests/diseases were clearly CWD (A) and BTB (B). While stakeholders in the supply chain (i.e. input sellers, extension, and exporters) and the Kamuli cooperative farmers were more worried about BTB, Buikwe farmers and traders both still felt that CWD was slightly more damaging to production.

The next group of pests/diseases were RBD (D) and CBB (C). Except for the Kamuli growers that ranked them approximately equally, the other groups agreed that RBD (D) was more of a threat than CBB (C). It should be noted that many of the stakeholders outside of production (i.e. not traders or growers) responded that the top two pests/diseases were the only ones to worry about and that the rest (C, D, E) were all very minor and not worth mentioning. There was widespread agreement that RMB (E) are not present very often on farmers' plots and are a very minor concern of the five diseases/pests presented. The only difference was that many

Buikwe farmers felt that although the RMBs do not come very often, they do cause a lot of damage when they are present on the plot. This response was likely driven by farmers only noticing the RMB after the tree had died from lack of nutrient transport in the roots.

In general, communication between stakeholders on disease/pests risks appeared to be effective. Even stakeholders quite far removed from production, like exporters, were well informed about the top pests/diseases of Robusta coffee. Traders as well were more informed than growers about the different types of Robusta diseases/pests that can affect the productivity of the coffee tree. Both of these findings are likely driven by how connected the stakeholders are to production due to the tight communication links to farmers. Traders talk with many farmers in the course of doing business since they need to travel such a wide area and buy from many farmers in order to achieve the scale to operate as a seller of *kase*. For exporters, the recent phenomenon of the companies getting directly involved in organizing farmers' associations and hiring agronomists (like interviewee #9 from Exporter B) have caused many of the employees to become very aware of the pests/disease issues that farmers face. While there does seem to be a fair amount of prioritization of the information transfer, everyone in the supply chain is aware and agreed on the major threats at the expense of not having a full understanding of the minor pests that farmers and traders are often dealing with as well. A significant finding was confirmation that the foreign pest and disease from the Democratic Republic of Congo were the worst of the pests/diseases of Robusta coffee in Uganda.

6.4.2. Risk aversion among coffee growers

The farmers and traders surveyed in Buikwe and Kayunga districts[169] were compensated after completing the survey with a risk-aversion game based on a multiple price list design, as explained in the methodology section 6.2.3. The aggregate results for the population of growers sampled are shown in Figure 57.

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[169] The only survey respondents that were not compensated using the risk preferences game were the farmers involved with NGO B in the Cooperative in Kamuli District. NGO B thought it was better to compensate survey respondents with a lunch at the group workshop to avoid giving cash directly; the research team respected their wishes with how to engage with their association.

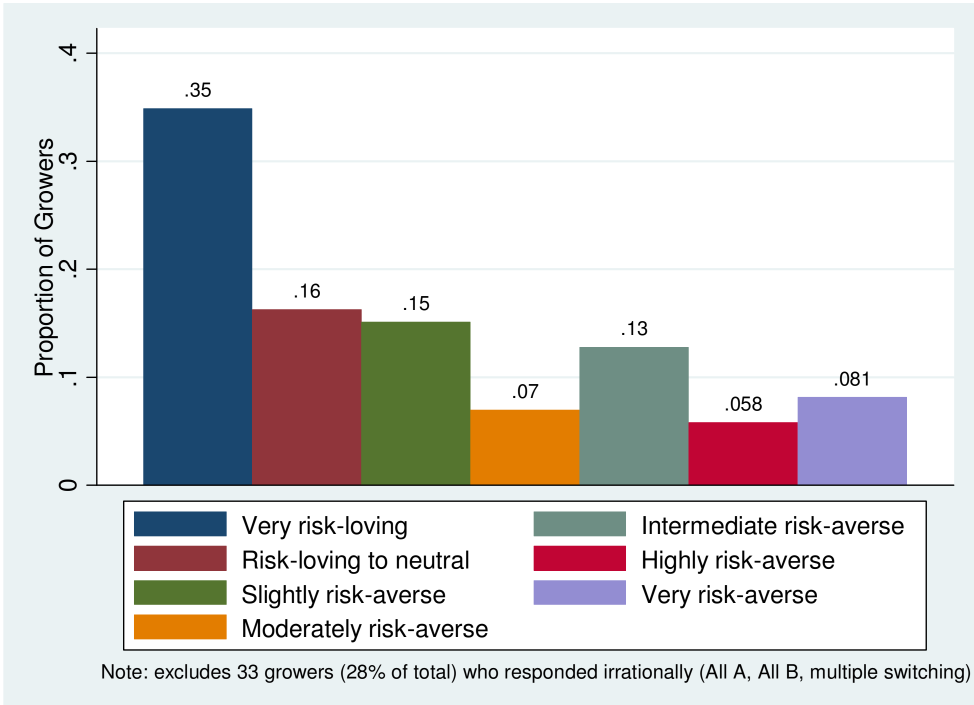

Figure 57: Risk-aversion responses of surveyed coffee growers in Uganda

Surprisingly, given a lot of the literature and NGO work on farmers in the developing world, the survey found that many farmers were quite risk-seeking—it was the largest group with 35% of those surveyed who answered rationally. Overall, though, farmers were risk-averse on average (see discussion below). There is a spike at the "intermediate risk-averse" level, which corresponds to switching to B—the probabilistic, risky choice—at row six (recall Table 46 in section 6.2.3 on page 228). Row six is also the first time within the sequence where the expected prize for the high-paying marble jumps 1,000 USh from 6,000 to 7,000 USh instead of the usual 500 USh increase per row. Likely, the psychological effect of this new larger price had an influence in pushing more people to switch to the risky prize option at this point as compared to just before or just after.

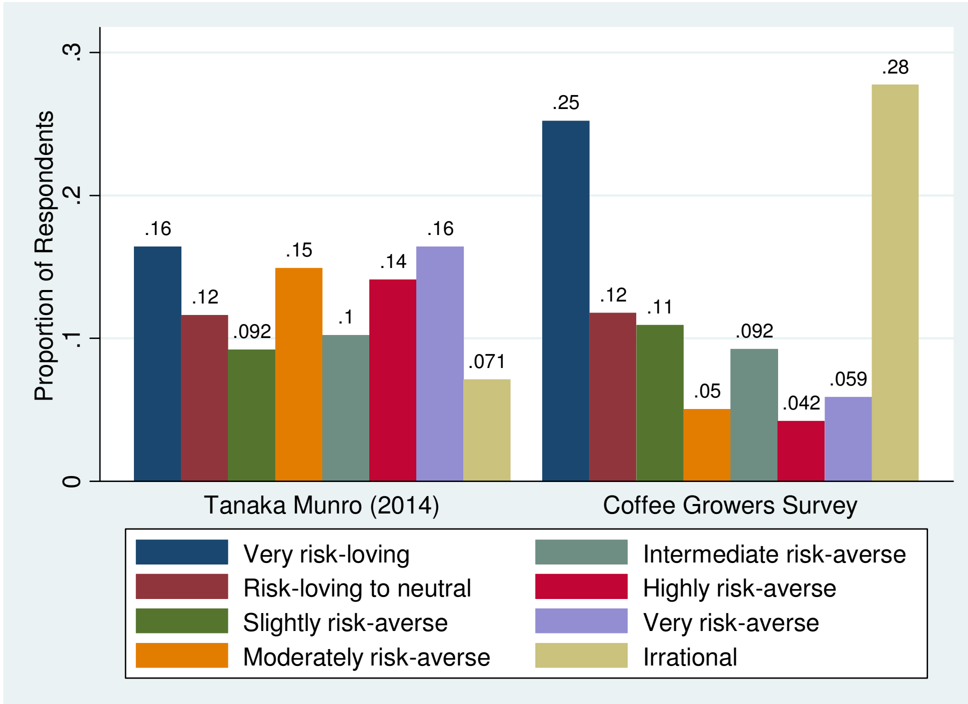

Figure 58: Comparison of responses of all Ugandans in Tanaka & Munro (2014) with only coffee growers in the present survey

The results for coffee growers showed more risk-seeking than the general population sample of Tanaka & Munro (2014) (see Figure 58). This result confirms the conjectures that Tanaka & Munro (2014) put forth to explain the differences in risk preferences across climate regions. In the districts where over 40% of the population was involved in coffee growing, they noted that the risk preferences were among the most risk-seeking and most significantly different compared to the base region (south-west highlands) in their interval regression model (Tanaka & Munro, 2014). Surely, other factors they discuss contribute to these differences, but coffee as a high-risk, high-reward crop likely makes the "background risk" (Herberich & List, 2012) that farmers are accustomed to much higher (i.e. risk tolerance is gained through exposure to "risky" situations over time). Additionally, since coffee is high-risk, high-reward farmers likely self-select to some extent into growing coffee, as it will appeal to more risk-taking individuals compared to those that are more risk-averse and prefer to invest in low-risk (low-value) opportunities.

Compared to the adult respondents at the Imperial Festival, the coffee growers of Ugandan were much more risk-seeking. The results for the London adults are plotted in Figure 59. The mean response for the farmer group's switch point was 3.97 ± 0.22 (switching at the upper end of the "Risk-seeking to neutral" category), while for the adult respondents in London the mean response was 4.5 ± 0.14 (corresponding to switching between the "Slightly" and "Moderately" risk-averse categories). By a two-sample T-test with unequal variances[170], these means were significantly different ($t = -2.089, p = 0.0384$). Given that the intervals between the different choices are not quite equal in terms of the range of the CRRA (see column 2 of Table 46 on page 228), the result is confirmed with the non-parametric Wilcoxon rank-sum test (i.e. Mann-Whitney two sample test statistic).[171] The results confirm there is a significant difference between the underlying distributions for risk preferences between the growers and the festival visitors ($z = -2.718$, $p = 0.0066$).

Remarkably though, the rate of irrational responses was not significantly different. The Ugandan farmers responded rationally 72% of the total responses, while the Imperial Festival attendees responded rationally 78% of the total. By a two-sample test of proportions, the rate of irrational response was not significantly different from each other ($p = 0.266$).[172]

[170] Levene's test rejected the hypothesis of equal variances for mean (p = 0.00015), median (p = 0.0019), and 10% trimmed mean (p = 0.00032). Shapiro-Wilk W-test provided some evidence that the data is approximately normal (z = 1.468, p = 0.071).
[171] A Wilcoxon rank-sum test is used since the dependent variable is ordinal, but the rank-sum test does not assume a normally distributed interval variable like the t-test (Wilcoxon, 1945).
[172] Rational responses—switching to B at rows 2, 3, 4, 5, 6, or 7—were coded as "1" while irrational responses including all A, all B, or multiple switching were coded as "0" before the two-sample test of proportions was done to compare the two groups (Uganda growers v. London adults) of respondents.

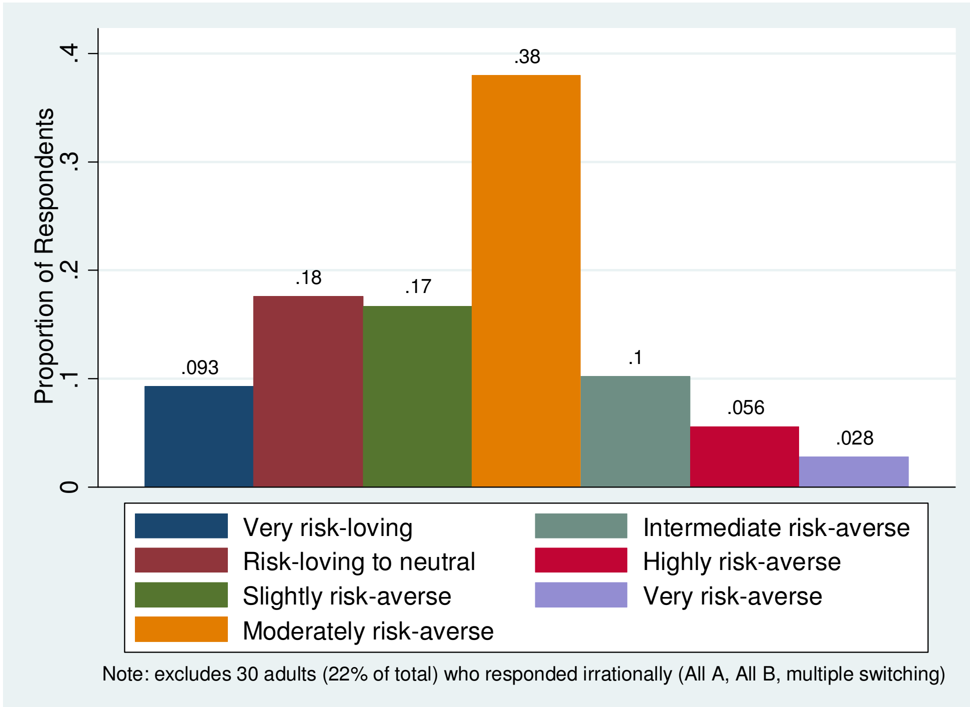

Figure 59: Risk-aversion responses of adults at May 2014 Imperial College London festival event

Lastly, the traders interviewed in Uganda took a shorter survey where rows 2, 4, and 6 were not present (see methodology in section 6.2.3 on page 223). The results from this abridged risk preference survey are reported below in Figure 60. Unfortunately, the wide bands of their risk preferences limit conclusions that can be drawn.[173]

[173] For instance, the first category for the traders includes risk preferences ranging from very risk-averse through to risk neutral since the decision point at row 2 was removed from the choice set. The consequences of the larger bands especially in the risk-seeking range were not fully considered when the change was decided in the field to adapt to requests from the local research team. In retrospect, larger compensation amounts should have been used instead of shortening the game to encourage the impatient traders to participate in a longer survey.

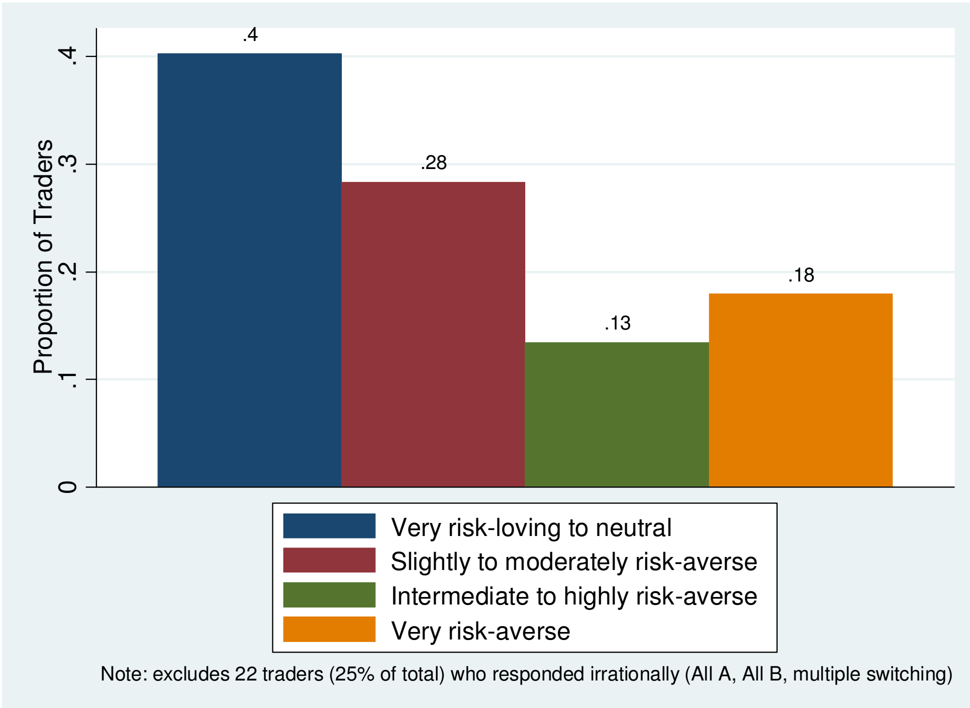

Figure 60: Risk-aversion responses of surveyed coffee traders in Uganda

It does appear that the traders were more risk-averse on average than growers were. Around 40% of traders were some degree of risk-seeking, but 51% of growers measured as some degree of risk-seeking (combining first two intervals for growers in Figure 57). Additionally, in the highest category of risk-aversion where growers and farmers had the same interval in the game, just over 8% of farmers, but a full 18% of traders switched at this most risk-averse point. The mean switch-point response for traders on the same response scale as the growers[174] was 5.00 ± 0.24 ("Moderately risk-averse" category), while for farmers it was 3.97 ± 0.22 as before. By a two-sample T-test with equal variances[175], the means were significantly different ($t = -3.21, p = 0.0016$). The result for traders vs growers is confirmed with the non-parametric Wilcoxon rank-sum test (Wilcoxon, 1945). The results confirmed there is a strongly significant difference between the underlying distributions for risk preferences between the growers and the traders ($z = -3.505$, $p = 0.0005$).

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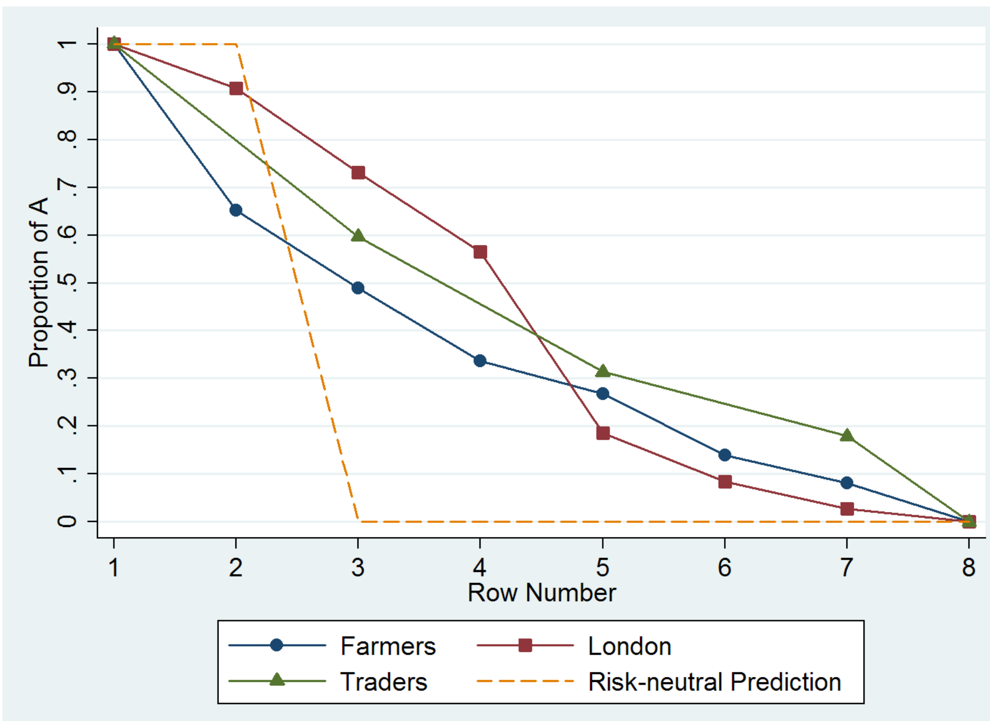
[174] Meaning that traders could choose from switching at row 1, 3, 5, 7, and 8, while farmers had the full choice set from 1 to 8.

[175] Levene's test could not reject the hypothesis of equal variances for mean (p = 0.68), median (p = 0.81), and 10% trimmed mean (p = 0.72). Shapiro-Wilk W-test provided some evidence that the data is approximately normal (z = 1.468, p = 0.071).

Figure 61 recreates the classic graphs of Holt & Laury (2002) with the responses from the Imperial Festival as well as the survey in Uganda. The predicted values for a risk-neutral position are also plotted as the dashed orange line in Figure 61. By the row number of the risk-neutral switching point (row 3), just over half of the farmers had switched to B and around 40% of the traders had switched to the risky option as well, while nearly ¾ of the London group were still in the safe, "A" position. All groups' means were each significantly different from the risk-neutral switching point using a one-sample T-test. These results indicate that on average, each group was some degree of risk-averse ($p < 0.0001$ for all three comparisons).



Note: Irrational responses (all A, all B, multiple switching) were excluded from this graph. As such, the response rate for A is 100% in row 1 and 0% in row 8 by definition.

Figure 61: Proportion of safe choices in each row/decision for three populations surveyed

Holt & Laury (2002) had irrational response rates among the students they surveyed of around 10% depending on the conditions of the game (i.e. the pay-off levels and whether it was played for real money or just hypothetically). Tanaka & Munro (2014) had an illogical or irrational response rate was of 7.1%. In the present survey, the irrational response rate was much higher. A sizable 28% of coffee growers responded irrationally, 25% of coffee traders, and 22% of adults in London responded irrationally as well. The high irrational response rate in London could be due to the speed at which the survey was conducted.[176] The irrational response rate for the farmers was likely driven by educational levels lower on average than those reported for a general Ugandan population sample in Tanaka & Munro (2014) as well as a faster and less simplified survey design since the choices were administered on one sheet of paper.

Holt & Laury (2002) find that men are slightly less risk averse than women, making 0.5 fewer safe choices on average for the risk-aversion design in their paper. The main review article on the topic of gender and risk from Eckel & Grossman (2008) also generally finds women are more risk-averse than men are. For traders in the present survey, the opposite is found (see Figure 62). For traders in the survey, the average switch point was 2.50 ± 0.17 for women and 3.25 ± 0.16 for men on the original scale of the game with five rows of decisions ($t = -3.14, p = 0.0032$).[177] A Wilcoxon rank-sum test as well confirmed significant differences between male and female risk responses ($z = -2.076, p = 0.0379$). Female traders were more likely to respond with less risk-aversion than male traders were. Interestingly, none of the female traders fell into the very risk-averse category, while 23% of men responded in this way (see Figure 62). The sample size for women was quite small though with only 20 female traders (69 were male).

[176] Respondents were attending a large science festival and only stopping at the booth for 5-10 minutes in order to review the research, try a sample of coffee, and participate in the risk survey.
[177] Two-sample t-test with unequal variances was used. Shapiro-Wilk W-test indicated some evidence of normality ($p = 0.0998$) and Levin's hypothesis test of equal variances was rejected strongly ($p < 0.03$).

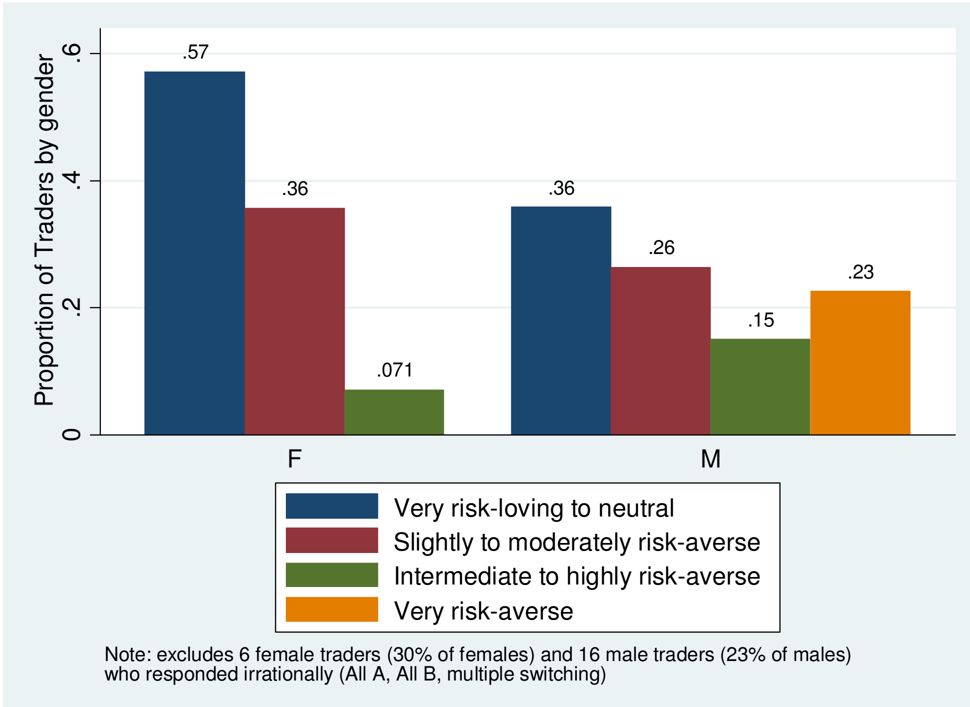


Figure 62: Risk preference responses by gender for traders in survey

Similarly to the traders, female coffee growers appeared to be more risk-seeking than the male coffee growers were (see Figure 63). For comparison with the traders, growers' responses were grouped into the same intervals that the traders were able to choose from in their survey design.[178] Over half of the female coffee growers (53%), fell into the risk-seeking to neutral category (compared to 36% for men). However, the differences were only weakly significant. The average female switched at row 2.75 ± 0.12, while the average male switched at row 3.11 ± 0.18 ($t = -1.72, p = 0.0879$).[179] A Wilcoxon rank-sum test suggested the differences between male and female growers' risk responses were not significant ($z = -1.62, p = 0.105$).

[178] To make the intervals equivalent, growers responses in brackets correspond to traders responses using the following: traders' 1 (1 for growers), 2 (2 and 3), 3 (4 and 5), 4 (6 and 7), and finally 5 (8).
[179] Two-sample t-test with equal variances was used. Levin's hypothesis test of equal variances could not be rejected (p > 0.22).

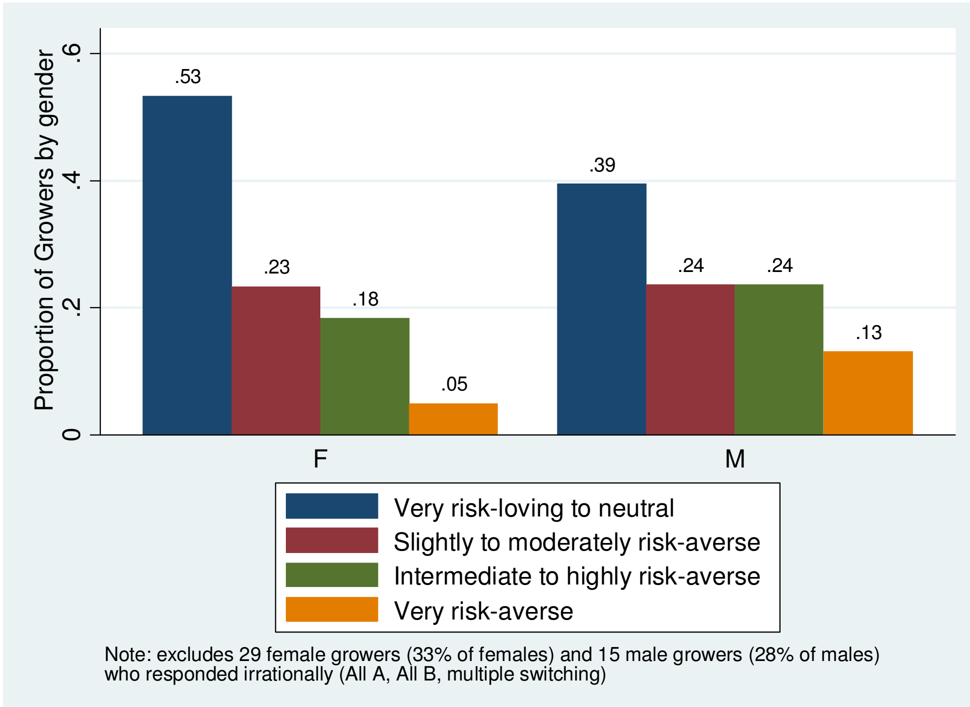


Figure 63: Risk preference responses by gender for growers in survey

Many studies find evidence of wealth affecting the risk aversion of a respondent (e.g. Yesuf & Bluffstone (2009); Rosenzweig & Binswanger (1992); Eswaran & Kotwal (1990)). However, some have reported positive correlations and others negative. Unlike these studies, there was no evidence for such an effect among the coffee growers in the survey. While Figure 64 does suggest that poorer farmers are more risk-averse than their richer counterparts are, the results are not robust to tests of statistical significance. The Kruskal-Wallis equality-of-populations rank test could not reject the hypothesis that the income groups were from an equivalent population $(H(2) = 0.164, p = 0.9212)$.[180] Additionally, a two-sample T-test with equal variance of the poorest 25% compared to the wealthiest 25% failed to find a significant difference in the mean response, any difference was likely due to chance ($p = 0.9125$).

[180] This test was used instead of a one-way ANOVA as normality is not assumed and the risk-aversion measure has unequal intervals, but is ordinal.

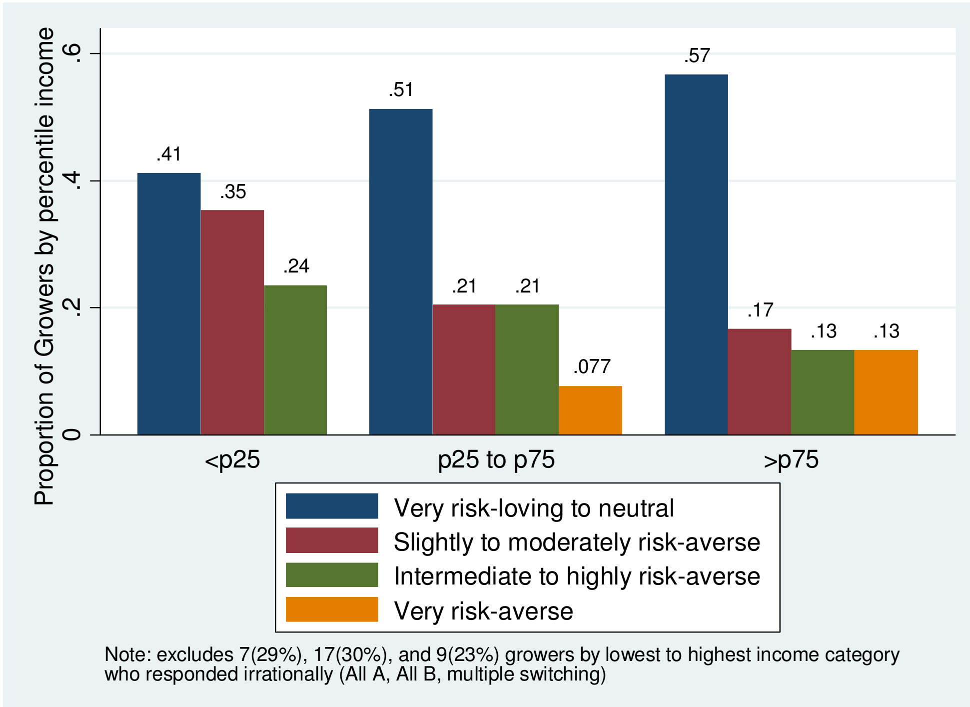


Figure 64: Effect of income percentile (wealth) on risk preferences of coffee growers

Running an ordered logistic regression of the risk-aversion response of growers on the three income categories failed to produce significant results (results not shown). Additionally, running the same model on the continuous income data instead of the percentile groupings also failed to produce significant results on predicting the risk preference response (results not shown). Similarly, when the risk-response was retained in the original scale in the grower survey from switching at row 2 to 8 (instead of 2 to 5 on the trader survey scale), both measures of income failed to provide any ability to predict the risk response.

The results were conclusive that there was no evidence that wealth had an impact on coffee growers' risk preferences. Perhaps this could be due to the similar socio-economic conditions of growers compared to other members of society and so there was not enough variation in income to lead to wealth having a significant impact on risk-aversion compared to background risks. Additional research incorporating the time-preference surveys and further variations in pay-outs in different choice environments (similar to alternative games conducted in Tanaka & Munro (2014)) could help to better understand the impact of wealth on coffee farmers' responses. It is possible that the wealthier have lower discount rates or less risk-aversion to games with loses, but it was not possible to test that with the present survey.

For the traders, there was some evidence (see Figure 65) that the self-reported wealthier of the traders were more risk-accepting (as expected from previous literature). However, a two-sample T-test with equal variances comparing the wealthiest traders (above 75th percentile income) and the poorest traders (below 25th percentile income) found that the mean responses were not significant different at the 10% level ($t = 1.548, p = 0.122$). A two-sample Wilcoxon rank-sum (Mann-Whitney) test did provide some limited evidence of difference at the 10% level, but not at the 5% level ($z = 1.754, p = 0.0795$). The lack of significance was likely driven by small sample sizes as the lowest income category had only 14 rational respondents and the highest income category had only 21.

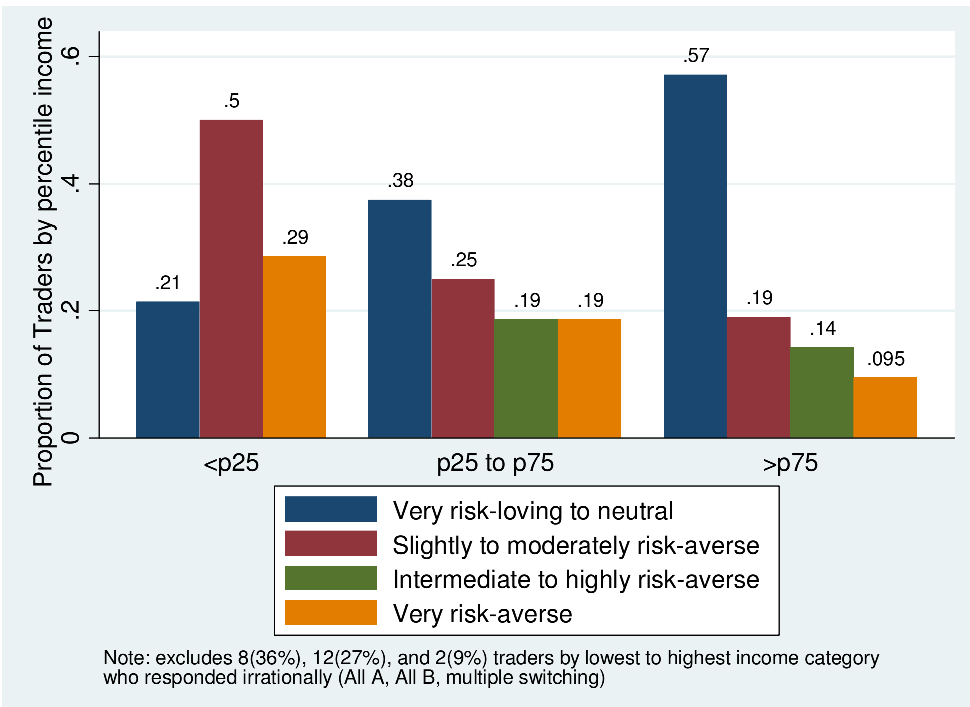


Figure 65: Effect of income percentile (wealth) on risk preferences of coffee traders

An ordered logistic regression of the risk-aversion measure on the percentile income category for traders did produce a marginally significant result for the coefficient on the percentile income category variable at the 10% level. The model passed the proportional odds assumption (i.e. parallel regressions assumption).[181] Again, with more samples of traders, the results would likely be more robust. However, a simple margins plot of the predicted probabilities for responding in the first category of the trader survey ("risk-seeking to neutral") is plotted in Figure 66. Richer traders are more likely to respond in the risk-seeking category than their poorer counterparts are. The 95% confidence intervals on this result are quite wide likely due to the low sample size for each category of income.

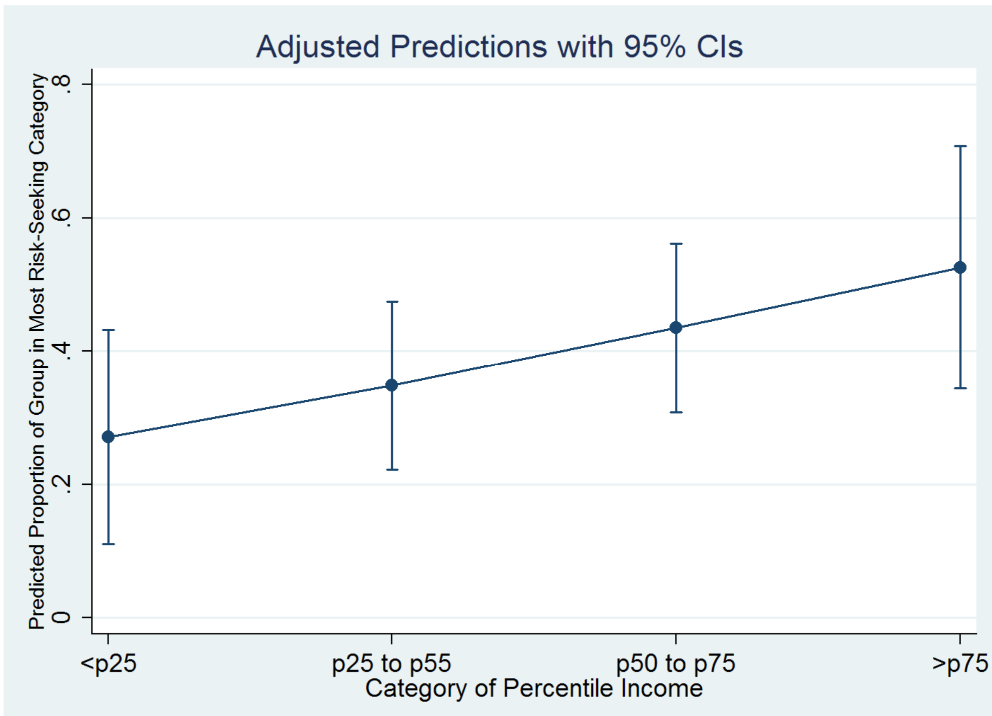


Figure 66: Predicted proportions from an ordered logistic regression for responding in the most risk-seeking category (e.g. switching in row 2) of the trader survey by percentile income category

Another metric to estimate the risk-aversion of a respondent is to calculate the number of risky choices (called NRC) that they make. Hellerstein, Higgins & Horowitz (2013) use this measure in their experiment as it allows the researcher to calculate a metric of risk-aversion without making assumptions about the utility function of the participant. This removes the difficulty of

[181] The Brant Test of parallel regression assumption returned $\chi^2(2) = 5.32, p = 0.07$, the lack of significance at the 5% level indicates the assumption has not been violated. An additional test using a likelihood ratio test and the null hypothesis that there is no difference in the coefficients between models could not be rejected at the 5% level ($p = 0.065$). These similar tests both confirm that the assumptions of the model are not violated.

understanding an individual who switches multiple times between option A and option B, which is inconsistent with a structural risk aversion parameter like CRRA.

The data is present to calculate the NRC for both traders and growers, however, since the number of rows in the experimental design differed, it would be difficult to compare the results. As such, the NRC was used as a robustness check for the measurement of risk-aversion in the regression results on the impact of risk preferences on behaviour (see Chapter 7), but is not shown here. Given that the irrational results likely come from people that do not understand the game at all and potentially choose randomly, the usefulness of the NRC as a measure of risk-aversion is questionable. It would likely bias the results of a predictive regression towards zero given the measurement error of the instrument, which may help explain the main lack of significant results for many behavioural predictions that Hellerstein, Higgins & Horowitz (2013) tested with the NRC.

To conclude this section, this study finds that coffee growers are more risk-seeking than the average Ugandan population given the same risk preferences choices by Tanaka & Munro (2014). Around 35% of coffee growers switched at row 2 in the risk preferences game corresponding to a "very risk-seeking" preference. Overall though, the average grower was neutral to slightly risk-averse (switching just before row 4, the "slightly risk-averse" category). The traders were significantly more risk-averse than farmers, switching over 1 row later on average. These results are tempered by the fact that traders were presented with an abridged version of the survey, but the results appear robust to this methodological detail. Compared to the London adults who participated in the game at the Imperial Festival, farmers are certainly more risk-seeking. Given the nature of coffee being a high-risk, high-reward crop, it is not surprising to find that the growers were less risk-averse than all other groups. It is important to emphasize though that on average, the traders, growers, and London festival participants measured as some degree of risk-averse, so the point is about degree of risk-aversion.

Comparing men and women, in both trader and grower groups the survey found evidence that women were less-risk averse than men. Only for the traders though were the results statistically significant. Despite the literature on the impact of wealth on risk-aversion, there was only limited evidence that traders with higher incomes were more risk-seeking than their poorer counterparts. There was no evidence that wealth had an impact on coffee growers' risk preferences, however, this could be due to the sub-population being a very similar socio-economic class.

6.4.3. Coffee market simulation with stable price contract

One of the advantages of a cooperative or certification scheme is a price premium offered to growers (see section 5.5.6). For instance, Fairtrade offers a price floor that guarantees farmers a minimal income (Sick, 2008). The coffee trading game attempted to assess to what extent growers would prefer a stable price and more certain income from a contract, instead of a volatile market price that varied above and below the stable offer (see methodology of game in section 6.2.2 on page 220).

The majority of teams (except Team 5) joined with and kept selling to Trader A, who offered the contract, throughout all years of the game for at least some of their coffee. Each team quickly realized that traders would have different prices and so they would wait until they had heard each offer before making a decision. Even when all teams signed the contract with Trader A, they still wanted to hear the prices from the other traders. On some teams, members were keeping track of the potential money they would have earned by switching out of the contract. Compared to the risk-aversion game in the survey, this game was understood better despite it being more complex. It was also very effective at generating lots of dialogue among participants.

The methodology was modified slightly during the 6th round of the game since the research team was unable to get much diversification of strategy from the farmers. For the first five rounds, Teams 1, 2, 5, and 6 were all selling the entire lot of their coffee to Trader A. Team 3 only sold a portion of coffee to a higher priced trader in one year. Only Team 4 was maximizing the benefit of a stable-priced contract for half of their annual coffee and then selling the other half to the highest-priced trader (the optimum strategy given the uncertainty of the type of year and price that would be offered). For the second half of the game, the research team decided to test what the farmers' response would be to Trader A failing to uphold the contract, but making promises that the event was a one-off occurrence. This allowed the team to see more diversification of responses for the second half of the game.

After Trader A violated the contract by only offering to buy half of what was promised (i.e. 25 kg), teams under contract had disparate responses. Teams 2, 3, and 6 sold Trader A the 25 kg of coffee that Trader A would take and then agreed to store their coffee for Trader A until the following year when they sold Trader A 175 kg (75kg from the previous year as well as 100 kg of the current season). Teams 1 and 4, sold Trader A 25kg, but refused to hold onto the remaining 75 kg instead selling that to the external trader with the higher price on the market at the time (see Table 54 at the end of the section). Both teams then sold to Trader A in year 7, which was a "bad" year when Trader A had the highest price anyway.[182]

However, trust had been broken to some extent. In the final year, when the price on the market was higher than the stabilized price, both teams (1 and 4) chose to sell half of their lot of coffee to the external trader with the highest price (something neither team had done in any of the previous years). Economically, given the last year is a one-shot game, they both should have sold the entire lot to the external trader and violated the contract as well since Trader A had already broken it previously. Both teams, though, chose not to violate their contract and sold 50 kg to Trader A.

Team 4 pursued the most optimal strategy for the game of all the teams. They signed the contract with Trader A, but would sell the maximum (excluding the first round) to the external market when prices were higher than the offer from Trader A. As a result, as shown in Figure 67 their revenues were the highest up until the last year. The winning team (Team 5) was actually the one that defected completely at year 6. Team 5 sold their entire 100kg to the highest offer (Trader C) when Trader A reported not being able to buy as much coffee as contracted. Team 5 then stored all 100kg of coffee during year 7 (a "bad" year) and subsequently sold all of the two-year "production" (200kg) during the ultimate year. While this strategy could have been disastrous had the last round been a "bad" year, they managed to win with this gambit.[183]

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[182] Refer to Table 45 on page 217 to review the design of the game and payouts each year
[183] See revenues during the game in Table 55 at the end of the section

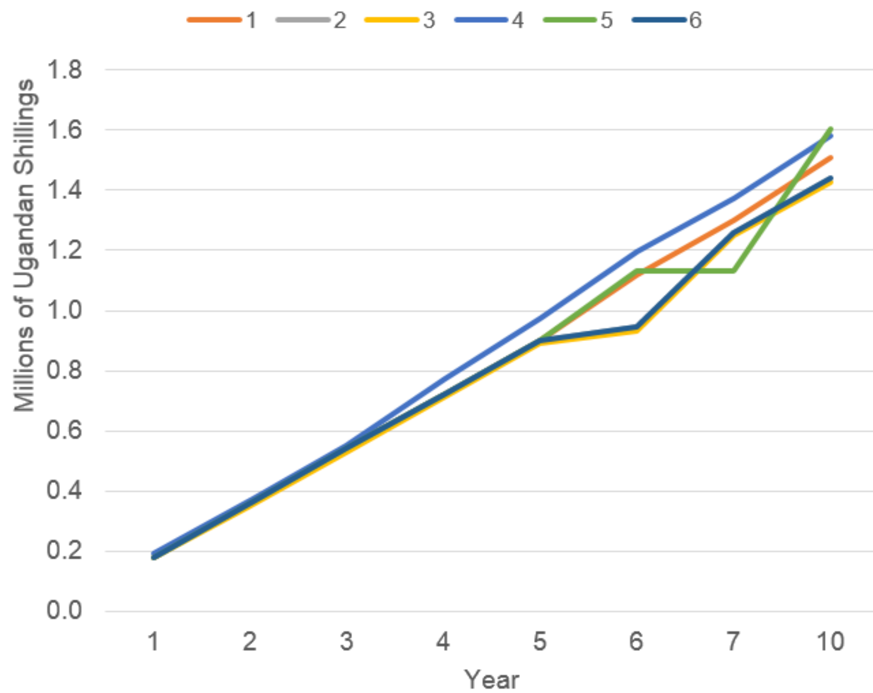

Figure 67: Cumulative revenue of Teams 1 to 6 from coffee trading game

Overall, the trading game demonstrated that farmers have an interest in price stability and prefer to take some of the risk out of a coffee market. Whether these results extend to how farmers might behave in a real market with an option to join a cooperative with a price contract is debatable. However, games have been used recently in various contexts with positive results for changing the behaviour of stakeholders and enhancing understanding of systems (Etienne, Du Toit & Pollard, 2011; Souchère, Millair, Echeverria, et al., 2010; Le Bars & Le Grusse, 2008).

Farmers expressed interest in a stable price and the willingness to uphold a contract even when the market price for their product is higher. When the contract was violated by Trader A in year 6, five out of six teams sold the limited amount that the trader was able to buy. In addition, three of the six teams followed through with the favour Trader A requested to hold onto year 6 coffee to sell all to Trader A in year 7. No teams broke the contract prior to Trader A's violation, and only one team broke the contract after Trader A had violated it.

The high rates of adherence to the contract and lack of cheating suggests there is potential for a cooperative to structure payments to farmers upon a guaranteed price for their coffee. The advantages for the farmer are to remove some of the price risk from coffee production; for the cooperative, there is a potential upside from market swings. A large enough cooperative could hedge their exposure using futures and options on the LIFFE in London—something impossible for an individual farmer. A market-based approach like this may be able to achieve the same ends that NGOs cite of the benefits to farmers that came from stable prices before liberalisation.[184] It also might achieve the same goals of income and consumption smoothing as micro-savings programs, which are encouraged by development organizations. Mitigating some of the risk of the high-risk, high-return nature of coffee production, may also encourage poorer farmers to participate. Several studies find that poorer farmers typically lose potential income due to focusing on low-risk, low-return agricultural production (Dercon, 2002; Elamin & Rogers, 1992; Eswaran & Kotwal, 1990; Rosenzweig & Binswanger, 1992; Yesuf & Bluffstone, 2009). However, whether such a business model could be financially viable needs further study. Additionally, a major threat to the business model is farmers' selling coffee outside the cooperative in good years and buying third-party coffee to sell as their own to the cooperative in bad years. Mechanisms to ensure compliance need investigation, as these issues may be very difficult to overcome.

There are several limitations to the game beyond the usual caveats about stated behaviour differing from actual decisions (Nyarko & Schotter, 2002; Hill, 2009). (1) The teams of farmers could have believed that the game had a "right" answer and the researchers were looking for them to agree to a contract. The incentive for winning the cash prize should have mitigated this behaviour. (2) Farmers could have been influenced by the personality of Trader A. Trader A may have been more influential than Trader B or C. Again, the cash prize incentive should have made teams more objective, but in the future, it would be useful to play the game multiple times with survey team members changing roles. (3) Farmers likely learned during the rounds and may perform differently had the game been played a second time. Teams may have choose to sign a contract out of uncertainty about the mechanisms of the game. While the re-signing of the contract in the 5th year tried to limit this bias, playing multiple times would have been beneficial. (4) The game did not simulate production risk (i.e. teams had a guaranteed 100kg to sell each year), which limited the realism of the simulation. Future research is discussed in the next section, building on these ideas.

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[184] See further discussion on the changes after liberalisation in Appendix A.26 starting on page 422

Table 54: Volumes sold by team (1-5) and by trader (A, B, and C)

	1			2			3			4			5			6		
YEAR	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
1	100			100			100			80		20	100			100		
2	100			100			70	30		100			100			100		
3	100			100			100			100			100			100		
4	100			100			100			50		50	100			100		
5	100			100			100			50		50	100			100		
6	25		75	25			25			25		75			100	25		
7	100			175			175			100						175		
8/9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	50		50	100			100			50		50	0		200	100		
TOTALS	675		125	800			770	30		555		245	500		300	800		

Table 55: Revenue in 1,000s Ugandan Shillings by team (1-5) and by trader (A, B, and C)

	1			2			3			4			5			6		
YEAR	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
1	180			180			180			144		47	180			180		
2	180			180			126	43		180			180			180		
3	180			180			180			180			180			180		
4	180			180			180			90		126	180			180		
5	180			180			180			90		117	180			180		
6	45		176	45			45			45		176			234	45		
7	180			315			315			180						315		
8/9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	90		117	180			180			90		117	-		468	180		
TOTALS	1,215		293	1,440			1,386	43		999		583	900		702	1,440		
SUM	**1,508**			**1,440**			**1,429**			**1,582**			**1,602**			**1,440**		

6.5. LIMITATIONS AND FUTURE WORK

This chapter contributes empirical results in three different contexts of risk beliefs and preferences for stakeholders in the Ugandan Robusta coffee supply chain. The first (1) is a comparison on stakeholder views at different levels of the supply chain on priority pests and diseases of Robusta coffee. The research found that the top two priority pests were widely agreed to be BTB and CWD throughout the stakeholder hierarchy. These two afflictions had entered the country from poor SPS regulations at the border with DR Congo. There was information prioritization further from production in the supply chain; many interviewees at export firms and NGO contacts only reported the top two pests/diseases as issues for farmers. Traders and growers had slightly different priorities as well. Traders ranked RBD and CBB much higher than Buikwe farmers who reported the severity of RMB as a higher concern. Likely this is due to differing priorities: farmers worry about the tree dying from RMB, while traders are concerned about the quality and weight loss from CBB and RBD that impacts their profits on *kase*. This difference also reflects that traders typically pay an average price to a farmer for the coffee without thorough inspection of the sack of coffee being sold. Consequently, the farmer is not incentivized to care about reducing RBD or CBB so long as the infestation is below some detection threshold when the trader has a cursory glance in the coffee sack at the point of sale.

Due to their position as intermediaries visiting many different plots, traders were the most informed on all five pests and diseases of the Uganda Robusta production system. Every participant in the survey (both trader and grower) claimed to have experience with CWD. For the other four pests and diseases, though, traders claimed to be familiar with all pests and diseases at significantly higher rates than the growers surveyed. Compared to growers, traders of agricultural commodities are understudied. Their knowledge of the market as well as production puts them in a unique position. Traders deserve a more dedicated research agenda especially in their role in mixing coffee from different farms, contributing to an average quality source of coffee (see further discussion on quality challenges in section 7.3 in Chapter 7).

The results from the risk-aversion game (2) revealed that traders were more risk-averse than the growers in Buikwe and Kayunga Districts were. Growers measured on average as "slightly risk-averse" while traders were "moderately risk-averse". Compared to Tanaka & Munro

(2014) coffee growers appeared to be more risk-seeking. This is likely explained by self-selection into the high-risk nature of coffee production (Hill, 2009; Tanaka & Munro, 2014).

Not all researchers have found positive results using risk preferences from HL experiments, and some question the usefulness of the methodology. Hellerstein, Higgins & Horowitz (2013) conclude based on their results and literature review that “lottery choices are a poor candidate for predicting real-world farming behaviour”. They found that the results from a classic HL design experiment were poor at predicting farm behaviour in terms of taking insurance, diversifying crop mix, and having off-farm income, which they argued should be strongly influenced by risk-aversion (Hellerstein, Higgins & Horowitz, 2013). This counters the findings of Barsky, Juster, Kimball, et al. (1997), whose study of health and retirement decisions, as well as the study by Knight, Weir & Woldehanna (2003) in the agricultural sector, which showed that stated risk preferences do correlate with risk taking behaviour. Similarly, the general results of the highly cited work of Nyarko & Schotter (2002) show that stated beliefs can be used to predict actual behaviour. The effect of the risk-aversion score on the decisions growers made on their plots will be analysed in Chapter 7.

Finally, the results of the coffee market simulation (3) found that farmers preferred to reduce price risk exposure through a stable secure price contact. They also adhered to the contract even in years with higher market prices. The methodology of the coffee trading game demonstrated the potential use of games to elicit information on how farmers and traders perceive the benefits of stable prices and react to market conditions. The game is rudimentary though and in need of several methodological improvements before being used more widely.

Three improvements should be piloted in future studies with the simulation. (1) The game could be more useful with an investment component that incorporated protection against risks from pests and diseases as well as planting of new seedlings. The teams should have the ability to allocate some percentage of their revenue (perhaps as a portion of the crop) into an “investment” in good practices on the farm. This could be one of the three main practices measured in the HH survey (i.e. weeding/pruning, fertilizing, and spraying). Perhaps each of these could have uncertain benefits as well which would cause the teams to discuss which one is worth investment. Additionally, farmers should have the ability to expand their coffee production capacity by buying seedlings. (2) The bad years could have been more variable between teams and given a context beyond pricing. It would have been interesting to see the farmers' responses to high prices, but low volumes due to a pest incident and see if their investment behaviour would change after such an incident in a bad year. Lastly, (3) it would be worthwhile to incorporate the decision to process coffee to *kase* by milling on their own as a team or perhaps in negotiation with another team to get a high enough volume to be economic to transport to the mill. This would have added an extra layer of complexity to the game, but possibly could elicit the reasons that farmers are reluctant to work together to bulk their coffee and self-process from *kiboko* to *kase,* which has a higher value per kg.

Ultimately, the game was reduced in complexity for simplicity. As a pilot survey, the author was unsure how well the game would be understood by farmers and traders. Given the simplified, but realistic nature of the game, understanding was very high and the game could be made more complicated in a future study to incorporate some additional components suggested above.

Chapter 7. Income Diversification and Decision-making

Understanding the drivers of agricultural decisions has been a topic of much research since the 1970s (see literature review, section 7.1). In recent decades—largely since the 1990s—the role of social connections and the people farmers consult when making decisions has received more attention among both researchers and development professionals.[185] As shown in Table 56, producing coffee involves many decisions at various steps during the season.

Table 56: Coffee lifecycle with decision points as elucidated by discussions at group workshop at RASD

Coffee Production Stage		Example Decisions
Investment		• How many seedlings to plant? • How much of total plot to devote to coffee? • Intercrop coffee with other crops?
Growth		• What type of fertilizer to use, if any? • Use pre-emptive pesticide treatments?
Treatment		• Use pesticide treatments on present pests/disease? • Prune infected branches? • Remove dead or diseased trees?
Harvest		• Selectively harvest ripe berries or strip the tree? • Sell "wet" cherry straight off tree?
Processing		• Dry coffee cherries on the ground or tarp? • Keep chickens and other contaminates out of coffee drying area? • Store dried cherries or sell immediately?
Sale		• Sell dried cherry or take to processing mill to remove husk? • Sell to mobile trader or take to town store?

Coffee production begins with investment at the beginning of the cycle. Next treatment decisions are made before harvest. Lastly, the timing of the harvest, the level of coffee bean

[185] See the review by Woolcock & Narayan (2000) and a recent summary of network analysis used to study export performance in the developing world by experts at the World Bank (Raj & Arvis, 2014).

processing, and whom to sell to must be decided by the grower (see Table 56). At various points during this process, farmers have the opportunity to consult other farmers, input suppliers, extension agents, and/or national agencies like the UCDA. They also likely will be influenced by their personal tolerance for risk and alternative income sources available to them. Each of these decisions points—and the networks of contacts farmers consult for each decision—should influence the design of policy in order to effectively implement a control strategy for a given pest or disease.

Once a farmer is confronted with an outbreak of a pest on her farm, what does she do about it? The research aim of this chapter was to see what determines investment in new seedlings and in activities meant to prevent production losses. It is likely that factors such as plot size, portion of plot devoted to coffee, the importance of coffee as an income source, ability to switch to alternative crops, and other characteristics of the farming household will influence decisions on the coffee plot. Of relevance for SPS policy, one important factor for generating more accurate damage estimates from foreign pests/diseases is how a farmer changes effort devoted to the crop after an incident. It is important to understand who carries on producing after a significant loss from disease and who exits the market in favour of other cash-generating activities.

Based on the findings in the literature (section 7.1) on the importance of social networks, section 7.2.1 presents analysis of the number of social connections farmers report consulting for coffee management advice. The impact of these social networks on choice of processing level of coffee sold (e.g. *kiboko* or *mwanyi mbisi*) is examined for different social groups. Section 7.2.3 assesses what factors predict weeding, fertilizing, pruning, and pesticide use on the coffee plot. Additionally, given the low rates of following best practices for these behaviours, the self-reported barriers to adoption are examined. The first part of section 7.2.4 summarizes the other crops, livestock, and income-generating activities reported by coffee farmers. Subsequently in the section, the drivers of being involved in other income-generating activities are examined, including the risk-aversion survey results that were discussed in Chapter 6 (section 6.4.2). The expectation is that both wealthier and more risk-averse farmers should have higher income stream diversity. Section 7.2.5 estimates the probability that a farmer will abandon/exit coffee production based on household and personal characteristics. The farmer's view on the fair price for their product is included as an explanatory variable in the models as well, building on the work in section 5.5.7 of Chapter 5. It is very difficult to measure exit from an industry in a survey because often the identification method of eligibility to participate in the survey (e.g. growing coffee in this case) automatically excludes those that have quit production of the crop. While it was not possible in this survey to measure exit from the coffee industry, the lack of planting seedlings in the past five years while reporting heavy disease incidence was used as a proxy for no longer investing in coffee production (i.e. exit of industry and abandonment of coffee production). A qualitative anecdote of one farmer who abandon coffee production is given in Appendix A.24 to enrich these quantitative results.

Achieving a better understanding of the characteristics that drive behaviour of farmers will help generate more accurate models of economic loses and market impacts after a pest/disease incident. Illuminating the incentive structure and decision-making of coffee farmers could also improve policy design for interventions meant to prevent catastrophic changes in coffee supply when disease prevalence spikes. As discussed in the Appendix (section A.25.4 on page 421), there is large annual variability in Ugandan coffee exports. Much of this is attributed to yield loss from disease; however, likely a sizable part is due to some farmers choosing to enter or abandon coffee production and changes to the effort they devote to coffee. The findings of this chapter demonstrate the importance of considering farmers' opinions and social connections when estimating their likelihood of abandonment of production after a disease or pest shock.

7.1. DECISION-MAKING ON THE FARM, ASSETS, AND SOCIAL CAPITAL

The framework presented below in Figure 68 draws upon the work of several theoretical decision-making models applied to farmers (Rajagopalan, Rasheed & Datta, 1993; Mumford & Norton, 1984; Simon, 1959; Errington, 1986; Rantamäki-Lahtinen, 2009). Recall the discussion in section 5.4.

In the grey ovals of Figure 68 are the variables measured in the HH survey of farmers that are used to proxy the factors of the conceptual framework for decision-making. Figure 68 highlights the decision to stay in or abandon coffee production, which is analysed in more detail in section 7.2.5. In addition, the following sections of 7.2 explore what drivers from the framework affect various decisions on the plot, from implementing GAPS to growing other crops. This work is more exploratory in nature to see which factors seem to have the strongest predictive power on the various decisions coffee farmers need to make.

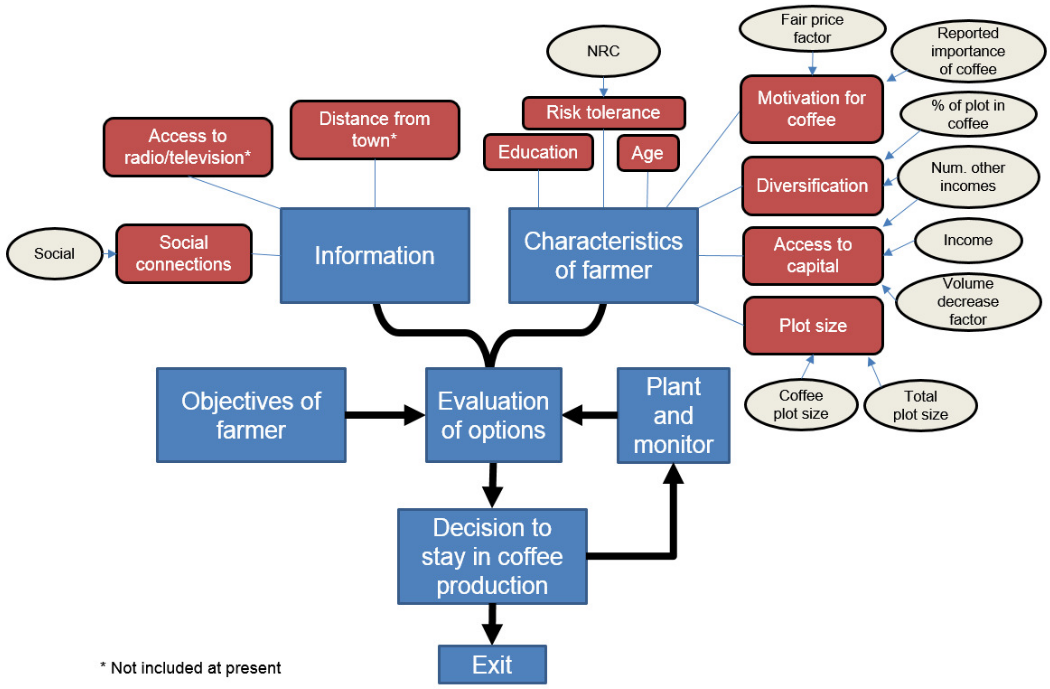

Figure 68: Conceptual framework of coffee farmer decision-making with measurement variables included from HH survey (grey ovals)

While there are many characteristics of farmers that will be explored to determine how they affect decisions, on the "Information" category of Figure 68 the only variable used is a farmer's response to the number of social connections they consult in decision-making about coffee. The importance of social networks as information sources and factors heavily influencing decisions has been shown in the empirical literature. Social networks play a role in problem detection and options awareness. In farming, Lunneryd & Öhlmér (2006) find empirical evidence that dairy farmers that were more connected to other peers were more sensitive to issue detection on their farm and knew more about how to respond to them. Interestingly, the variables they used to express information access were not significant as compared to the one used for "cooperation with fellow farmers"; it appeared that peer connections were a more useful source for problem detection (Lunneryd & Öhlmér, 2006). Hansson (2007) found that farmers who participated in "peer study circles" and who made decisions in discussion with a partner were more efficient dairy producers. Rantamäki-Lahtinen (2009) shows that more dense informational networks formed from social connections of a farmer were correlated with higher resources on the farm and higher profitability. Similarly in a wide-ranging study of farmland abandonment in the EU, the lack of access to advice and support from a network of growers led to higher likelihood of farming abandonment (Terres, Nisini & Anguiano, 2013). Shared decision-making and the importance of who the decision-maker consults has been shown in other fields as well (e.g. medical decision-making (Hanson, 2008)). Given the empirical evidence in the literature, it was expected that Ugandan coffee growers who consulted their peers more often would be more aware of how to respond to pests and the price to sell their coffee, as well as, be less likely to abandon coffee production.

Theoretically, a discussion of decision-making in the context of relationships that link the farmer to a wider group is grounded in the work on social capital by Coleman (1989), Putnam (1995), and Bourdieu (1986). All of these authors have different conceptions of social capital as explained in detail by Sutherland & Burton (2011). Two of the authors, Putnam (1995) and Coleman (1989), build their social capital frameworks on institutional relationships and formal obligations. These institutions form the basis by which people can build a sense of community. Especially for Putnam (1995), social capital is built and reflected by memberships in parent-teacher associations, labour unions, religious institutions, and other forms of civic engagement. These are arguably not as applicable to a rural farming context in a developing country. In the Ugandan context, bartering and building of relationships based on clan as well as family groups are very common especially in the village setting. Instead of trust based on institutions and formal obligations, these exchanges of favours or goods often rely on trust that is made through both a history of past exchange with the individual and a history built from the actions of the person's close-ties (e.g. family or clan members). Sutherland & Burton (2011) explains that in a rural context, farmers exchange resources usually in the form of machinery and labour. These exchanges rely on the previous development of social capital which promote feelings of trust and obligations (e.g. like the obligation to help a family member that is in need).

In the context of Bourdieu (1986), it is the ability of an individual to use their credential from a member group to exchange types of capital—trading social capital for economic capital for instance through a loan or borrowing of equipment. The amount of capital (economic, social, and cultural[186]) an individual can leverage is dependent, to an extent, on their social network of connections. This would suggest that farmers that have more social ties might have better access to accurate pricing information, can leverage others' knowledge of pests (and borrow spraying equipment if necessary), and could rely on their network for economic capital to invest in improving agricultural production. Section 7.2.1 tests some of these potential outcomes from social capital with the results from the HH survey of growers.

Previous research has shown that where farmers go for information before they make decisions matters. Williamson, Little, Ali, et al. (2003) surveyed rice farmers in Kenya and India to understand the information that guides pesticide usage. They find that untrained farmers spray based on recommendations of the pesticide dealer, while those that had insecticide training made more decisions based on their own assessment. Additionally, trained groups had very different beliefs about the potential damage and risks presented by different pests (Williamson, Little, Ali, et al., 2003). Similarly, in a survey of farmers in Ghana, Ntow, Gijzen, Kelderman, et al. (2006) find those with less training tend to over use and inappropriately use hazardous pesticides. In a key piece of work on social learning in the *American Economic Review*, Conley & Udry (2010) finds evidence that pineapple farmers in Ghana learn about the performance of inputs through their relationships and update their own behaviour in the subsequent season.

In the absence of an expert opinion, farmers also may rely on peers to inform their choices. Heong & Escalada (1999) find that rice farmers in the Philippines when making spraying decisions were most influenced by chemical company agents, but also by extension agents, spouses, neighbours, and village leaders (in that order of importance). To the author's knowledge, there is a lack of empirical work on the effect of social connections on value addition to a crop before it is sold. It is hypothesized that farmers that are more connected to others in the village will be more aware of how to take advantage of the market opportunity in further processing coffee (i.e. will add the most value by going from selling *mwanyi mbisi* to *kiboko* to *kase*).

[186] Cultural capital is defined by Bourdieu (1986) as existing in three states: embodied, objectified, and institutionalized. The idea is generally the capital that an individual attains from cultural goods like books, marks of distinction such as educational achievement, and "long-lasting dispositions of the mind and body" that come from one's social status, work, and upbringing. While cultural capital is important, the focus of subsequent sections is on the relationship between economic and social capital.

7.2. ANALYSES OF UGANDA ROBUSTA GROWERS' DECISION-MAKING

Analyses presented in the following sections are based on data collected from the HH survey.[187] Part of the discussion in sections 7.2.4 and 7.2.5 is informed by the workshop in Nkokonjeru.[188] In addition to the questions already examined in Chapter 6 about fairness and supply chains, groups at the workshop were also asked to discuss the following questions:

1. What other crops can you grow with coffee?
2. What crops could you grow instead of coffee?
3. What crops have you considered growing for income, but have not yet tried?
4. With the plot you currently have, what are the limitations to coffee production?

The groups' answers to questions (1) and (3) were particularly useful to highlight growers' willingness to try new crops. The answers also highlighted the recent experience growers have with abandoning crops that they believe are no longer worth producing. These results are further examined in section 7.2.5.

7.2.1. Social networks of farmers in Buikwe and Kayunga

One implication following the literature review in section 7.1 is that farmers who are more connected with stronger social ties should have access to more economic capital. Farmers with more economic capital should also be able to invest more effectively in their farms and produce greater output—or at least weather shocks more effectively—than farmers without a strong social capital base to lean on.

The theoretical underpinnings of social capital would predict that individuals rely more on close tie networks where social capital has been built and common cultural capital is established more strongly than weaker tie networks (Bourdieu, 1986). In Buikwe and Kayunga districts, the survey found in practice this was true for coffee growers. Farmers were asked who they consult for advice when making coffee farming decisions (see question 14 of grower

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[187] Review survey methodology in Chapter 5, section 5.3.5, starting on page 167.
[188] Review workshop methodology in Chapter 5, section 5.3.3, starting on page 164.

survey in Appendix A.19). Based on suggestions from RASD as well as previous literature[189] the seven types of social connections asked about were: spouse, friend, neighbour, community leader, extension officer, buyer/trader, and input supplier (see Figure 69).

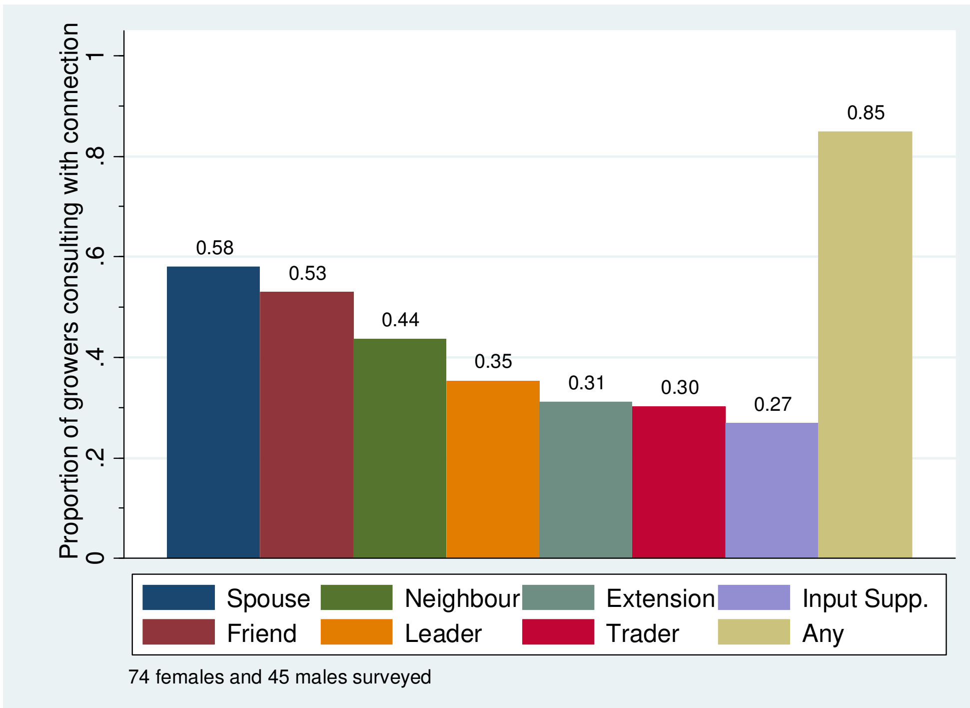

Figure 69: Proportion of growers who ask the given social connection for advice when making on-farm decisions for coffee

As shown above in Figure 69, the vast majority (85%) of farmers consulted at least one of their social connections when making decisions on their plot (see "Any" category). The further that tie was away from the family unit, the less the person seemed to be consulted on average. While farmers are most likely to make decisions with their spouse, they are far less likely to engage with an input supplier or trader. The friend, spouse, or neighbour might have the best interests of the individual in mind when providing advice, but that is less clear for the input supplier who has an incentive to sell product or the trader who wants to give a lower price.

[189] Social connections were examined in several field-based studies (Fafchamps & Lund, 2003; Sutherland & Burton, 2011; Dercon, 2002).

The low rank of the extension agent in the survey reflected the qualitative results from in-person interviews with experts in the area. NAADS—while the official extension arm of the government and often a provider of seedlings when sponsored by a political campaign (see section 7.2.5)—does not engage with farmers very often or very deeply as best as the researcher could determine. The Managing Director of Exporter B (interviewee #10) with decades of experience in the Ugandan coffee supply chain said simply that NAADS "do nothing to train farmers" and have "very little impact" (personal conversation). Similarly, while traders may engage with farmers more frequently to buy coffee, they were not consulted frequently for decision-making. Most farmers reported that they would sell to anyone who came down the road on a bicycle or motorcycle buying coffee. Growers often believed that traders were making much more money than they were and so the level of trust seemed to be quite low for most farmers interviewed.[190] Alternatively, for the input suppliers the low percentage grower consultation is most likely due to the low levels of inputs use by smallholders in the survey (see Figure 73 in section 7.2.3 below).

Gender did play some role in farmers' use of social ties (see Figure 70). Males appear to consult various social ties more on average than female growers do. The responses for the use of each of the seven social ties were checked for statistical significance between genders. The results on the tests of independence including a Fisher's Exact test[191] are reported below in Table 57.

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[190] The majority of traders were wealthier than the typical growers as discussed in the summary statistics for traders in Chapter 6 section 6.3.2.

[191] Fisher's Exact test is used for small samples, which inevitably may have low frequencies of counts in one or more cells of a 2x2 contingency table. All of the social variables had counts of at least 5 in each cell of the contingency table with gender, but Fischer's Exact test results are reported for completeness and robustness to the question of violating the large sample assumption of the χ^2 test.

Table 57: Tests of independence between male and female responses on use of social connections for coffee decision-making

Social Connection	Mean∓ M	Mean∓ F	$p - values$ Proportion test	χ^2 test	Fisher's Exact test
Spouse+	0.86	0.74	0.1798	0.180	0.262
Neighbour	0.53	0.38	0.0984*	0.098*	0.128
Neighbour+	0.61	0.40	0.0692*	0.069*	0.111
Leader	0.47	0.28	0.0429**	0.043**	0.050**
Leader+	0.47	0.33	0.2115	0.211	0.250

Note: * p < 0.1, ** p < 0.05, *** p < 0.01
Shown in the table are only social connections with $p < 0.10$ from χ^2 test of independence between male and female groups for the given social connection in the full survey sample (74 females, 45 males).
∓ Mean indicates the proportion of each group saying "yes"
+ Married only sub-sample (42 females, 35 males)

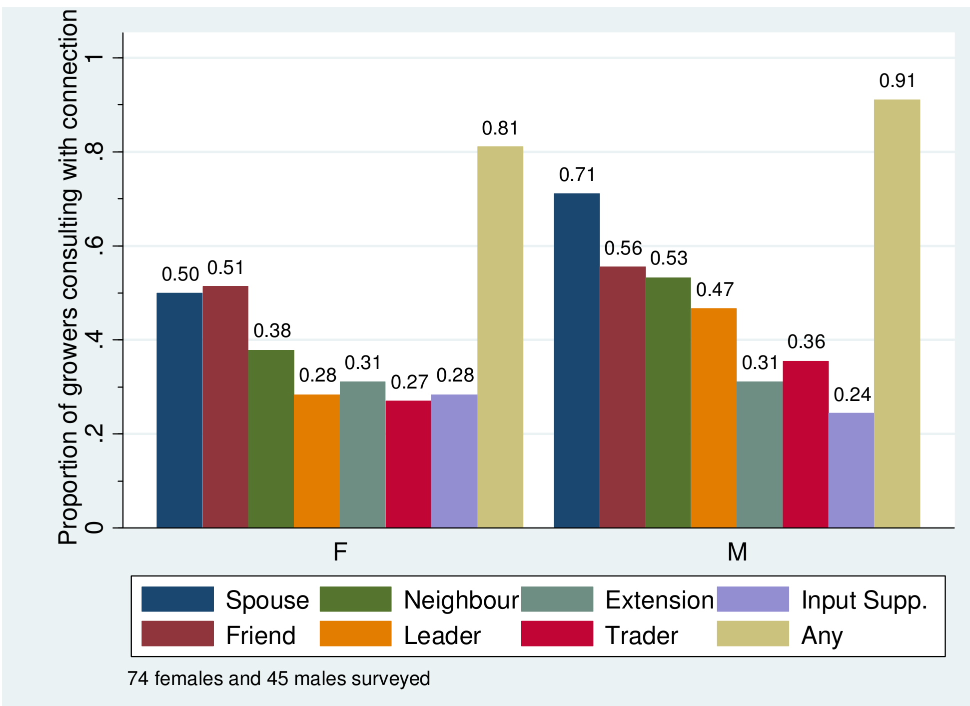

Figure 70: Social connections that growers ask advice from for decision-making varies by gender

As shown in Table 57, in the full survey sample, male coffee growers were more likely to respond that they discussed coffee plot decisions with leaders in the community. There was marginal significance ($p < 0.10$) suggesting that males were more likely to consult their neighbours, which was a bit stronger for the married sample of coffee farmers, but still not significant at $p < 0.05$.[192] There was also strong evidence in the full survey sample that male coffee growers are more likely to consult a leader in the community for advice on producing coffee ($p < 0.05$). However, this effect was driven by single women that do not go to a leader for advice; as such for married coffee growers, there was no significant difference by gender about who consults a community leader (final row Table 57). Despite the explanations from expert interviews (interviewee #1) that women may feel ownership over the coffee plot and therefore would not consult their husbands, married men and women consult their spouses at statistically the same rate (see row 1 of Table 57).

The results above concerning gender suggest that the main differences in consultation with social connections are that single, female coffee farmers are quite different from the rest of the coffee growers. Just over 1/3 of all single female growers reported that they do not go to any social connections for advice (see Figure 71). This is significantly higher than reported for males or married females where only 8% of all those surveyed reported consulting no one for advice. The mean number of social connections for single females was 2 on average, while for the other group the mean number of social connections was 3.[193, 194]

[192] Interestingly, married individuals are marginally more likely to consult their neighbours than single individuals ($\chi 2$ test, p=0.056), but overall, married and non-married individuals had statistically the same patterns of use of social connections for coffee production advice (results not shown).
[193] These means were significantly different given a two-sample T-test with unequal variances ($\mathbf{p = 0.015}$)
[194] The mean for single females would have been lower without the spike of women reporting having 5 social connections which they go to for advice. There was no obvious distinction from the data collected to suggest why these six women reported having so many avenues of advice as compared to the other single women interviewed.

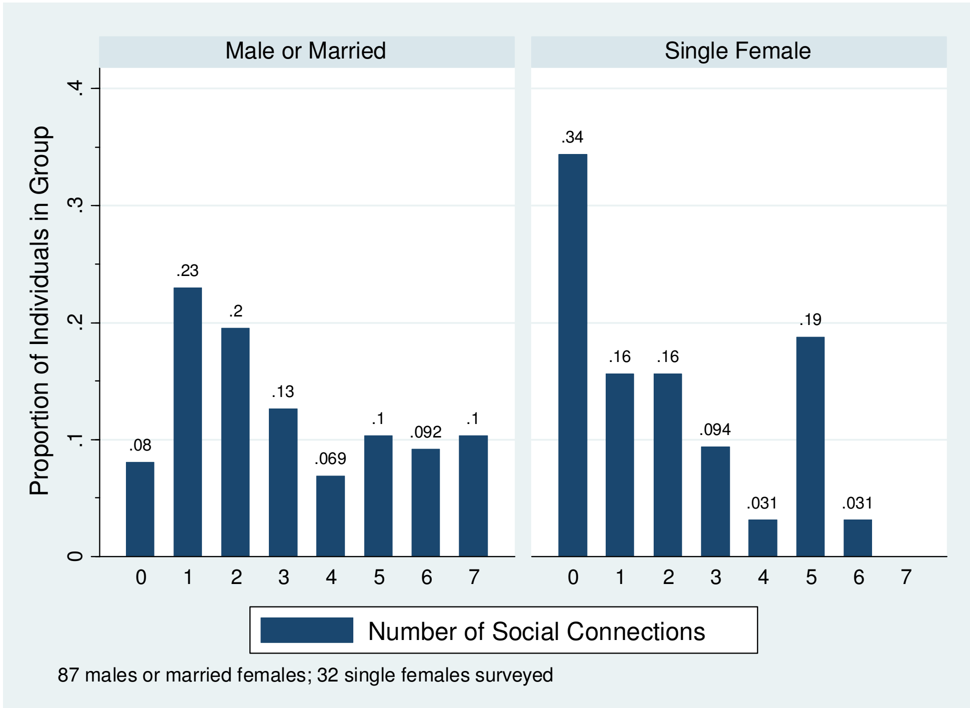

Figure 71: Number of social connections for coffee advice by gender/marital status

If the number of consulted social connections shows the ability of an individual to leverage social capital, one would expect those with fewer social connections to be more constrained in their ability to improve coffee production. The inability to rely on a social network for advice, labour, credit or machinery, may both make the individual more susceptible to risks and less able to respond to them.

As shown in section 5.5.7 (Chapter 5), farmers who dry their coffee before selling it earn a higher price from the coffee than those who sell the wet cherry. Additionally, drying the coffee on the ground—as opposed to on a tarp, raised platform, or concrete slab as UCDA recommends as best practice—results in a lower price on average. Unfortunately for the single women group of the survey, they did both of the detrimental practices more often than men or married women (see Figure 72). [195]

[195] One single woman did not respond to this question on drying method and two responded that they did a mixture of both tarp and ground. The three respondents are not included for this analysis on drying method. There was one male who did not respond to the question on drying method choice and was excluded. In total 23 farmers reported selling both dry coffee and sometimes selling wet coffee when in need of cash. Given that many farmers who report selling just dry coffee might as well sell wet if desperate, those that sold both were counted for the portion that they sold as dry. Thus "wet cherry" reflects the farmers that always sell wet cherry and reported never selling any dried coffee during the year.

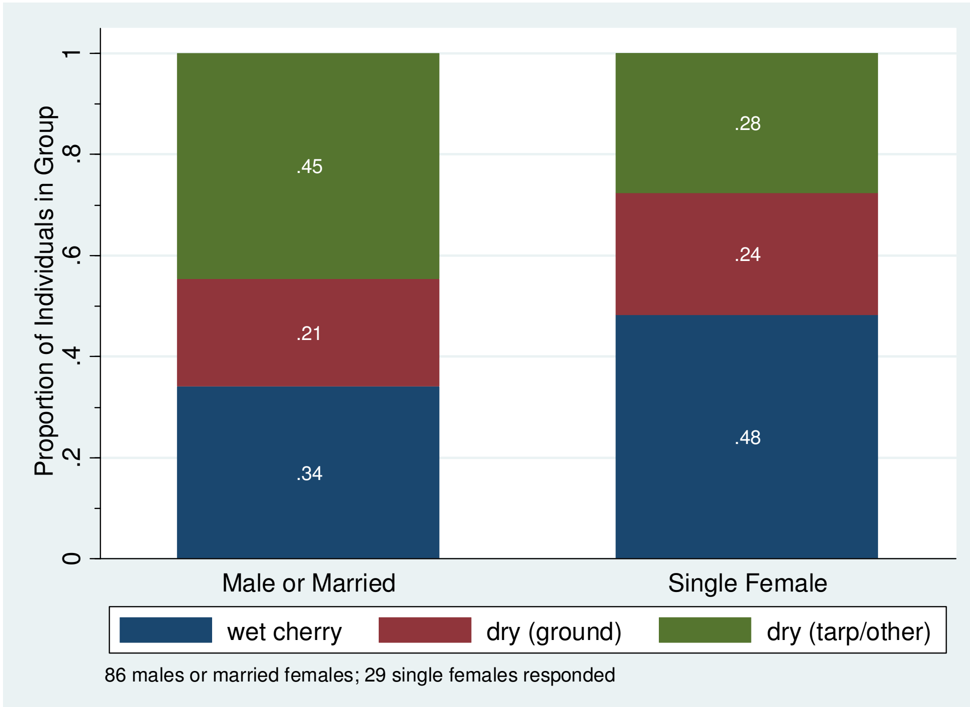

Figure 72: Processing method before sale differs for single females in the survey

Nearly half (48%) of the single females surveyed sold only wet cherry—that is coffee that is sold directly off the tree without any drying or processing. While for males and married women, only roughly 1/3 (34%) sold wet cherry (see Figure 72). Of those 66% of men and married women who sold dry coffee (*kiboko*), around 70% (or 45% of the group total) chose to dry the coffee on a tarp or platform complying with what is considered best practice and yielding the highest price for coffee. While less than 1/3 of those men and married women that sold dry coffee made the decision to dry on the ground (21% of group total), which results in poorer quality coffee. For the single women who did dry their coffee before selling it (52% of group total), nearly half dried their coffee on the ground (representing 24% of the total group of single women—see Figure 72).

The choice on how to process coffee before selling it to a trader can be modelled as a set of two choices (sell wet, or sell coffee dried on the ground) against the base choice (the best practice in this case: coffee dried on a tarp or platform). The results of Table 58 show that the decision to sell coffee immediately when wet is more likely for those with no social connections, regardless of gender (which was not significant). Based on interviews, the decision to sell *mwanyi mbisi* is often done out of need for an immediate supply of cash for household expenses (see next section, 7.2.2). Thus, it is not surprising that those without a social network to rely on would be more likely to sell wet coffee. Beyond the need for cash, without consulting a larger network of people the grower might be less aware of the financial implications of the decision or potentially, the ease at which dry coffee can be processed and sold. The results in the second column show that as soon as a grower is talking to at least one other social connection, the extent of their network (the extent of social connections, measured in the "social" term in the table) is irrelevant to the decision between selling wet coffee and the best practice of coffee dried on a tarp.

Table 58: Multinomial logit model of gender and social connection impact on coffee processing choice prior to sale.

		(1)	(2)
Wet cherry			
	gender	-0.133	-0.158
		(0.445)	(0.437)
	is social	-1.740**	
		(0.822)	
	social		-0.145
			(0.0978)
Dry (ground)			
	gender	-1.186**	-1.173**
		(0.592)	(0.596)
	is social	-1.777**	
		(0.869)	
	social		-0.227*
			(0.132)
Dry (tarp/other)		(base)	
Observations		114	114

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Robust standard errors in brackets.
$gender$ - Male is recorded as 1 and base 0 is female
$is\ social$ - Binary variable if the grower reported consulting at least one person
$social$ - Count variable of the number of social connections grower reported

Given the choice between drying on a tarp or on the ground, gender and number of social connections appeared to be strong drivers (review Table 58). Females were much more likely to dry on the ground instead of a tarp. Talking to at least one social connection decreased the probability that a grower would sell wet coffee (*mwanyi mbisi*). The more connections a grower conferred with seemed to drive the grower to dry on a tarp or platform (see social coefficient in column (2)). The anecdotal reasons for selling *mwanyi mbisi* are explored in the next section.

7.2.2. Reasons for selling wet coffee

Interviews with NGO A's Executive Director (interviewee #1) highlighted the challenges farmers face with managing a cash crop in a cash-scarce setting. Often farmers need to pick their crop early and sell for whatever price they can get because of a bill that comes up, or an immediate need for food. While the majority of the farmers surveyed seem to eat three meals per day and did not report hunger, food security has a strong connection to the ability of a farmer to make the appropriate decisions to maximize wealth generation. If someone is more food secure and has other crops or livestock to depend upon, they can wait until coffee is ripe to harvest (personal conversation, interviewee #1).

Others interviewed argued that the behaviour to strip the coffee tree and sell wet coffee was not out of desperation, but was perhaps an optimal decision to prevent theft. Exporter B's Regional Sustainability Manager (interviewee #8) said that many farmers worry about losing their coffee both to in-house theft from older children or neighbours stealing cherries. In the survey as well, several farmers reported coffee being stolen either by children or by others at night.[196] The degree to which losses to children compare to pests/diseases was not addressed, but previous studies in Pakistan orchards confirm that theft can amount to a serious loss for growers (Hai, Stonehouse, Poswal, et al., 2003).

Coffee drying can take two weeks. As such, selling coffee cherries right off the trees, one also does not have to worry about thieves stealing the drying coffee and will get immediate cash. One surveyed farmer explained that when the children needed school fees she simply told them to go pick some coffee and earn their fees. One can pick and sell on the same day. Those who sold both wet and dry suggested they did so to balance immediate needs for cash along with longer-term investments when they would dry and store coffee.

The Project Manager for Exporter A (interviewee #2) discussed that some farmers sell the ripe cherries because in actuality they have already sold the coffee as an option once the tree had produced flowers. Some traders will pay farmers in advance to "book" the coffee still on the tree as flowers. Either the trader will then come collect off the tree, or the farmer will harvest when it is ripe and give the coffee to the trader to repay the debt (personal conversation,

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[196] Growers often reported theft as an additional "pest" to the pests/diseases discussed in the HH survey.

interviewee #2). The trader takes on a high degree of production risk and as a result, the farmer often gets a much lower price for the coffee. The only advantage for the farmer is immediate cash and lower risk of loses due to pests and disease.

7.2.3. On farm practices for coffee plot

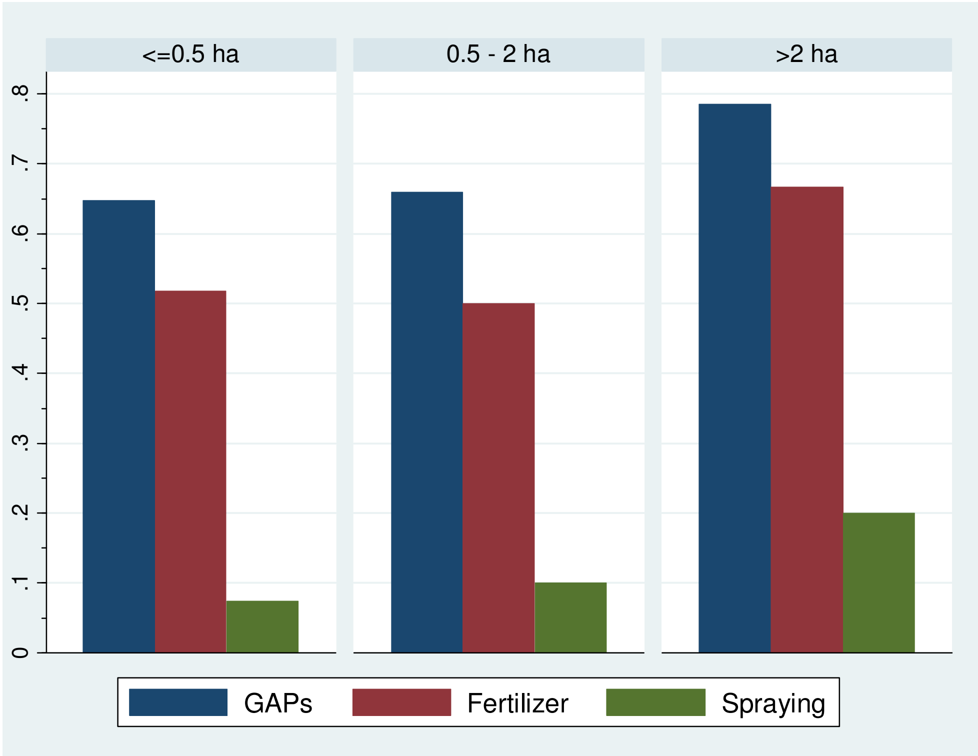
While there are a myriad of decisions that could be explored in the survey, the three practices analysed were (1) the choice to fertilize or not, (2) the choice to do any type of spraying[197], and (3) whether the farmer implemented Good Agricultural Practices (GAPs) that NAADS and NGOs often recommend. While fertilization with manure is a GAP, what is meant by GAPs in this context is implementing any of the following:

1. Pruning of the coffee tree to remove dead branches
2. Weeding (often called "slashing" locally)
3. Removing dead trees from the plot
4. Removing and burning branches infested with BTB
5. Uprooting and burning dead trees infected by CWD or infested by BTB[198]

It was expected that farmers with more wealth or larger plots of coffee would be more likely to engage in behaviours that are thought to improve coffee production (i.e. fertilizing, spraying, and implementing GAPs). However, there was little variation in practices by coffee plot size until the 75th percentile (2 ha) and larger plots of farms (see Figure 73). Growers that had less than two hectares followed the three practices on the farm at approximately the same rates.

Overall, around 70% of farmers in Buikwe and Kayunga pruned their gardens, removed dead trees, or did one of many things to treat pests and diseases in accordance with GAPs. Around 50% of the farmers fertilized. However, for the growers that had the largest coffee plots of all those surveyed, they chose to follow all three practices at higher rates. Despite the appearance of difference between top and bottom quartiles, a two-sample test of proportions found no significant difference in adoption rates for any of the practices (results not shown).

[197] Spraying was the term used locally and included insecticides, herbicides, and fungicides.
[198] While practice (1) and (4) as well as (3) and (5) only differ by burning the branches, they were coded separately for future work investigating the impact of burning on preventing spread of BTB.



Note: Graphs by percentile coffee plot size, <=0.5 ha is below 25th percentile, and >2 ha is above 75th percentile (n=119).

Figure 73: Proportion of growers following practices on the plot by coffee plot size

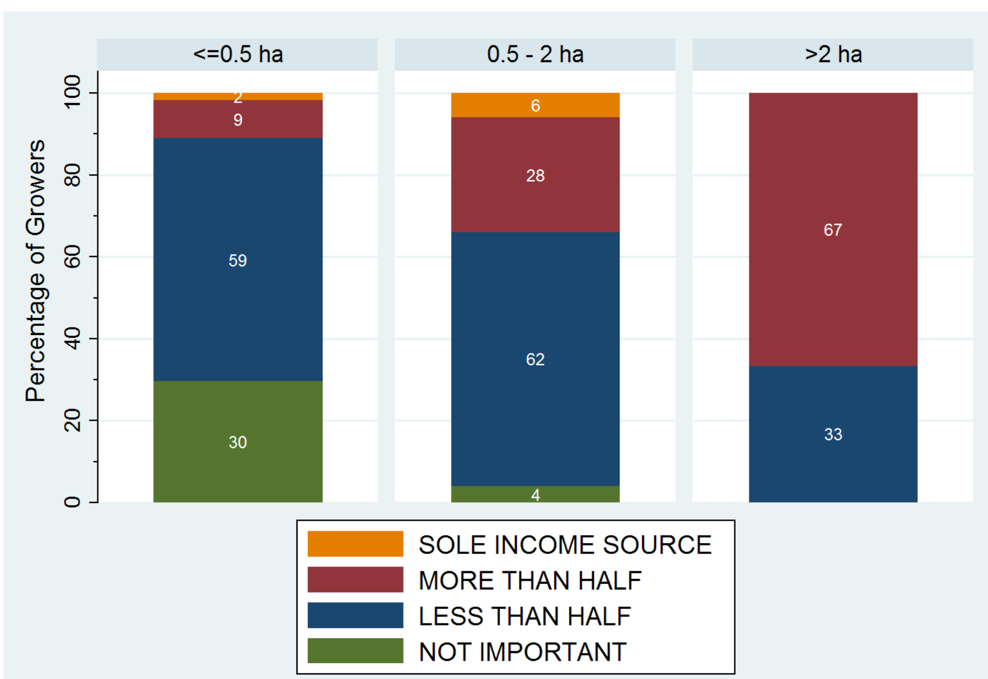


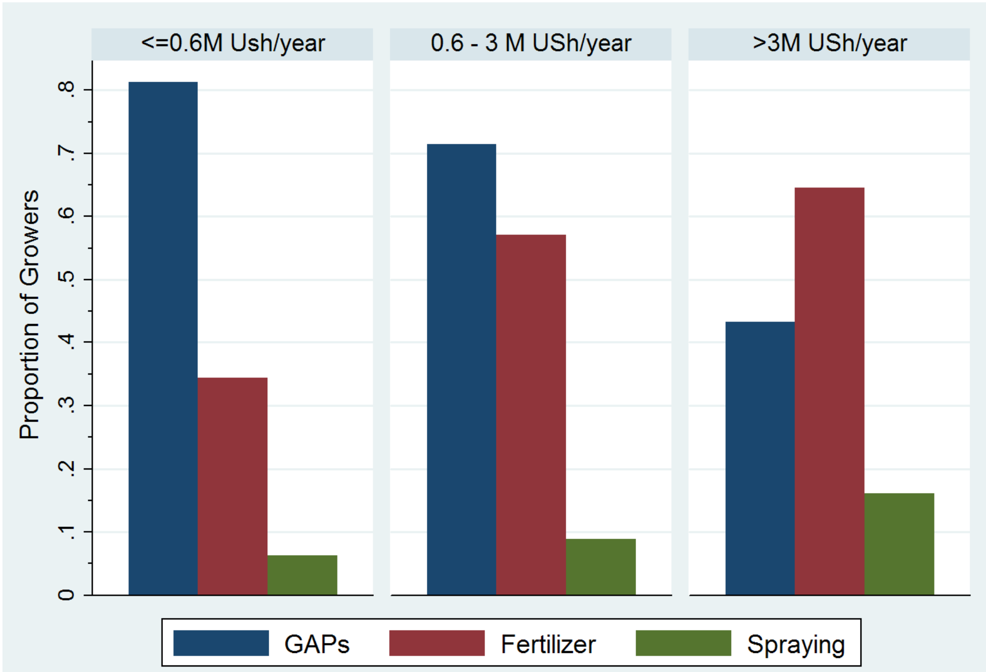
Figure 74: Growers' reported importance of coffee to their total income by coffee plot size

While not statistically significant, an explanation of this result could be that a plot of >2 ha of coffee starts representing the primary crop for a grower. The grower engages more in practices that will have an impact on yields, but have a financial and labour cost for the primary crop. There also could be a fixed cost of "effort" to coffee management, which prevents many growers with smaller plots from investing in coffee maintenance. Figure 74 demonstrates that for 2/3 of farmers with more than 2 ha of coffee, they self-report that coffee represents more than half of their income source.[199]

Unlike plot size, income had significant effects on adoption of practices. Richer growers were more likely to fertilize and spray for pests, but they were less likely to implement GAPs on their plot (see Figure 75). In the survey, $81\% \pm 6.8\%$ of growers in the poorest quartile implemented GAPs, but only 43% ± 9.0% in the highest income quartile did by a two-sample test of proportions ($z = 3.0886, p = 0.0020$). For fertilizing, 34% ± 8.4% of growers in the lowest income quartile did, but only 65% ± 8.6% in the poorest quartile did ($z = -2.3924, p = 0.0167$). Lastly, while 6% ± 4.3% of the poorest quartile reported spraying and 16% ± 6.6% of the richest quartile reported spraying, the results were not statistically different ($z = -1.2474, p = 0.2123$).

The explanation for the difference in following GAPs and using fertilizer is likely that richer farmers chose not to engage as often in labour-intensive practices like pruning, but do engage in practices that require a higher expense or owning high-cost assets like cattle (e.g. cattle manure was the most common natural fertilizer utilized by coffee growers).

[199] No farmer with more than 2 ha claimed that coffee was his/her sole income source. Likely, it takes a certain amount of wealth to have at least 2 ha of coffee and most farmers with that amount of wealth will also diversify their income sources. Diversification of income streams into other crops and activities is examined subsequently in section 7.2.4



Note: Graphs by percentile incomes, <=0.6 M USh is the 25th percentile income and >3M USh is the 75th percentile income of the growers surveyed who answered the income question (n=110).

Figure 75: Proportion of growers following practices on the plot by income range

One might expect that more risk-averse farmers would be more likely to implement GAPs, fertilize, and/or spray to prevent losses on their coffee plot. However, like the findings of Hellerstein, Higgins & Horowitz (2013), the measured risk-aversion of growers in terms of NRC did not predict behaviour.[200] Farmers who did not fertilize made on average 4.66 ± 0.24 risky choices vs. those that did fertilize made 5.11 ± 0.29 risky choices in the game, but they could not be distinguished from each other by a two-sample T-test with equal variances ($p = 0.2474$). The NRC measure had even less distinguishing power for GAPs and spraying decisions (results not shown).

The remaining question is whether fertilizing, spraying, and/or implementing GAPs resulted in higher prices received for coffee products or resulted in increased yield per coffee tree. As shown in Figure 76 below, looking at the mean prices received by growers who follow different practices, there does seem to be a positive impact on price received for *kiboko* in the 2013

[200] Review in section 6.2.3 of Chapter 6 the risk-aversion game that farmers took at the end of the HH survey.

season, especially from fertilizing the plot and implementing at least one GAP. Spraying did not seem to result in higher prices (a proxy for a higher quality product) for the farmer, but this may be due to the pest/disease incidence being significantly higher on a plot where spraying became necessary.

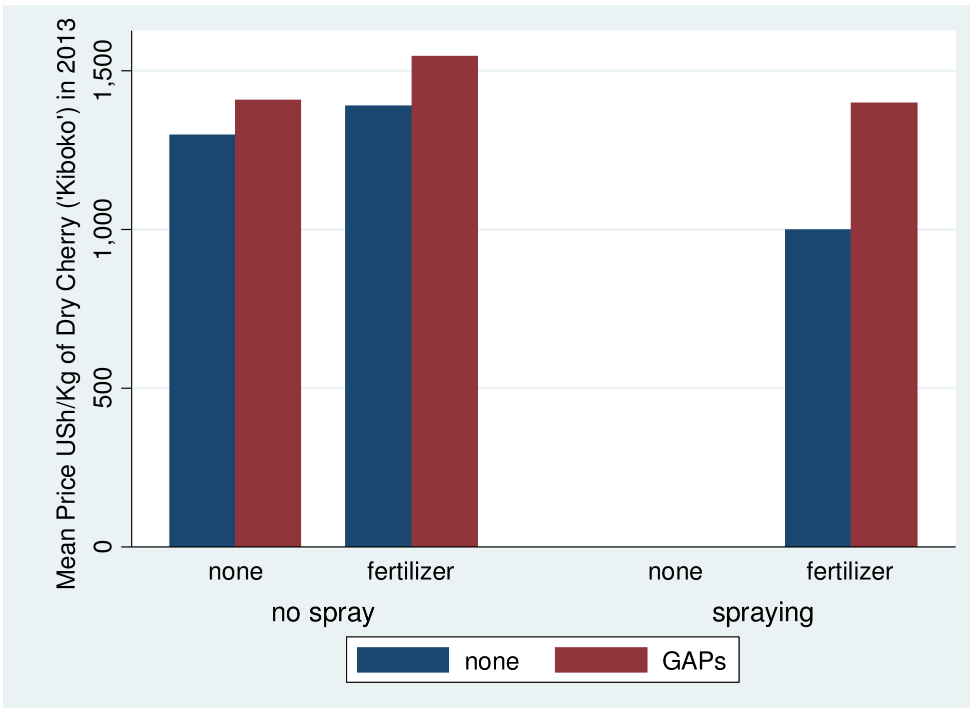


Figure 76: Impact of plot decisions on price received for dry coffee cherries

Using an ordinary least squares (OLS) regression model with robust standard errors to control for the heteroscedasticity of the residuals that was present, the impact of these three farm decisions on the price received for *kiboko* and for *mwanyi mbisi* is confirmed in Table 59. Spraying had a negative impact on the price of *kiboko*, but this is likely due to the reasons mentioned above about the heavy pest incidence requiring spraying to have any product left. It was clear that fertilizer increased the price that farmers received at the gate for their dry (by 121 USh/kg) or fresh (by 132 USh/kg) coffee cherries. Following at least one GAP, the most common being pruning dead branches—a good mitigation measure against BTB (see section A.22.2 on page 390)—seemed to benefit sellers of *kiboko*, but did not have a significant impact on the price for *mbisi* sellers.

Table 59: OLS results on the effect of three farm decisions on price received for coffee

	(1) *Kiboko* Price	(2) *Mbisi* Price
GAPs (Y/N)	141.9**	-51.08
	(62.87)	(60.00)
Fertilize (Y/N)	120.9*	132.2***
	(65.29)	(42.64)
Spray (Y/N)	-228.8**	-46.51
	(99.76)	(41.72)
Observations	71	65

Note: * p < 0.1, ** p < 0.05, *** p < 0.01
Robust standard errors in brackets

While there were impacts on price, there was less of a clear impact on the self-reported yield after following different practices. As shown in Table 60 below, only the impact of following at least one GAP produced significantly higher yields, but only for sellers of *kiboko*.[201]

Table 60: OLS results on the effect of three farm decisions on yield per tree for coffee

	(1) *Kiboko* Seller Yield	(2) *Mbisi* Seller Yield
GAPs (Y/N)	1.009**	0.168
	(0.401)	(0.301)
Fertilize (Y/N)	0.342	0.515
	(0.471)	(0.378)
Spray (Y/N)	-0.645*	-0.140
	(0.331)	(0.445)
Observations	44	40

Note: * p < 0.1, ** p < 0.05, *** p < 0.01
Robust standard errors in brackets

It is surprising that fertilizing did not have a significant impact on yield. A major caveat is that the data on yield per tree is highly suspect. Many farmers are jointly estimating the number of trees they have on their plot as well as the number of kilograms of coffee they sold in the year. Dividing one rough estimate by the other is likely to produce a large measurement error, which may bias the results towards zero (i.e. "regression attenuation"). This error may be particularly significant for sellers of *mbisi* who are more often socially isolated and less educated (see section 7.2.1). These reasons may explain the lack of significance and much smaller coefficient on the GAPs term for *mbisi* seller yield in column (2) model of Table 60.

[201] The sellers of *mbisi* and kiboko were analysed separately such that no assumptions on the wet weight of the kiboko were made.

In addition to the quantitative metrics, there are qualitative results to suggest factors that encourage a farmer to implement GAPs and fertilize. The Head of Programs at NGO B (interviewee #5) said that they teach pruning as well as weeding, however, farmers complain about pruning being too difficult. She believes that the growers do not like to prune as they think that the "bushier" the coffee tree gets, the more yield it might produce, and more branches means some may produce in the event that others are attacked by BTB (personal conversation, interviewee #5). NGO B also encourages farmers to remove dead trees from their plots and to use cow manure for fertilizer. It appears some of their encouragement and training is effective (recall Figure 37 on page 188 that cooperative Kamuli growers fertilized at higher rates than Buikwe and Kayunga non-cooperative growers). Training programs may change behaviours of farmers on these practices.

The Managing Director of Exporter B (interviewee #10) believed farmers do not manage their plots according to best practices due to both a lack of knowledge and, importantly, a lack of belief that these practices improve outcomes. The MD also pointed out two drivers that cascade into everything else: volatile prices and weather. These affect pest severity for the year as well as the farmers' responses to them. When prices are low, growers do nothing and the season is quite bad then for Ugandan exporters. As a result, farmers end up abandoning fertilizing, pruning, and other best practices on their plots (personal conversation, interviewee #10). In the MD's opinion, GAPs need to be incentivized or farmers will never learn from trainings that encourage them to adopt the practices (personal conversation, interviewee #10). Farmers may also invest time in a primary activity other than coffee. One grower (#21) in the HH survey stated she primarily cares about her pigs and "doesn't concern herself with coffee or what causes the drying" (personal conversation).

Part of the reason for inaction on pruning and spraying also has to do with a collective action problem. Pests like BTB infest neighbouring plots and trees. If a farmer acts, but her neighbours do not, the farmer's plot will only be reinfested in a short period. NAADS encourages farmers to form a task force to treat BTB by pruning and burning (personal conversation, interviewee #16). Implicitly their strategy recognizes the futility of a farmer doing this practice on his/her own. The most common reasons farmers gave in the HH survey for the barriers to following best practices are displayed in Figure 77. The biggest drivers were a lack of money and knowledge on how to treat pests, but many farmers also felt that the pests spread too fast to allow for effective action. Often farmers assumed the best treatment was spraying and that was why they claimed to lack money.

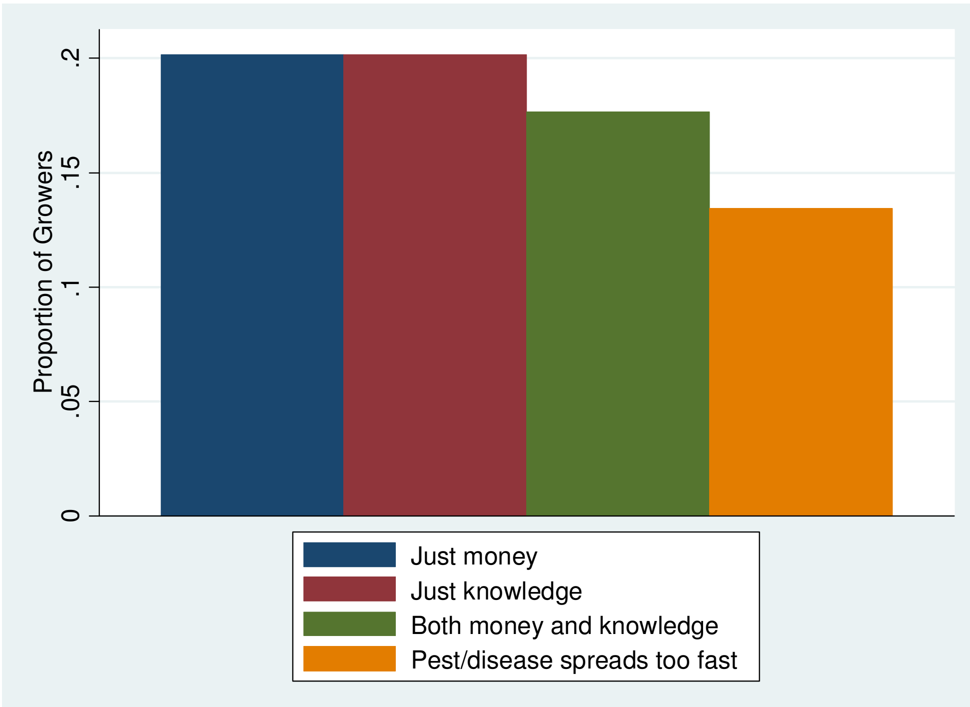


Figure 77: Growers' top reasons for not implementing GAPs and treating pests/diseases

The NAADS contacts (interviewees #16 and #17) said that spraying is not cost effective or very efficient at controlling BTB (personal conversation, interviewee #16). However, the pesticide NAADS recommended was "Roket" (the senior scientist at NaCCRI/COREC, interviewee #15, recommended "E-max"; the inputs store employee, interviewee #13, recommended cypermethrinin).[202] Some example pesticides on the market from the inputs store are shown in Figure 78. It is readily apparent with all this conflicting advice and disagreement on pesticides why farmers reported that they do not have the knowledge to treat the pests (Figure 77). This issue is worthy of future research both to determine the scientific effectiveness and economic efficiency of various pesticide/fungicide combinations recommended by various stakeholders in the coffee supply chain.

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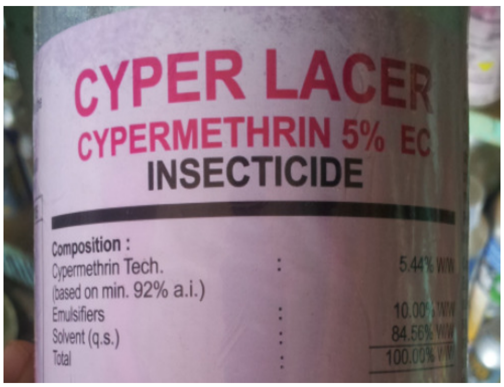
[202] Recommended treatments for BTB are further discussed in Appendix A.22.2 starting on page 380.

(a)

(b)



(c)

(d)

Note: (a) Overview of pesticide/insecticide/fungicide sprays sold in inputs shop;
(b) Most common herbicide was a branded Glyphosate 50% W/W soluble liquid;
(c) Recommended insecticide for controlling BTB by interviewee #16;
(d) Another insecticide, a branded version of dimethoate 40% W/V

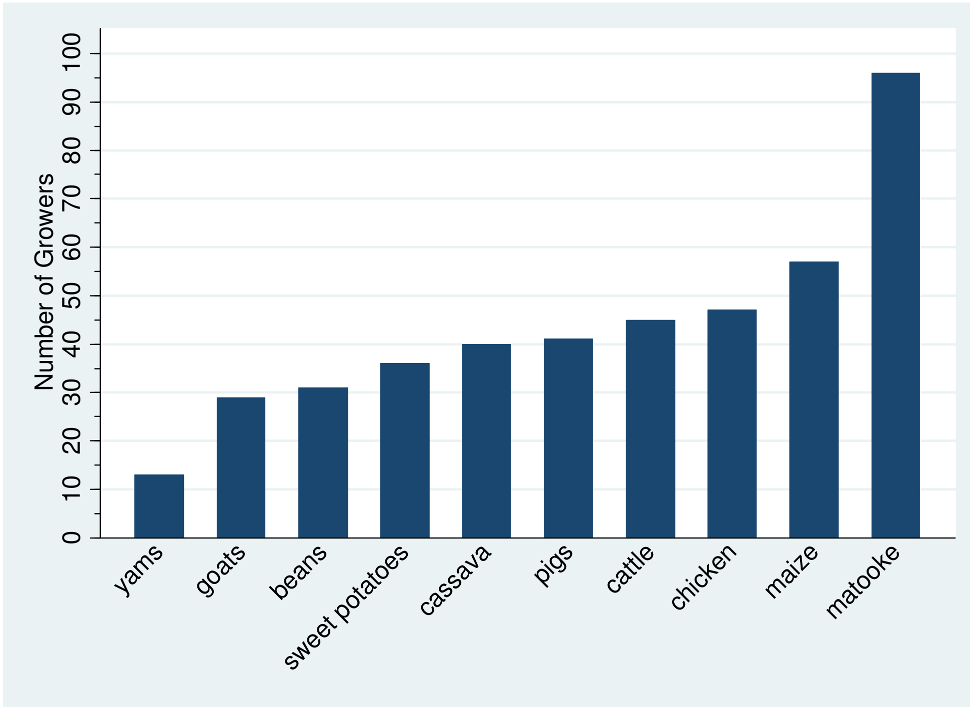
Figure 78: Examples of "sprays" sold in the inputs store of interviewee #13

Overall, there was a discrepancy between the practices that do have an impact on price and yield and the ones that farmers' would like to implement if they were able. Farmers reported many barriers that prevent them from buying and using various sprays, but the factors that seemed to increase price and/or yield were following GAPs and using fertilizer. It appears that a lack of belief in the effectiveness of these measures may be driving inaction, and training by NGO B seemed to increase fertilizer adoption rates in Kamuli. However, training did not increase GAP adoption in Kamuli and spraying rates were much higher. The issue with GAPs are likely that farmers believe they should be adopted to treat BTB, but based on experience, know that the BTB will re-infest regardless of what they do just on their own plot.

7.2.4. Other crops grown in addition to coffee

To call a smallholder a coffee grower is a bit of a misnomer. Smallholders are extremely diversified into a variety of crops and animal agriculture ventures; many have non-farm income as well. Figure 79 highlights the top 10 other crops/livestock production activities that coffee growers also engaged in. *Matooke* (a plantain and staple food of the Ugandan diet) is the most common crop that is grown on plots along with coffee. This result is good news. The NAADS office in Nkokonjeru recommends planting *matooke* along with yams to supplement coffee incomes with useful food crops that are also easy to sell at the market (personal conversation, interviewee #17). The Sustainability Manager at Exporter B (interviewee #8) also reported that *matooke* intercropped with coffee was thought to be the best welfare-improving cropping regime for the region (personal conversation).

The NAADS Coordinator mentioned that farmers often were interested in maize, but NAADS recommends that maize needs at least 1 ha of the plot to break even (personal conversation, interviewee #16). From the HH survey, however, farmers were often growing maize even when they had less land than recommended. Maize was commonly grown in the area around Nkokonjeru. Maize is the main ingredient for *posho* a porridge commonly provided for schoolchildren. Nkokonjeru has developed a reputation for its boarding schools with many students sent to the region from Kampala. As a result, many farmers were speculating in maize since there is consistent demand.



Note: Answers from question 1 from growers' survey see Appendix A.19

Figure 79: Other crops/livestock that coffee growers also produced on their plots

To distinguish food grown solely for home consumption, the survey also asked about other income-generating activities that farmers had. Farmers reported a variety of other sources of income, including many of the crops that they mentioned producing in addition to coffee. Four farmers mentioned getting money from adult children who were employed, five sold *waaragi*[203], ten sold milk in the market, and others sold crafts, firewood, real estate, or worked in a salon in town. There were many unique income-generating activities that the smallholders reported that were not fully analysed from the data collected. The average coffee grower was engaged in at least three income-generating activities in addition to coffee, with the most prolific smallholder engaged in 8 other activities.

Given the heterogeneity in income streams, what motivates the degree of diversification? Hellerstein, Higgins & Horowitz (2013) elicited from farmers the portions of their land that they divided into different crops as well as the number of different livestock they produced. They used this information to construct a few different measures of crop diversification,

[203] Uganda's national liquor made from *matooke* distilled like gin.

including portion of land in max crop (a form of concentration ratio used by Gollop & Monahan (1991)). Hellerstein, Higgins & Horowitz (2013) primarily were interested in risk-aversion, but found both NRC and CRRA had no predictive power to estimate income diversification. However, a simple binary variable (based on classifying someone as risk-averse or risk-seeking) did have explanatory power, but in the opposite of the predicted direction. They found more risk-averse farmers were more likely to make seemingly less risk-averse choices on farm management. As an example, the risk-seeking farmers were more likely to diversify their plot into different crops (Hellerstein, Higgins & Horowitz, 2013). While the present survey did not collect enough data from the farmers about the acreage of their fields in different crops, it was possible to analyse the predictive power of NRC on the number of other income-generating activities that farmers had.

A Poisson model was fit to predict the number of other income-generating activities that farmers had in addition to coffee. The factors that were thought to predict this were the farmer's income, hectares of coffee, hectares of total plot size, and the risk-aversion of the farmer as measured by the NRC. A goodness-of-fit chi-squared test confirmed that the Poisson model was appropriate for the data. In order to correct for minor violations of the assumptions of the model, robust standard errors were used to obtain parameter estimates following the suggestion of Cameron & Trivedi (2009, p.70).

The results of the parameter estimates in terms of incident ratios are reported in Table 61. As expected, farmers with higher income are more likely to be associated with larger number of alternative income-generative activities as well. This is not to suggest causality. Likely farmers are wealthy because they have become involved in a variety of income generating activities, not because wealth alone led them to try new activities—though that is certainly possible as well. Entry constraints such as lack of skills or capital may prevent the poorest from finding alternative cropping and non-farm income streams (Dercon, 2002). Higher income farmers may find it easier to diversify than the lower income farmers. In addition, the model results show that farmers with smaller coffee plots were more likely to have diversified into other income-generating activities.

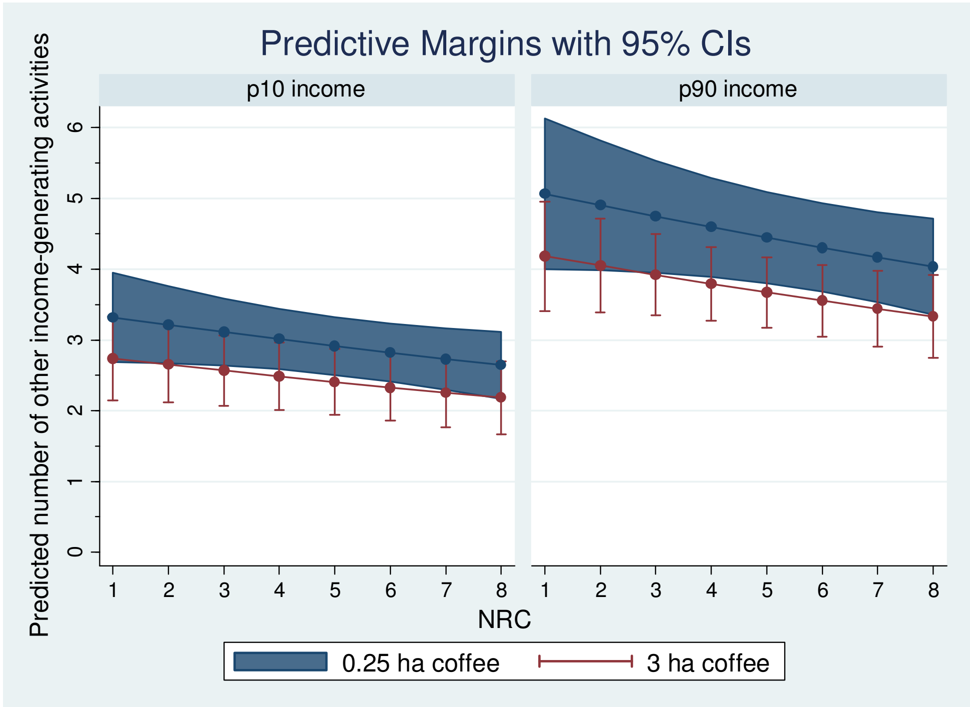
Table 61: Poisson results for predicting count of number of other income-generating activities

	(1) Num. Other Income Activities	(2) Num. Other Income Activities
NRC	0.968*	0.972*
	(0.0169)	(0.0161)
log(income)	1.174***	1.152***
	(0.0490)	(0.0449)
Coffee plot (ha)	0.933**	
	(0.0259)	
Percent of Plot in Coffee (%)		0.615**
		(0.144)
Total Plot (ha)	1.004	0.988**
	(0.00601)	(0.00480)
Observations	110	110

Note: * p < 0.1, ** p < 0.05, *** p < 0.01
Exponentiated coefficients; Robust standard errors in brackets

In the model in column (1), moving from the 10^{th} percentile income to the 90^{th} percentile income would be associated with an increase in 2 additional income-generating activities on average in the data. A similar percentile increase in the size of the coffee plot would only lead to a decrease in 1 income-generating activity on average. Given the difficulty of interpreting coefficients across the spectrum of the data, the predicted counts are plotted in Figure 80 and Figure 81. The model in column (2) shows that the predictor with the largest impact on number of other income-generating activities was the percentage of land devoted to coffee. Farmers with a smaller portion of coffee, as well as, a smaller total plot were much more likely to be diversified into other income-generating activities.

In model (1) and (2), NRC did have weakly predictive power ($p = 0.063$ in model (1)). The more risk-averse (i.e. lower the NRC) the farmer was the more the farmer had diversified into different crops or other income-generating activities. The effect was stronger for higher income farmers. The most-risk averse farmer (NRC=1) with high income (90^{th} percentile) and a small plot of coffee (0.25 ha) would be predicted to have around 5 other income-generating activities. The equivalent farmer who is the most risk-seeking (NRC=8) would only be expected to have about 1 less income-generating activity. The effect of NRC was thus quite small. This is the expected direction of effect that was predicted in the paper of Hellerstein, Higgins & Horowitz (2013), however, the opposite of their empirical results.



Note: p10 income was 0.36M USh/year; p90 income was 5M USh/year; 0.25ha of coffee is the 10th percentile amount of coffee land and 3 ha is the 90th percentile; total plot size held at mean 4.5 ha.

Figure 80: Predicted number of other income-generating activities by NRC from model (1)

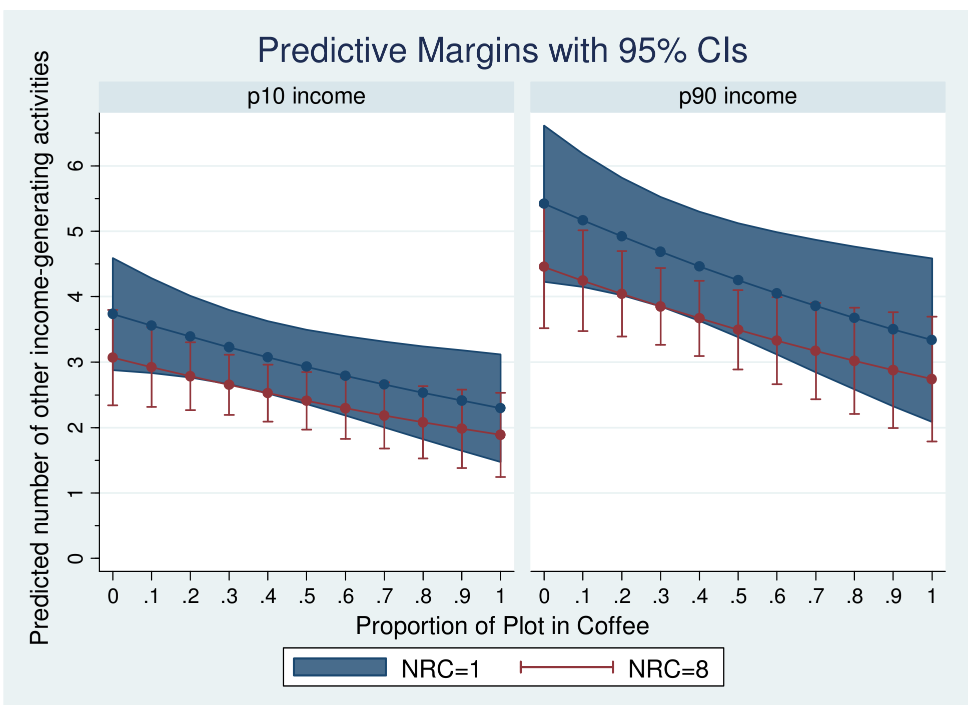


Figure 81: Predicted number of other income-generating activities by NRC from model (2)

Figure 80 and Figure 81 both show the impact of NRC, while statistically significant, is very marginal in terms of differentiating the choices farmers make on income stream diversification. Analysing a farmer's income as well as their plot size of coffee were much better indicators of how many other income-generating activities they likely have. As expected, the percentage of the total plot that the farmer devotes to coffee has a large impact on how many other activities they can devote time and land to production.

While Hill (2009) found evidence that wealthier farmers in Uganda generated a higher portion of their income from coffee, the present survey found statistically no difference in wealthier farmers (1) reported importance of coffee or (2) percent of total plot devoted to coffee (see Figure 82). From the self-reported data in the HH survey as well, the average coffee grower in the upper quartile of income devoted only $31\% \pm 4.3\%$ of their plot to coffee; the average coffee grower in the lowest quartile of income devoted $41\% \pm 3.9\%$ of their plot to coffee ($t = 1.6869, p = 0.0967$). For the communities surveyed in Buikwe and Kayunga districts, it appeared that the wealthiest farmers devoted less of their total plot to coffee as compared to the poorest farmers, but the results were not significant at the $p < 0.05$ level. Additionally, the highest income farmers were no different from others in terms of the self-reported importance of coffee to their income (results not shown).

Both poor and rich coffee farmers are involved in other income-generating activities. The richer farmers with less land devoted to coffee have upwards of 5-7 other activities, but even the poorer farmers with a high dedication of land to coffee will usually be involved in 2-3 other income-generating activities (e.g. usually *matooke* and one or two others like chicken, maize, or sweet potatoes). Given that all coffee growers have other activities that allow them to generate at least some money and food that offsets cash expenses, what keeps them growing coffee and what could potentially cause them to stop growing coffee? Who would likely abandon coffee production if disease and pests become quite frequent and severe? The next section will explore these questions for growers in Buikwe and Kayunga districts.

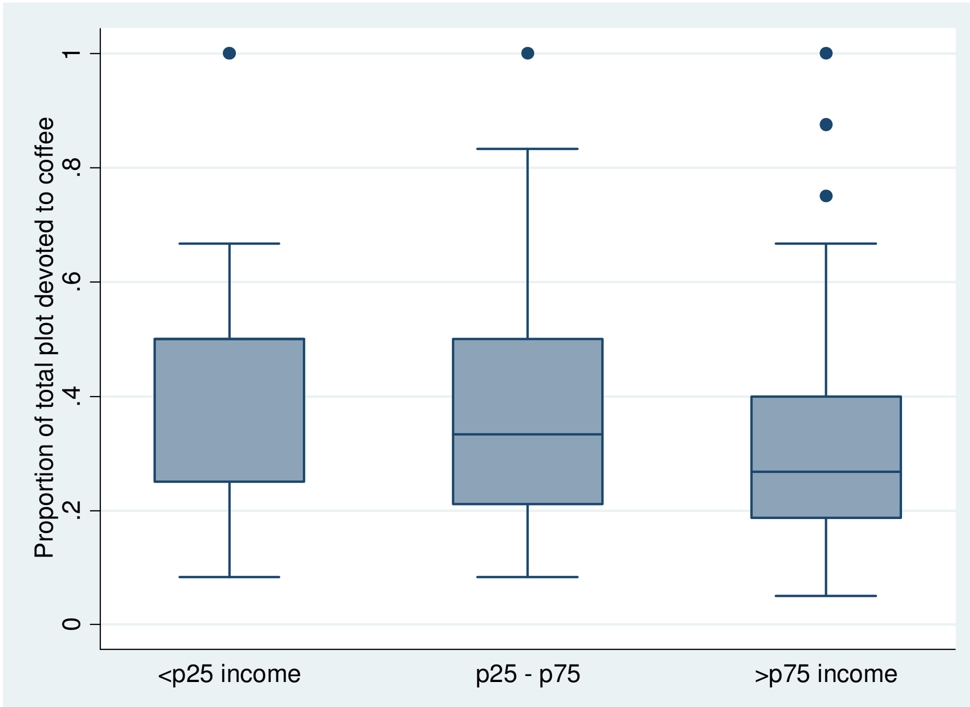


Figure 82: Self-reported income has little influence on proportion of the plot devoted to coffee production

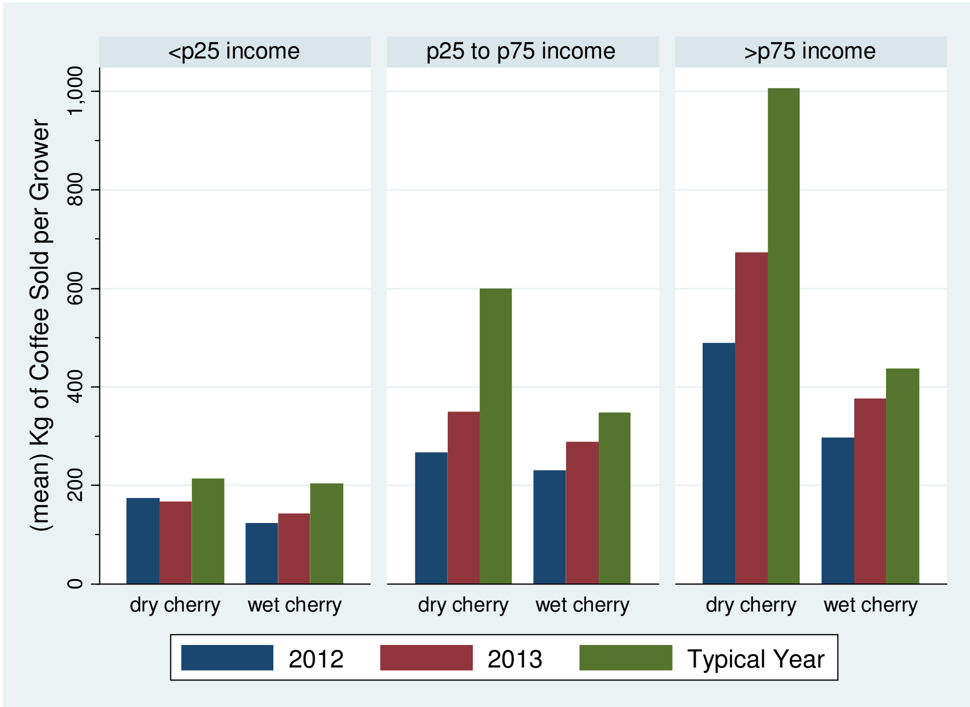
7.2.5. Exit and abandonment of coffee production

It is difficult to measure what drives a farmer to abandon coffee production (i.e. exit from coffee). In the survey, growers needed at least 10 trees to participate and so no one had completely switched out of coffee production. In this setting in Uganda, however, the lack of planting seedlings can be used as a rough proxy for abandoning coffee production. By not planting seedlings the farmer has stopped investing in the plot and, given the typical losses from pests and disease, would eventually lose the remaining trees as well. Many farmers do not remove the trees until they have cash to replant another crop and so a farmer may stop putting effort into coffee while saving or deciding what to grow instead.

One hypothesis was that farmers were not investing in planting seedling because they could not afford to or because they could not access them in their village. If this were the case then, not planting seedlings may not represent coffee abandonment, but a lack of funds. This hypothesis seemed unlikely since (1) the price of seedlings is low[204] and (2) thousands of free seedlings are given away in the district around five times per year.[205]

The reason this lack of investment is a good proxy in Uganda is due to the high disease/pest incidence on the coffee crop. All coffee growers in the survey reported heavy pest damage. In addition, while Hill (2009) reported an assumption of 900 tree/ha in her models of Ugandan coffee growers, the average number of trees per ha in the survey of Buikwe and Kayunga growers was 300. When asked what limited their production, 88% of growers identified pests/disease as the main limitation.[206] The majority were selling less coffee in 2013 than in 2012, and much less than what they thought as a typical year in the past (see Figure 83).

[204] The price of seedlings was still considered affordable at around 300-500 USh (£0.07 - £0.12) per seedling according to both surveyed grower #52 and interviewee #14.
[205] The local NAADS chapter offered on average five trainings per year between NAADS centrally sponsored programs, UCDA sponsored events, and local politicians or MP candidates running for office. Within the past year, interviewee #17 reported that 17,250 seedlings were distributed when the president's office supported a program; 17,000 when an MP was running for election; and a further 20,000 when a local councillor was running for office. Given the low rates of seedling planting within the last five years reported by growers in the survey, it was unclear where the seedlings were going—if they were indeed given out in such massive quantities—without any real large-scale farmers in the area. Interviewee #1, NGO A's director in the area, could confirm that seedlings were distributed from the NAADS office, but was unsure how many and how often they were distributed.
[206] Answers to question 10a "What limits your production?" see Appendix A.19.



Note: Graphs by percentile income category; 25th percentile income was 0.6M USh/year, 75th percentile income was 3M USh/year.

Figure 83: Reported annual production of coffee in 2013, 2012, and a typical year in the past

As shown in Figure 83, the drop in volumes sold also occur regardless of income level; likely pests and diseases are inhibiting production across the entire industry. Is this drop in production leading farmers to exit coffee? The Senior Scientist interviewed at NaCCRI/COREC (interviewee #15) thought that overall, coffee farmers are not leaving coffee across the country, but many were abandoning production in areas with alternative options for cash. In the Bisoga area of Uganda, Indian-owned firms are promoting sugar cane and so farmers are more tempted to grow that as their cash crop. In Masaka District, where coffee is the top crop for most farmers, there are few alternative options for cash there (personal conversation, interviewee #15). The Senior Scientist thought that in Buikwe and Kayunga there are many other options for food crops, but not large industries promoting out-grower schemes like in Bisoga. Interviewee #15 did confirm though that the lack of planting seedlings is likely a good indicator that a farmer will either chose or be forced to stop producing coffee as pests/disease eventually eliminate many of the trees (personal conversation, interviewee #15).

It was expected that those devoting more land to coffee would also have a harder time exiting the coffee industry for other crops. Comparing those that have planted seedlings in the last 5 years, those that are actively replacing coffee trees have an average of 1.6 ± 0.23 ha of land in coffee, while those that have not planted seedlings in the past 5 years have only 0.9 ± 0.15 ha of land devoted to coffee ($t = -2.9704, p = 0.0036$).[207] Partially the land size difference will be explained by income. Higher income farmers—not constrained by the cost of seedlings or transport to access them—were also more likely to plant within the past five years. Those that had not planted earned an average of 1.6 ± 0.36 M USh/year, while those that had planted in the past 5 years earned 2.5 ± 0.27 M USh/year ($t = -1.9977, p = 0.0483$).

Given the multifaceted reasons for deciding to invest in coffee seedling planting, the most appropriate tool to use is a logistic regression. Following a similar setup to equation (1) on page 202 for the decision to invest in coffee, a model is constructed for the decision to exit coffee (stop planting seedlings). As before, $\%\ plot\ in\ coffee$ is the percentage of the farmer's total plot devoted to coffee and $fair\ price\ factor$ is the multiple of the 2013 reported price the fair price was for the farmer (e.g. a factor of 1.5 means the farmer though the fair price for coffee was 50% higher than he reported receiving in 2013). The new variables included in the regression are the following:

- The variable $social$, which is the number of social connections growers, reported consulting with for decision-making on the plot (see section 7.2.1).
- The variable $Num.other\ incomes$, which was the number of alternative sources of income the farmer reported in section 7.2.4.
- The variable $volume\ decrease\ factor$, which is the farmers reported kg output in 2013 divided by the typical year in the past (numbers from 0 to 1 would represent less volume in 2013 than a typical past year).
- The variable NRC is the number of risky choices the farmers made in the risk-aversion game (see section 6.4.2).
- The ordinal variable $importance$ ranged from 1 to 4, where 1 was coffee farmers that said coffee was "not important" to total income up to 4 where coffee was "sole income source".

[207] Results from a two-sample T-test with equal variances. Coffee plot size was made lognormal for comparison, confirmed by a Shapiro-Wilk test for normal data. Levene's test confirmed equal variances for the two groups of those that have planted seedlings and those that have not.

- The variable $importance$ was interacted with farmers' reported $log(income)$ in the models in columns 2-5 in Table 62. It was expected farmers with higher incomes will be less likely to exit coffee in general. In particular, the more important coffee is to their total income, the larger this effect from income will be.
- Finally, variables for $total\ plot\ size$ and $coffee\ plot\ size$ were included.

The summary statistics for all the variables used are given in Table 83, Appendix A.27, page 435. The results of the logistic regressions are displayed in Table 62 below.

Table 62: Results of logistic models for predictors of coffee exit behaviour

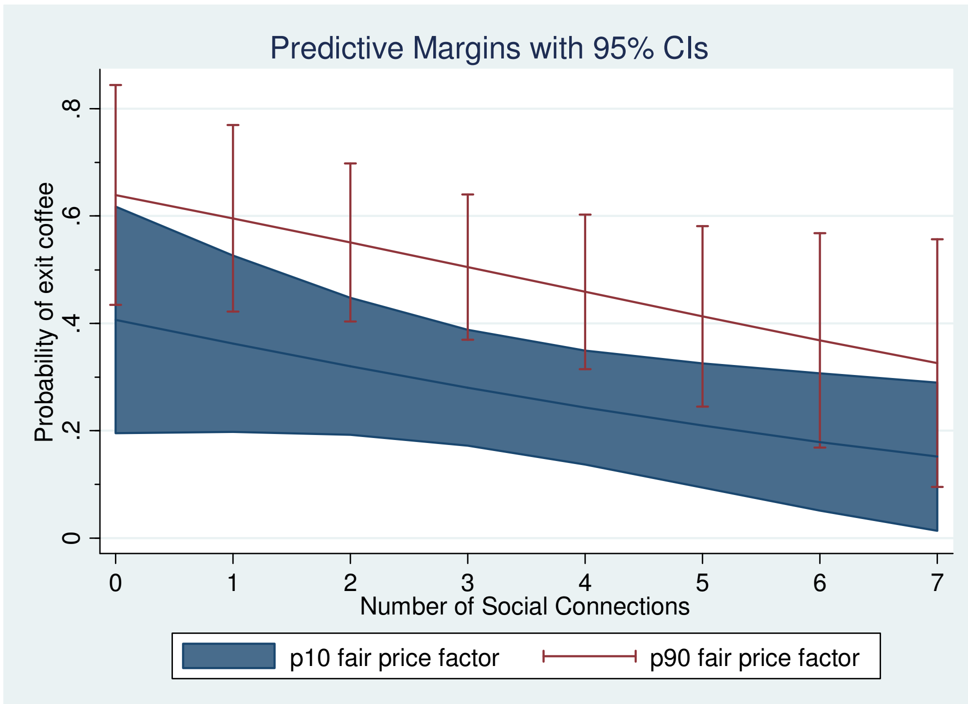
	(1) exit	(2) exit	(3) exit	(4) exit	(5) exit
fair price factor	2.170**	2.107**	2.342**	2.400**	2.400**
	(0.724)	(0.688)	(0.804)	(0.869)	(0.865)
% plot in coffee	0.446	0.747	0.789	0.703	0.703
	(0.460)	(0.844)	(0.898)	(0.883)	(0.881)
Num. other incomes	0.884	0.877	0.839	0.825	0.825
	(0.137)	(0.140)	(0.143)	(0.142)	(0.144)
social	0.806**	0.829	0.793*	0.808*	0.808*
	(0.0861)	(0.0945)	(0.0968)	(0.101)	(0.101)
log(income)	0.562**				
	(0.149)				
importance=1 # log(income)		0.567**	0.579*	0.630	0.630
		(0.161)	(0.164)	(0.183)	(0.183)
importance=2 # log(income)		0.560**	0.580**	0.636	0.636
		(0.155)	(0.159)	(0.181)	(0.180)
importance=3 # log(income)		0.534**	0.559**	0.623	0.623
		(0.159)	(0.164)	(0.190)	(0.190)
importance=4 # log(income)		0.539**	0.553**	0.617	0.617
		(0.164)	(0.167)	(0.191)	(0.192)
volume decrease factor			1.156	1.135	1.135
			(0.323)	(0.318)	(0.318)
coffee plot size				0.820	0.820
				(0.346)	(0.354)
total plot size				0.979	0.979
				(0.0654)	(0.0649)
NRC					1.000
					(0.113)
Observations	105	105	102	102	102

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Exponentiated coefficients; Robust standard errors in brackets.
(1) Growers selling both *kiboko* and *mbisi* are counted just for their *kiboko* activities, which was the primary volume for most of the 23 mixed coffee sellers.
(2) All five model runs passed a link test for model specification error as well as collinearity test checking for severe multicollinearity among all dependent variables.

There were a few surprising results from the models in Table 62. Consistently, the percentage of the total plot dedicated to coffee did not have a significant impact on the likelihood of exiting coffee. Perhaps this could be explained by a lag effect, which could not be captured in this cross-section of Ugandan farming. Farmers may take longer than five years to change the allocations of their land and invest in planting other crops or may leave the land fallow when the coffee trees die, instead of uprooting to plant something else. As such, while the farmer has decided to not plant seedlings for 5 years, they may not have made any drastic changes to their allocation of their plot to coffee. As such, the land becomes less dense with coffee trees, but the size of the coffee acreage does not change. Given that Hill (2009) assumes 900 coffee trees per ha in her models for Ugandan coffee and the present survey's average was 300, this explanation of behaviour is plausible, but impossible to confirm with only one year of data.

Other unexpected results were the lack of significance on $volume\ decrease\ factor$ and the number of other incomes. It was expected that farmers that have produced much less in 2013 than in a typical past year would be less likely to have planted seedlings to keep investing in coffee. However, this assumption may not fully capture the extent to which pests and diseases have caused damages across the coffee growing sector regardless of whether a farmer is replanting or not. In addition, it takes a seedling around 3-4 years to mature enough to produce a good quantity of sellable coffee beans. As such, only those that planted seedlings 5 years ago could be expected to produce more volume in 2013. So the measurement of the volume decrease factor is not refined enough to capture differences between farmers, since all experienced high losses. The count variable of the number of other income generating activities ($Num.\,other\ incomes$) similarly is only a count metric. A more detailed survey design with the percentage of income coming from each activity may have been able to capture the effect of farmers switching out of coffee. In addition, as shown in section 7.2.4 the choice of effort into additional income-generating activities is closely related to total income, which—while passing the collinearity test in the model checking for cols 1 to 5—still may capture much of the variation making that variable insignificant.

The most robust determinants of exit from coffee investment were the number of social connection the farmers utilize when making decisions on the coffee plot ($social$) and the degree to which they view the current price for their coffee product as unfair ($fair\ price\ factor$). Those farmers who consult more (less) people in the supply chain when making decisions are less (more) likely to exit the coffee industry. As before in the previous model for investment behaviour, farmers that believed the fair price for their coffee product much higher than the 2013 offered price were more likely to not plant seedlings in the past 5 years (i.e. abandon coffee production). Using the results from the model run of column 4 of Table 62, the predicted coffee exit probability for different values of $fair\ price\ factor$ and $social$ are plotted with other variables held at their means in the dataset in Figure 84 below.



Note: p10 fair price factor was 1.25 meaning that the fair price stated by the farmer was 1.25 times the price the farmer reported receiving in 2013; p90 fair price factor was 2.5.

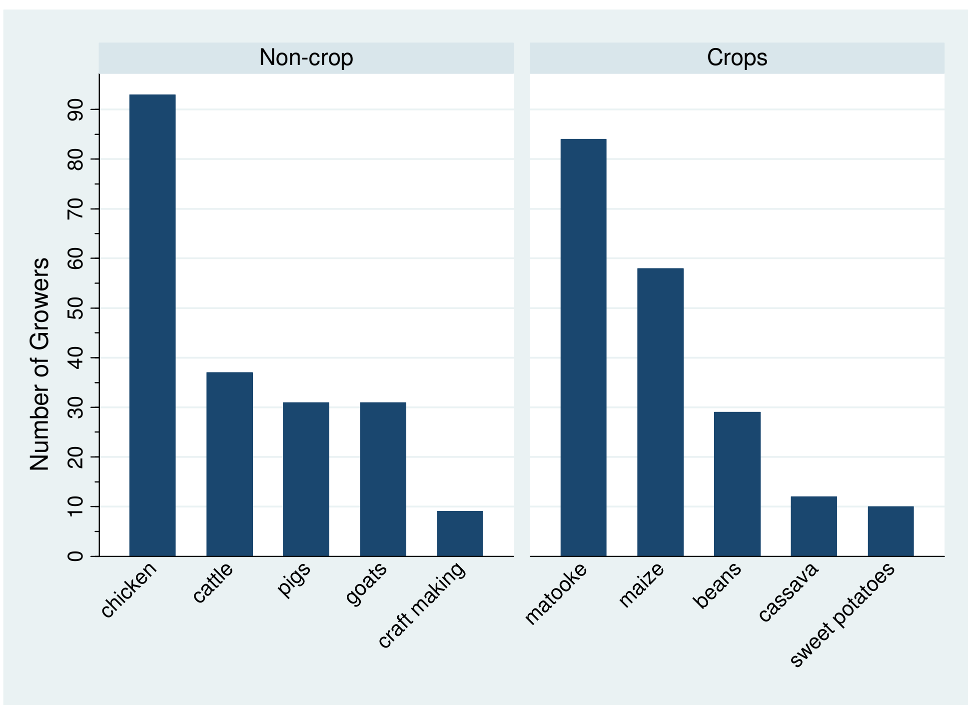
Figure 84: Predicted probabilities of exit based on number of social connections and opinion of the fair price for coffee

From Figure 84, the model shows that farmers that talk to all seven types of stakeholders asked about in the survey are around half as likely to exit coffee on average as compared to those who consult no one in their decision-making on the coffee plot. Similarly, those that view the price as more unfair are more likely to exit coffee than those that are less upset about the current price for their coffee products.

While the direction of these results are not surprising, they highlight the value of measuring these opinions and social connections as part of a survey given their power to predict an important outcome like not investing in coffee seedling planting. The usual economic indicators like the portion of land devoted to production or the stated importance of the crop to total income were poor at predicting which farmers were likely to abandon production.

7.2.6. Activities to switch to instead of coffee production

Famers were asked what they thought they would switch to producing if they did abandon coffee (Question 26 of HH survey, Appendix A.19).The results for the top five choices in crops and in non-crop activities are shown below in Figure 85. Many of the crops are the same as those currently produced in addition to coffee (compare with Figure 79 on page 295). However, in the workshop in Nkokonjeru, farmers had more ideas of alternative crops. Craft making was the only activity that farmers widely thought of switching into for cash-generation that they were not currently producing. This may have negative implications for poverty alleviation, as participation in non-farm work is one useful method to protect families from income shocks associated with crop losses (Kochar, 1999).



Note: Answers to question 26 in farmer HH survey (see Appendix A.19)

Figure 85: Five most common crop and non-crop alternatives to coffee that farmers reported

At the workshop, groups were asked to discuss what crops they would consider growing if they stopped growing coffee. While many groups reported crops that many were growing already, there were some unique answers. The discussion amongst the whole group—while not fully quantified in the analysis to date—was suggestive. There were two interesting anecdotes. Firstly, growers discussed a crop (vanilla) that nearly everyone previously grew when prices were high and then quickly abandoned when prices went back down (see panel (a) of Figure 86). In the early 2000s, there was a large cyclone in Madagascar that devastated the world's supply of vanilla (Abraham, 2004). Ugandan farmers rapidly switched into growing vanilla and made substantial money from it. When the prices crashed, the vast majority switched back to other crops. One of the farmers in the HH survey (#14) mentioned she grew coffee, but then switched to vanilla until that crashed and then she moved back to growing coffee.

(a) (b)

Note: Images from video capture of workshop. Red circles indicate hands that were raised to respond to questions from group facilitator.
(a) Top panel – growers who grew vanilla when prices were high.
Bottom panel – growers who exited vanilla when prices crashed.
(b) Top panel – growers who currently grow cardamom.
Bottom panel – growers who would consider growing it in the next five years.

Figure 86: Growers' responses to workshop questions on alternative crops to switch to from coffee

The second anecdote that emerged from the workshop about switching behaviour was farmers' responses to one group's suggestion of growing cardamom. While, only one of the farmers was growing cardamom currently, many stated that they would consider growing it in the next five years (see panel (b) of Figure 86). Both the eagerness to try new crops, the results from the risk-aversion game (section 6.4.2), and the previous experience with vanilla, all seem to indicate that the average grower in these districts is willing to switch out of coffee, if the growing conditions and prices deteriorate. A brief example of one grower who did switch out of coffee is discussed in Appendix A.24 (starting page 405).

7.3. CONCLUSIONS ON COFFEE PLOT DECISIONS

The analysis in Chapter 7 has been partially explorative in nature and builds off the previous studies in Chapter 5 on the performance of cooperatives and Chapter 6 on the risk-aversion of coffee growers and traders. Using a decision-making framework discussed in section 5.4, this chapter assessed characteristics of the survey participant and his/her household that may explain choices made on the coffee plot.

Section 7.2.1 found that single, female coffee farmers have smaller social networks that they reach out to for advice compared to other growers. The results confirmed the findings of Rantamäki-Lahtinen (2009) that solitary farmers struggle for profitability. Coffee growers in the HH survey without any social connections were found—using a multinomial logit model—to be more likely to both dry coffee on the ground or sell wet coffee as opposed to best practices. Coffee growers with fewer social connections and women were also more likely to dry coffee on the ground. Selling wet coffee has a few advantages for immediate cash and avoiding the risk of theft, and this may explain why more socially isolated farmers and single women are more likely to sell wet coffee even when it results in lower prices (section 7.2.2). The isolation may also prevent this group from detecting the problem that their decisions are having on farm profitability (Lunneryd & Öhlmér, 2006).

Section 7.2.3 found adoption rates of relatively capital-intensive practices like fertilizing were nearly twice as high (65% v. 34%) for the highest income farmers compared to the lowest income farmers, and relatively higher labour-intensive practices like implementing GAPs were nearly half the rate (43% v. 81%). The risk-aversion score was not significantly different among groups of farmers that implemented and those that did not implement any of the three practices discussed. Results showed the fertilizing increased the price received by farmers for *kiboko*, but the impact on yield was not statistically significant, likely due to the challenge of farmers recalling plot size and volumes sold accurately. Farmers claim to lack both knowledge and money to effectively control pests, but it appears they believe the best solution is a pesticide that they cannot afford, as opposed to implementing best practices. Coffee growers were not different in that respect than other studied farmers in the literature (Stonehouse, 1995; Storehouse, Gbongboui, De Groot, et al., 1997; Williamson, Little, Ali, et al., 2003; Williamson, Ball & Pretty, 2008).

The average coffee grower produced three other products in addition to coffee (section 7.2.4). More risk-averse farmers were more likely to diversify their incomes, but the effect was marginal. Unlike the results of Hill (2009) finding wealthier farmers specialized in coffee, in the survey higher-income farmers had a lower percentage of their land devoted to coffee and had more diversified incomes. Richer farmers may have specialized more in coffee during Hill's survey in 2008/9 before BTB was a significant issue and coffee prices were higher.

The main qualitative and quantitative evidence suggests that farmers are adept at switching into and out of agricultural production depending on production conditions and price (section 7.2.5). They likely actively update their evaluations of coffee each season and make a decision to meet their livelihood objectives (recall Figure 68). Findings contribute to the literature by demonstrating the factors that are shown to significantly predict a coffee farmer staying in coffee production. Understanding these factors helps to inform Ugandan government policies on replanting coffee seedlings and who to target for extension service for alternative crops. In a resource poor setting, coffee extension agents should target their efforts towards farmers likely to stay in coffee production. Additionally, the importance of the number of social connections shows that there can be benefits to organizing in cooperatives despite the challenges that were discussed in section 5.5.5.

7.4. FINAL CONCLUSIONS OF CASE STUDY CHAPTERS

Chapter 5, Chapter 6, and Chapter 7 examined the risk perceptions and decisions made by stakeholders in the Ugandan Robusta coffee supply chain in response to foreign coffee pests and diseases that have established in the country. Conclusions on the various pieces of analysis from the surveys, interviews, and workshops are found at the end of each chapter. A few points are highlighted below, with some tentative suggestions, and future avenues of research.

The President and CEO of an industry research organization (interviewee #14) explained that "everything has a market" and so traders can still turn a profit on poor quality coffee. This statement was confirmed by the Quality Control Manager at Exporter A (interviewee #3) who explained that even the reject pieces of husk, coffee, nails, rope, etc. that are rejected by their mechanical sorting machine are sacked up and bought by a Chinese firm (personal conversation, interviewee #3). The interviewee thought they used it for fuel, but was not completely sure why they bought it.

Why would the export firm take such poor quality coffee? The industry expert (interviewee #14) mentioned that is partially driven by the fact that there is a lot of invested capital in machinery at the exporters and often these machines are running at 40-50% capacity. Considering exporters can process upwards of 23 tonnes of Robusta per hour, there is a huge volume of slack when not running at capacity (personal conversation, interviewee #2). Exporters then just want more volume and hope to get some average quality beans along with the additional volume of poor quality they receive. This was confirmed indirectly by the Managing Director of Exporter B (interviewee #10) who said that the industry is all about volume and their goal when working with farmers is yield improvement. The firm's participation in various sustainability certification schemes was largely to give them an opportunity to train farmers and hopefully boost yields. Anecdotally, the MD (interviewee #10) stated directly while the author was in the office to the Regional Sustainability Manager (interviewee #8) who was reporting some poor results after the latest audits that "failing certifications were irrelevant, just use the money to get more coffee coming out of the farms" (personal conversation, interviewee #10). In many ways, they were using sustainability schemes as a method of training farmers. That was the priority more so than creating a high value, certified product for which there were limited uncertain markets. In the best years, certified coffee represented some 5% of their total sales of coffee (personal conversation, interviewee #8). The focus on productivity was a real point: in Uganda productivity hovered around 10 bags / ha on average while in Vietnam Robusta producers were able to get some 40 bags / ha (personal conversation, interviewee #10).

The focus on volume also led to accepting more beans that were smaller than a quality roaster would want to buy. The industry expert (interviewee #14) said that "undergrades" (below screen 12, see Table 82 on page 408 below) still get a good price for producing instant coffee.

Before 1991 liberalisation, undergrades were no more than 2-3% of coffee produced in a given year, but now it is much higher—he estimates maybe 10% or more is an undergrade and not exportable (personal conversation, interviewee #14). Partially this is driven by an old tree stock as well which tend to produce more screen 12s and undergrades than trees in their prime (personal conversation, interviewee #3). In addition, traders often dry coffee with little effort and care because they know that (1) there will be a market even for the undergrades or broken pieces and (2) because it is difficult for the next trader or buyer to tell the quality of dried *kiboko* coffee. As a result, some traders drying operations look like that of Trader #5 shown in Figure 87. Such drying methods have obviously negative impacts on coffee that can only be mixed with acceptable coffee to have a chance of meeting export standards.

Note: Trader (left) drying *mbisi* coffee that is mostly unripe, contaminated by chicken faeces (right, bottom) and with obvious signs of mildew/mould damage (right, top) from poor drying techniques likely leading to higher mycotoxins levels than SPS regulations would allow in importing countries. Photos by author.

Figure 87: Example of poor quality coffee drying from Trader #5 in the HH survey

The Project Officer of NGO B (interviewee #7) perhaps summarized the situation best: "[it is] a lot of work to do agriculture and coffee needs to be worth it." There is a need to get farmers to work together to treat BTB with a financial penalty for non-compliance and an incentive to follow best practices. They need to be convinced it will work as well because currently many growers do not believe pruning and implementing GAPs is effective since their neighbours are not doing it (see section 7.2.3). Farmers organized into a cooperative, like NGO B's cooperative in Kamuli, did implement some best practices (e.g. fertilizing) at higher rates, suggesting that training may be effective at changing farmers' behaviour. There were some significant downsides to an NGO's running the cooperative, particularly a lack of sufficient operating capital to buy all of the members' coffee (see section 5.5.5).

Exporters are perhaps best positioned to organize farmers into effective associations and pass on quality information via traders about what the market is willing to pay. NGO B struggled when the grant money was gone, and the farmers could not afford to maintain certification (see section 5.5.5). Additionally, fundamentally, the NGO functioned as an institutional intermediary between the exporter and the growers; it was unclear how this structure could be supported on such small premiums for UTZ certified coffee (e.g. Exporter B could offer only 50 USh/kg to their associations). Though the farmers associations of Exporter B were not visited, the staff seemed to have a vast understanding of the market and connections to NGOs to help with their work of running farmer field schools. The effectiveness of different organizational structures for cooperatives is worthy of further investigation.

Many farmers sold wet coffee for immediate cash and to prevent theft (see sections 7.2.2). Exporter B and Start-up A (interviewee #19) independently setup washed Robusta producing cooperatives to offer farmers the ability to sell *mwanyi mbisi* while earning a premium price. The main difficulty was the logistics of getting ripe coffee processed in a timely manner (see discussion in Appendix A.26.1). A potential solution to resolve the issue of farmers selling wet coffee as well as the difficulty of transportation to a central processing hub is to develop a mobile processing unit. Exporter B Sustainability Manager (interviewee #8) recommended a mobile buying unit complete with a processor, quality manager, buying manager, and some security could function quite well in the coffee trade. The mobile unit could travel around during the harvest season. This would solve the additional issue of traders mixing coffee and limiting the traceability of quality coffee to a given farm. With the mobile unit, quality premiums could be given at purchase and good producers identified in order to establish deeper and more consistent business relationships. Although, there is limited scale to a washed Robusta operation due to a lack of demand, it could work well for a small community that has identified a premium buyer.

From the farmer workshop on ideal supply chains (section 5.5.7). It was clear that farmers are well informed about the state of the current supply chain and believe an ideal supply chain reduces the number of intermediaries. Additionally, groups agreed that only selling *kiboko* is the best option for growers. Farmers as well have strong views on what a "fair" price for their coffee should be. This price expectation was actually one of the strongest predictors of coffee farmers' investment and abandonment behaviour for coffee (see sections 5.5.7 and 7.2.5). These results showed that it is important to consider whether farmers will stay in a given agricultural market when a disease incident occurs. Like other small businesses, growers use some form of cost-benefit to decide whether their effort is best used on their current cropping pattern. The impact from an SPS incident can have long-lasting market effects. While CWD killed around half of the Robusta trees in Uganda during its peak decade of impact, the long-term effects on growers' decision-making is arguably more important. The emergence of BTB and the low-levels of implementing best practices on coffee plots could reflect farmers divesting effort away from a crop they feel is no longer reliable. Part of the driver towards abandonment of coffee though is also price. Farmers with higher expectations on a fair price than the market price were more likely to stop planting seedlings (section 7.2.5).

The survey found that coffee growers are more risk-seeking than the average Ugandan population given the same risk preferences choices by Tanaka & Munro (2014). The traders were significantly more risk-averse than farmers, switching over one row later on average (see section 6.4.2). Income had no impact on risk-aversion for farmers, and weakly significant impact for wealthier traders who reported higher risk-seeking. Like the literature on experimental games' ability to predict behaviour, this study found mixed effects. The number of risky choices (NRC) the farmers made were a good predictor of the number of other crops farmers' chose to invest in (see section 7.2.4); the risk-averse farmers were more likely to diversify. However, NRC had no predictive power over any of the three behaviours on the plot (fertilizing, following GAPs, or spraying) or the decision to exit coffee production (see sections 7.2.3 and 7.2.5 respectively).

Social connections seemed to have strong relations to behaviour and outcomes from selling coffee. Farmers who reported consulting more social ties when making decisions on their coffee farms were more likely to plant seedlings (see section 7.2.5). Additionally, farmers who consulted no one were most likely to sell wet coffee, missing value addition from processing (see section 7.2.1). Those farmers that did decide to sell dried *kiboko* were more likely to make the UCDA mandated decision to dry on a tarp when they reported consulting more of their social ties. These results have relation to gender as well. Single females are a distinct group that was found to be most often isolated from consulting supply chain actors and other social ties (see section 7.2.1). They were also most likely to sell wet coffee and for the ones that did sell *kiboko*, often dried it on the ground. All decisions that result in a lower price for coffee.

All stakeholders agreed unanimously that BTB and CWD are the top priority pests (see section 6.4.1). While stakeholders in the supply chain besides growers and traders were more worried about BTB, Buikwe farmers and traders both still felt that CWD was slightly more damaging to production. It is clear that this beach in SPS restrictions at the border created lasting damage to the coffee industry in Uganda, which may only be matched by a subsequent introduction of BTB in recent years. Beyond these top two pests/diseases, the next group of pests/diseases were RBD and CBB. Except for the Kamuli growers that ranked them approximately equally, the other groups agreed that RBD was more of a threat to the coffee supply chain than CBB. Overall, it seems information on pests and diseases do flow between actors in the supply chain. For the exporters, this is facilitated by some of their employees' direct involvement in organizing farmers' associations. There is prioritization of pest/disease concerns the further the actors are away from production, but not enough data was collected to make firm conclusions.

Several data collected were not fully analysed. The distance between growers and town features such as the coffee-milling factory in Nkokonjeru could be measured since GPS coordinates were collected. It is likely that farmers in more remote villages were offered lower prices for their coffee and faced higher barriers to milling on their own due to transport costs. Unfortunately, the road conditions outside the home were not recorded in the survey, and too low resolution on Google Earth to distinguish between wet and dry season conditions or quality of the road. A subsequent study of the impact of location and transport costs should be conducted in this area with a new survey taking into account several factors. (1) The conditions of the road from the village to the town centre, (2) the different transport options available to the farmer[208], and (3) qualitative questions about what they see as barriers to getting a higher price for their coffee. Such a study could help to elucidate the drivers of the very different

[208] The current survey did not distinguish between motorcycle and vehicle ownership. It also did not ask about bicycle ownership.

prices offered farmers in the present survey. Since the GPS locations of the farmers and traders were recorded, it would be relatively easy to conduct a follow-up survey asking further questions about their practices and collecting new data about the conditions affecting transport.

To augment the work on social connections, each of the farmers at the workshop was asked for up to 10 people that they went to for advice and up to 10 people that came to them for advice. Since many of the farmers who participated in the workshop were also interviewed in the HH survey, it is possible to match their social connections to the data collected in the HH survey. A social network map—similar to the work of Conley & Udry (2010) for pineapple farmers in Ghana—could then be created to get a better understanding of the connectedness of the farmers and if the more connected farmers in the social network are indeed performing better in coffee production.

One point that was very poorly understood was the impact (and actual numbers) of free seedlings distributed by NAADS. A follow up survey when a distribution occurs would be needed. It would be interesting to test whether farmers (1) improve practices after receiving training and getting seedlings and (2) if it causes them to devote more of their plot to coffee production.

Chapter 8. Conclusion and Future Work

Agricultural exports are an increasingly important part of agricultural production and a key economic development area for hundreds of millions of farmers in emerging economies (Cheong, Jansen & Peters, 2013). Quality standards and safety regulations are critical for mitigating the risks that come from imports of agricultural products, but these measures can be used arbitrarily to protect domestic producers. The overarching aims of this thesis were to (1) analyse the use of import risk-mitigation measures employed by nations under the SPS agreement and to (2) investigate the risk perceptions and actions of stakeholders in a case study where SPS policy failed to keep out damaging plant pests and diseases.

SPS regulations serve a necessary function to protect a country's producers and ability to export products at prices commensurate with quality production. The lack of mitigating against import risks from neighbouring countries were highlighted in the case study of Ugandan coffee. Uganda's paucity of SPS institutional capacity and control at the border allowed in foreign pests, which forever changed the structure of the coffee industry. It is important to design SPS regulations that consider the potential impacts that pests will have on the decision-making of producers. Despite the potential difficulties that developing countries face in legal challenges to their SPS notifications shown in Chapter 3, active participation in the system to mitigate import risks is important. On the export side for Uganda, while not explored in the present research, working with importers of Ugandan coffee to develop a control point framework to address SPS issues where they occur in the supply chain could help to alleviate importers concerns about quality and mitigate the price impact from perceptions of product risk.

All five objectives given in the introduction (section 1.2) were achieved in the pursuit of the first aim. (1) Both the theoretical and empirical literature on the evidence of policy substitution of NTM measures for lost tariff protection is reviewed in section 2.4. (2) Econometric tests of this substitution for SPS and TBT measures is thoroughly analysed, given the constraints of the data reporting systems, with results reported in sections 2.8 and 2.10. (3) Disagreements that have arisen in the implementation of the SPS and TBT agreement are summarized in section 3.5. Statistical models analysing the determinants of these Specific Trade Concerns are utilized and the results are reported in section 3.6. (4) Whether developing countries struggle to resolve claims they raise is scrutinized in section 4.4. Lastly (5), on a subset of SPS STCs regarding plant health, section 4.5 examines the specific reasons countries give when they raise a concern against another member's policies.

In pursuit of the second aim, all seven objectives—outlined in section 1.2—were met. (1) Stakeholders (19 in total) were interviewed from all different levels of the Robusta coffee supply chain in Uganda and a household survey of 119 farmers and 89 traders was completed (see section 5.3). (2) The differences in production outcomes and behaviours for farmers organized in cooperatives and independently were analysed in sections 5.5.3 and 5.5.4 with more qualitative discussion in sections 5.5.5 and 5.5.6. (3) The coherence of pest priority views among different stakeholders in the supply chain was examined in section 6.4.1. (4) Risk-aversion of coffee growers was measured in section 6.4.2 and the impact of risk preferences on the behavioural decision to abandon investment in coffee production was analysed in section 7.2.5. (5) Coffee growers' views on fair prices for coffee was examined both in the household survey and in a workshop (results in section 5.5.7); the impact of that view on coffee abandonment behavioural choices was analysed in section 7.2.5. (6) In a workshop, a novel game developed by the author was piloted and the opinions of farmers on their interest in stable price contracts were examined in section 6.4.3. Finally, (7) the results of various factors including measures of social networks (section 7.2.1) from the household survey were used to analyse the determinants of exiting the production of coffee in section 7.2.5.

Every year disease and pest outbreaks, of varying intensity, occur throughout the world from both unpredictable occurrences and known underlying risks. Once established, they can have devastating consequences for an agricultural industry—affecting both short-term output and long-term decisions of growers of that crop. In the case of Uganda, CWD caused extensive damage that may be exceeded only by the contemporary outbreak of BTB. Both issues likely originated in the Democratic Republic of Congo and became established in Uganda due to poor SPS measures at the border. The importance of effective SPS and TBT policies are clear, but are difficult to implement without some disagreement among WTO members. While conclusions are included at the end of each chapter, some key results are highlighted below.

Chapter 2: Environmental Protection or Protectionism?

Results showed robustly that with a decline in bound tariff the probability and number of SPS measures issued in subsequent years increases. Liberalisation was a driver for some countries to issue TBT measures, but the results were not robust to more refined modelling specifications. Additionally, it was found that countries that have higher environmental governance metrics, more complete democracies, better regulatory quality, and older populations were also more likely to issue SPS measures.

Chapter 3: Patterns of Trade Concerns in SPS/TBT Use

The decline of bound tariffs does not predict the issuing of an SPS measure that will later become subject to a STC. These results suggest that the relation between tariffs and SPS measures use is perhaps driven by a regulatory workload selection bias, but that the measures that are implemented are deemed fair for the most part by other WTO members.

Chapter 4: STC Resolution and Plant Health Cases

As expected from the literature on WTO and GATT disputes, there was some evidence that developing countries were less likely to resolve concerns they raise against developed country trade partners. The reasons behind the increasing number of SPS STCs that are left unresolved each year is worthy of future research, to determine issues and practices that could improve consensus and cooperation among members. Complaints that were scientific in nature for plant health STCs took longer to resolve, but the resolution rate was not different from that of economics-based STCs.

Chapter 5: A Case Study of Responses to SPS Issues

Cooperatives appear to achieve higher yields than independent farmers do, but this result deserves further scrutiny to test if more able farmers self-select into cooperatives or what the drivers within the cooperative are that lead to better production results, and whether the results are sustainable.[209] Cooperative farmers were also more likely to consult other stakeholders for advice. Robusta coffee certification schemes are not able to generate the premium from importers that would be required to adequately boost farm gate prices to the level farmers reported as their “fair” price.

[209] A recent review by the International Initiative for Impact Evaluation of 500 farmer field school projects suggested that field schools often achieve production results that are not possible to maintain beyond the project timeline or at scale for a wider community (Waddington & White, 2014). It is likely many of the learnings from this study apply generally to the benefits of cooperatives as well, many of which—including NGO B in Kamuli District—use the farmer field school method for training.

Chapter 6: Risk-aversion of Coffee Farmers and Traders

Coffee growers are more risk-seeking than traders and more risk-seeking than the general population of Uganda; this is likely explained by self-selection or habituation to coffee production which is a high-risk, high-reward crop (Hill, 2009). A pest survey confirmed stakeholders have similar views on the top two priority pests, but stakeholders further down the supply chain prioritize information and disregard the importance of other pests/diseases. Preliminary evidence from a coffee market simulation suggests that growers are interested and willing to accept lower income in good years with a fixed-price contract in order to smooth out the bad price years for coffee.

Chapter 7: Income Diversification and Decision-making

Growers do not specialize in coffee and are adept at re-evaluating whether they should remain producing the crop or abandon investment in it. More risk-averse farmers are expected to have marginally more income sources. The most robust factors for determining abandoning of coffee production were (1) the magnitude of the difference between the current price and the adequate price a grower reported for coffee, and (2) the number of social connections consulted for advice about coffee growing decisions.

8.1. FUTURE DIRECTIONS OF RESEARCH

There are two potential projects extending the current work. The first is to analyse the impact of trade facilitating SPS measures. There is a tremendous amount of econometric estimation of the trade impact (or tariff equivalent) of SPS measures (see section 2.4 for review). However, to the author's knowledge, there has not been analysis of measures that are marked as "trade facilitating" by the country notifying them in the SPS-IMS. There were 274 such measures from 1996 to 2010, which were excluded from the analysis of Chapter 2. Perhaps the mixed findings in the literature on the trade impact from SPS measures are due to the lack of good indication of the expected effect of the measure. An estimation of the trade enhancing effect of SPS measures meant to facilitate trade would help put a more nuanced view on their trade impact. On a related note, the EU maintains a list of country-commodity combinations that have been identified for "reduced inspections" due to consistent acceptable quality coming from the country (i.e. a lack of interceptions at the border due to sanitary or phytosanitary violations). An analysis of the trade impact after the qualifying year could help better estimate the magnitude of the barrier resulting from inspections at the border, an aspect of the trade effect from SPS/TBT measures.

The second extension into a new research project would be a deep analysis of products rejected at the EU border due to failing to comply with SPS or TBT regulations. One goal would be to identify SPS/TBT measures that are implemented and notified that were effective at reducing subsequent border rejections. This would indicate that the new/changed SPS/TBT measures were effective at reducing the risk at the border. Alternatively, a second aim would be to observe if a product with increased border rejections is more likely to be subject to new/changed SPS measures in the following years by the importing country. The author obtained permission (see Appendix A.29) to use EU border rejection data, but was not able to obtain a product concordance to effectively merge the data from the food/agriculture rejection database[210] with trade and SPS notification data (see Appendix A.30). The non-food rejections data[211] are posted weekly in HTML tables on individual websites; the author created a methodology for scraping the data using publically available tools to get the data prepared for research. The research idea is more fully explained with some summary figures in Appendix A.28, the details for the process of acquiring the data are also demonstrated on the author's YouTube channel.[212]

8.2. FUTURE OF SPS, TBT, AND MULTILATERAL CONVERGENCE

The original mandate and economic justification for the WTO assumed that producers in importing countries would be the only stakeholders pushing for protectionism. Generally, the theoretical economic models show that consumers always benefit (i.e. prices go down, consumer surplus goes up, welfare increases) when trade becomes more free (assuming invasive species, food contaminates, etc. are effectively excluded). However, Hobbs & Kerr (2006) show that if consumers' value "credence attributes" of goods[213]—that an imported product may lack—then it can create an economic rationale for consumer-based protectionist desires. Labelling can address many of these issues, but the current rules of the TBT agreement

[210] The EU Rapid Alert System for Food and Feed (RASFF)
[211] The EU Rapid Alert System for non-Food Dangerous Products (RAPEX)
[212] Data scraping: <http://youtu.be/eXsRH2Sn7No> ; Preparing the data: <http://youtu.be/iZJR9RanlIs>
[213] For example characteristics like knowing the good is not genetically modified or produced using child labour.

(and SPS agreement) prevent countries from acting on consumer-led pressure unless there is a valid risk-based justification for imposing a policy (Hobbs & Kerr, 2006). Economic integration further forces countries to work on harmonization of standards, which pitches different societal understandings of risk against each other. Unlike a tariff on which every nation can agree on a definition, the ideas of "safe food" or appropriate "precautionary" measures are more difficult to get universal consensus. Food and agriculture also have cultural values that make the topic even more difficult compared to discussing appropriate protections for products like steel or furniture. Multilateral consensus is more challenging as a result.

The trend towards plurilateral agreements has been happening for some time, augmented by the stalled multilateral Doha Round talks. The newest plurilateral agreement currently under negotiation is the Trans-Pacific Partnership (TPP); a free trade agreement among Asia-Pacific nations.[214] The TPP has potential to set the tone of future TBT and SPS policies around the world. The hope according to Darci Vetter, Deputy Under Secretary for the United States Department of Agriculture (USDA) is to harmonize on a framework for evaluating risks as opposed to the actual measures taken (Vetter, 2014).[215] The TTP allows a set of countries to achieve facilitated SPS standards across the major markets of TPP members in a way that developing countries would likely not accept in a multilateral agreement of the WTO (Vetter, 2014). However, most parties believe that the results of the TPP will set the standard for any new agreement in the WTO involving SPS and TBT measures (Lamy, 2014; Vetter, 2014).

US industry groups in particular have lobbied for a stronger SPS agreement within the TPP. In particular, they push for "enforceable SPS commitments" with strict dispute settlement mechanisms. As well, they argue for the development of a Rapid Response Mechanism to resolve SPS disputes on a "specific shipment of perishable goods" (Inside U.S. Trade, 2013). Another change US industry groups are pushing for is standardization of laboratory protocols to confirm contamination, along with a mechanism for an exporter to challenge any test result, requiring an immediate confirmation test by the importer. The overall goal is to raise the standard for what qualifies as "scientific-evidence" and set rigid guidelines that all parties agree

[214] Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, USA and Vietnam

[215] The author was an attendee at the Forum on the Future of Agriculture (FFA) in Brussels on 1, April, 2014. The citations reflect that each session was video recorded, so all comments made by speakers can be viewed online.

on as a “fair” assessment of risk. The drive from the US to enforce rigid definitions on scientific evidence follows the results of the types of STCs they have been raising in plant health (see Chapter 4). Such a change leaves less room for countries to argue for their SPS policies and some nations, Australia in particular, have said they do not support changing the SPS agreement from the WTO standard (Inside U.S. Trade, 2012). A thorough review of US interests and the status of SPS issues in the TPP can be found in Johnson (2014), but in short the future of the multilateral trading system as well as the future of the SPS/TBT agreement are uncertain. Understanding the current dynamics of the SPS/TBT system is thus even more important to address the shortcomings for the new policy undertakings.

Works Cited

Abraham, C. (2004) Uganda's vanilla boom: Uganda is currently experiencing a vanilla boom. And growers are laughing all the way to the bank. Curtis Abraham reports from Kampala. *The Free Library*. [Online] (Available at: http://www.thefreelibrary.com/Uganda's+vanilla+boom%3a+Uganda+is+currently+experiencing+a+vanilla...-a0115628127>), [Accessed: 25 June 2014].

Aker, J. & Mbiti, I. (2010) Mobile phones and economic development in Africa. *Center for Global Development Working Paper*. (211).

Aksoy, A. & Ng, F. (2010) The Evolution of Agricultural Trade Flows. *World Bank Policy Research Working Paper Series*. WP5308.

Alavi, A. (2007) African countries and the WTO's Dispute Settlement Mechanism. *Development Policy Review*. 25 (1), 25–42.

Aliga, I. (2013) Lwengo farmer uses sugar and animal bones to fight black twig borer. *Daily Monitor*. [online] October 9. (Available at: http://www.monitor.co.ug/Magazines/Farming/Lwengo-farmer-uses-sugar-animal-bones-to-fight-black-twig-borer/-/689860/2024230/-/7ajigfz/-/index.html), [Accessed 28 Nov 2013].

Almeida, I. (2012) Robusta Coffee Supplies May Match Demand, Armajaro Says. *Bloomberg Businessweek*. [Online] March 28. (Available at: http://buswk.co/GYGXQA), [Accessed: 10 Mar 2014].

Anders, S.M. & Caswell, J.A. (2009) Standards as Barriers Versus Standards as Catalysts: Assessing the Impact of HACCP Implementation on U.S. Seafood Imports. *American Journal of Agricultural Economics*. [Online] 91 (2), 310–321. Available from: doi:10.1111/j.1467-8276.2008.01239.x.

Andersen, S., Harrison, G.W., Lau, M.I. & Rutström, E.E. (2006) Elicitation using multiple price list formats. *Experimental Economics*. 9 (4), 383–405.

Anderson, J.R. (1971) Economic aspects of spatial diversification of sheep enterprises in the pastoral zone. *Review of Marketing and Agricultural Economics*. 39 (04).

Anderson, J.R. (2003) Risk in rural development: challenges for managers and policy makers. *Agricultural Systems*. 75 (2), 161–197.

Anderson, K. & Martin, W. (2005) Agricultural trade reform and the Doha Development Agenda. *The World Economy*. 28 (9), 1301–1327.

Anderson, S.P. & Schmitt, N. (2003a) Nontariff barriers and trade liberalization. *Economic Inquiry*. 41 (1), 80–97.

Anderson, S.P. & Schmitt, N. (2003b) Nontariff barriers and trade liberalization. *Economic Inquiry*. 41 (1), 80–97.

Arellano, M. & Bover, O. (1995) Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*. 68 (1), 29–51.

Arrow, K.J. (1971) *Essays in the theory of risk-bearing*. North-Holland Publishing Company Amsterdam, London.

Asiedu, E. & Lien, D. (2011) Democracy, foreign direct investment and natural resources. *Journal of International Economics*. 8499–111.

Austin, E., Willock, J., Deary, I., Gibson, G., et al. (1998) Empirical models of farmer behaviour using psychological, social and economic variables. Part I: linear modelling. *Agricultural Systems*. 58 (2), 203–224.

Avelino, J., Zelaya, H., Merlo, A., Pineda, A., et al. (2006) The intensity of a coffee rust epidemic is dependent on production situations. *Ecological Modelling*. 197 (3), 431–447.

Baldwin, R.E., McLaren, J. & Panagariya, A. (2000) Regulatory Protectionism, Developing Nations, and a Two-Tier World Trade System [with Comments and Discussion]. In: *Brookings Trade Forum*. 2000 pp. 237–293.

Barrett, C.B. (1994) Understanding uneven agricultural liberalisation in Madagascar. *The Journal of Modern African Studies*. 32 (03), 449–476.

Le Bars, M. & Le Grusse, P. (2008) Use of a decision support system and a simulation game to help collective decision-making in water management. *Computers and electronics in agriculture*. 62 (2), 182–189.

Barsky, R.B., Juster, F.T., Kimball, M.S. & Shapiro, M.D. (1997) Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study. *The Quarterly Journal of Economics*. 112 (2), 537–579.

Bauer, M. & Chytilová, J. (2010) The impact of education on subjective discount rate in ugandan villages. *Economic Development and Cultural Change*. 58 (4), 643–669.

Baylis, K., Nogueira, L. & Pace, K. (2012) Something Fishy in Seafood Trade? The Relationship between Tariff and Non-Tariff Barriers. *International Agricultural Trade Research Consortium*. New Rules of Trade?, December 2012, San Diego, California.

BBC News Business (2014) WTO members fail to agree global trade deal . *BBC*. [Online] August 1. (Available at: http://bbc.in/WQb1qP), [Accessed: 2 August 2014].

Bechtel, M.M., Bernauer, T. & Meyer, R. (2012) The green side of protectionism: environmental concerns and three facets of trade policy preferences. *Review of International Political Economy*. 19 (5), 837–866.

Beghin, J.C. & Melatos, M. (2011) The Trade and Welfare Impact of Australian Quarantine Policies: The Case of Pigmeat. *Staff General Research Papers*.

Bhagwati, J. (1988) *Protectionism*. The MIT Press.

Bhattacharyya, S. & Hodler, R. (2010) Natural resources, democracy and corruption. *European Economic Review*. 54 (4), 608–621.

Bhavnani, R. & Backer, D. (2000) Localized Ethnic Conflict and Genocide Accounting for Differences in Rwanda and Burundi. *Journal of Conflict Resolution*. 44 (3), 283–306.

Bindhe, E. (2014) Coffee Mealybug Threatens Rakai Farm. *Uganda Radio Network*. [Online] Jan. 13th. (Available at: http://ugandaradionetwork.com/a/story.php?s=59985), [Accessed: 03 April 2014].

Bolwig, S. & You, L. (2007) Quality or volume? An economic evaluation of coffee development strategies for Uganda. *Development in Practice*. 17 (3), 433–438.

Bourdieu, P. (1986) The forms of capital. *Handbook of theory and research for the sociology of education*. 241.

Bown, C.P. (2004a) Developing countries as plaintiffs and defendants in GATT/WTO trade disputes. *The World Economy*. 27 (1), 59–80.

Bown, C.P. (2004b) On the economic success of GATT/WTO dispute settlement. *Review of Economics and Statistics*. 86 (3), 811–823.

Bown, C.P. (2005) Participation in WTO dispute settlement: Complainants, interested parties, and free riders. *The World Bank Economic Review*. 19 (2), 287–310.

Bown, C.P. (2004c) Trade disputes and the implementation of protection under the GATT: an empirical assessment. *Journal of International Economics*. 62 (2), 263–294.

Bown, C.P. & Hoekman, B.M. (2005) WTO dispute settlement and the missing developing country cases: engaging the private sector. *Journal of International Economic Law*. 8 (4), 861–890.

Brandt, P.T. & Schneider, C.J. (2007) So the reviewer told you to use a selection model? Selection models and the study of international relations. *Unpublished manuscript*. 4 (23), 07.

Buchler, S., Smith, K. & Lawrence, G. (2010) Food risks, old and new demographic characteristics and perceptions of food additives, regulation and contamination in Australia. *Journal of Sociology*. 46 (4), 353–374.

Bureau, J.C., Marette, S. & Schiavina, A. (1998) Non-tariff trade barriers and consumers' information: The case of the EU-US trade dispute over beef. *European Review of Agricultural Economics*. 25 (4), 437.

Busch, M.L. (2000) Democracy, Consultation, and the Paneling of Disputes under GATT. *Journal of Conflict Resolution*. 44 (4), 425–446.

Busch, M.L. & Reinhardt, E. (2006) Three's a crowd: third parties and WTO dispute settlement. *World Politics*. 58 (03), 446–477.

Bussolo, M., De Hoyos, R. & Medvedev, D. (2011) Free Trade in Agriculture and Global Poverty. *The World Economy*. 34 (12), 2019–2043.

Calvin, L., Krissoff, B. & Foster, W. (2008) Measuring the costs and trade effects of phytosanitary protocols: a US-Japanese apple example. *Applied Economic Perspectives and Policy*. 30 (1), 120.

Cameron, A.C. & Trivedi, P.K. (2009) *Microeconometrics using stata*. Stata Press College Station, TX.

Campbell, H.R. & Coombes, B.L. (1999) Green protectionism and organic food exporting from New Zealand: crisis experiments in the breakdown of Fordist trade and agricultural policies. *Rural Sociology*. 64 (2), 302–319.

Chapagain, A.K. & Hoekstra, A.Y. (2004) Water footprints of nations. *UNESCO-IHE Institute for Water Education*.

Charlier, C. & Rainelli, M. (2002) Hormones, risk management, precaution and protectionism: an analysis of the dispute on hormone-treated beef between the European Union and the United States. *European Journal of Law and Economics*. 14 (2), 83–97.

Chaves, B. & Riley, J. (2001) Determination of factors influencing integrated pest management adoption in coffee berry borer in Colombian farms. *Agriculture, Ecosystems & Environment*. 87 (2), 159–177.

Chen, C., Yang, J. & Findlay, C. (2008) Measuring the effect of food safety standards on China's agricultural exports. *Review of World Economics*. 144 (1), 83–106.

Cheong, D., Jansen, M. & Peters, R. (2013) *Shared Harvests: Agriculture, Trade, and Employment*. International Labour Office, United Nations Conference on Trade Development.

Cheyns, E., Mrema, H. & Sallée, B. (2006) Socio-economic study of the Ugandan coffee chain. *FAO*.

Chloupkova, J., Svendsen, G.L.H. & Svendsen, G.T. (2003) Building and destroying social capital: The case of cooperative movements in Denmark and Poland. *Agriculture and Human values*. 20 (3), 241–252.

Coleman, J. (1989) Social capital in the creation of human capital. *American Journal of Sociology*. 94(Suppl) pp. S95–S120.

Conley, T. & Udry, C. (2001) Social learning through networks: The adoption of new agricultural technologies in Ghana. *American Journal of Agricultural Economics*. 668–

673.

Conley, T.G. & Udry, C.R. (2010) Learning about a new technology: Pineapple in Ghana. *The American Economic Review*. 100 (1), 35–69.

Costinot, A. (2008) A comparative institutional analysis of agreements on product standards. *Journal of International Economics*. 75 (1), 197–213.

Crivelli, P. & Gröschl, J. (2012) SPS measures and trade: Implementation matters. *WTO Staff Working Paper*. No. ERSD-2012-05.

Crous, P.W., Gams, W., Stalpers, J.A., Robert, V., et al. (2004) MycoBank: an online initiative to launch mycology into the 21st century. *Studies in Mycology*. 50 (19-22), 22.

Damon, A. (2000) A review of the biology and control of the coffee berry borer, Hypothenemus hampei (Coleoptera: Scolytidae). *Bulletin of Entomological Research*. 90 (6), 453–466.

Davis, A.P., Govaerts, R., Bridson, D.M. & Stoffelen, P. (2006) An annotated taxonomic conspectus of the genus Coffea (Rubiaceae). *Botanical Journal of the Linnean Society*. 152 (4), 465–512.

Davis, C.L. & Bermeo, S.B. (2009) Who files? Developing country participation in GATT/WTO adjudication. *Journal of Politics*. 71 (3), 1033–1049.

Dercon, S. (2008) Fate and fear: Risk and its consequences in Africa. *Journal of African Economies*. 17 (suppl 2), ii97–ii127.

Dercon, S. (2002) Income risk, coping strategies, and safety nets. *The World Bank Research Observer*. 17 (2), 141–166.

Devitt, P. & Szary, W. (2014) Warsaw says Russian ban on Polish produce is revenge for EU sanctions. *Reuters*. [Online] July 30th. (Available at: http://reut.rs/1kmoctW), [Accessed: 2 Aug 2014].

Disdier, A.C., Fontagné, L. & Mimouni, M. (2008) The impact of regulations on agricultural trade: evidence from the SPS and TBT agreements. *American Journal of Agricultural Economics*. 90 (2), 336.

Disdier, A.C. & van Tongeren, F. (2010) Non-tariff measures in agri-food trade: what do the data tell us? Evidence from a cluster analysis on OECD imports. *Applied Economic Perspectives and Policy*. 32 (3), 436–455.

Driesen, D.M. (2006) Environmental Protection, Free Trade, and Democracy. *The ANNALS of the American Academy of Political and Social Science*. 603 (1), 252.

Eckel, C.C. & Grossman, P.J. (2008) Men, women and risk aversion: Experimental evidence. *Handbook of experimental economics results*. 1 (7), 1061–1073.

Edwards, W. (1954) The theory of decision making. *Psychological bulletin*. 51 (4), 380.

Van Egmond, H.P., Schothorst, R.C. & Jonker, M.A. (2007) Regulations relating to mycotoxins in food. *Analytical and bioanalytical chemistry*. 389 (1), 147–157.

Egonyu, J., Kucel, P., Kangire, A., Sewaya, F., et al. (2009) Impact of the black twig borer on Robusta coffee in Mukono and Kayunga districts, central Uganda. *Journal of Animal and Plant Sciences (JAPS)*. 3 (1), 163–169.

Elamin, E.M. & Rogers, L.F. (1992) Estimation and use of risk aversion coefficient for traditional dryland agriculture in western Sudan. *Agricultural Economics*. 7 (2), 155–166.

Elbakidze, L. (2008) Modeling of avian influenza mitigation policies within the backyard segment of the poultry sector. *Journal of Agricultural and Resource Economics*. 195–211.

Emerson, J., Esty, D.C., Levy, M.A., Kim, C.H., et al. (2010) *2010 Environmental Performance Index*. [Online] (Available at: http://epi.yale.edu/resource-category/2010-epi-materials), [Accessed: 20 Aug. 2011].

Errington, A. (1986) The delegation of decisions on the farm. *Agricultural Systems*. 19 (4), 299–317.

Escalada, M. & Heong, K. (2004) A participatory exercise for modifying rice farmers' beliefs and practices in stem borer loss assessment. *Crop Protection*. 23 (1), 11–17.

Esty, D.C., Levy, M.A., Srebotnjak, T. & de Sherbinin, A. (2005) *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. [Online] (Available at: http://www.yale.edu/esi/), [Accessed: 20 Aug. 2011].

Eswaran, M. & Kotwal, A. (1990) Implications of credit constraints for risk behaviour in less developed economies. *Oxford Economic Papers*. 42 (2), 473–482.

Etienne, M., Du Toit, D.R. & Pollard, S. (2011) ARDI: a co-construction method for participatory modeling in natural resources management. *Ecology and Society*. 16 (1), 44.

Fafchamps, M. & Hill, R.V. (2008) Price transmission and trader entry in domestic commodity markets. *Economic Development and Cultural Change*. 56 (4), 729–766.

Fafchamps, M. & Lund, S. (2003) Risk-sharing networks in rural Philippines. *Journal of Development Economics*. 71 (2), 261–287.

FAOSTAT (2014) *FAOSTAT Gateway*. [Online] (Available at: http://faostat3.fao.org/home/), [Accessed: 24 June 2014].

Farzin, Y.H. & Bond, C.A. (2006) Democracy and environmental quality. *Journal of Development Economics*. 81 (1), 213–235.

Feinberg, R.M. & Reynolds, K.M. (2007) Tariff liberalisation and increased administrative protection: is there a quid pro quo? *The World Economy*. 30 (6), 948–961.

Feinerman, E. & Finkelshtain, I. (1996) Introducing socioeconomic characteristics into production analysis under risk. *Agricultural Economics*. 13 (3), 149–161.

Flood, J. (2009) Introduction. In: Flood, Julie (ed.). *Coffee Wilt Disease*. CAB International, Wallingford, UK. pp. 1–6.

Fontagné, L., Mimouni, M. & Pasteels, J.M. (2005) Estimating the impact of environmental SPS and TBT on international trade. *Integration and Trade Journal*. 22 (3), 7–37.

Fontagné, L., Orefice, G., Piermartini, R. & Rocha, N. (2013) Product standards and margins of trade: Firm level evidence. *CEPII Centre D'Etudes Prospectives et D'Information Internationales, WP*. (2013-06).

Frederick, S., Loewenstein, G. & O'donoghue, T. (2002) Time discounting and time preference: A critical review. *Journal of economic literature*. 351–401.

Fredriksson, P.G., Neumayer, E., Damania, R. & Gates, S. (2005) Environmentalism, democracy, and pollution control. *Journal of environmental economics and management*. 49 (2), 343–365.

Fredriksson, P.G. & Wollscheid, J.R. (2007) Democratic institutions versus autocratic regimes: The case of environmental policy. *Public Choice*. 130 (3), 381–393.

Gawande, K. & Krishna, P. (2003) The political economy of trade policy: empirical approaches. *Handbook of International Trade*. 1139–152.

Geiser, D.M., Ivey, M.L.L., Hakiza, G., Juba, J.H., et al. (2005) Gibberella xylarioides (anamorph: Fusarium xylarioides), a causative agent of coffee wilt disease in Africa, is a previously unrecognized member of the G. fujikuroi species complex. *Mycologia*. 97 (1), 191–201.

Gigerenzer, G. & Goldstein, D.G. (1996) Reasoning the fast and frugal way: models of bounded rationality. *Psychological review*. 103 (4), 650.

Gollop, F.M. & Monahan, J.L. (1991) A generalized index of diversification: trends in US manufacturing. *The Review of Economics and Statistics*. 73 (2), 318–330.

Green, C.J. (1981) The New Protectionism. *Northwestern J. of Int. Law & Business*. 3 (1), 1–20.

Grossman, G.M. & Helpman, E. (1992) Protection for sale. *National Bureau of Economic Research* . Working Paper No. 4149Cambridge, Mass., USA.

Guzman, A.T. & Simmons, B.A. (2005) Power Plays and Capacity Constraints: The Selection of Defendants in World Trade Organization Disputes. *The Journal of Legal Studies*. 34 (2), 557–598.

Götz, C., Heckelei, T. & Rudloff, B. (2010) What makes countries initiate WTO disputes on food-related issues? *Food Policy*. 35 (2), 154–162.

Haack, R.A. & Brockerhoff, E.G. (2011) ISPM No. 15 and the incidence of wood pests: Recent findings, policy changes, and current knowledge gaps. *The International Research Group on Wood Protection*. 3 (IRG/WP 11-30568).

Hai, M.A., Stonehouse, J., Poswal, A., Mumford, J., et al. (2003) Losses of plums to theft in North-West Frontier Province, Pakistan. *Crop Protection*. 22 (6), 891–892.

Hakiza, G., DT, K., Musoli, P., Wetala, P., et al. (2009) Coffee Wilt Disease in Uganda. In: Flood, Julie (ed.). *Coffee Wilt Disease*. CAB International, Wallingford, UK. pp. 28–49.

Halbert, S.E. & Manjunath, K.L. (2004) Asian citrus psyllids (Sternorrhyncha: Psyllidae) and greening disease of citrus: a literature review and assessment of risk in Florida. *Florida Entomologist*. 87 (3), 330–353.

Hanrahan, C.E. (2010) Agricultural Biotechnology: the US-EU Dispute. *Congressional Research Service Reports*. Paper 69.

Hanson, J.L. (2008) Shared decision making: have we missed the obvious? *Archives of Internal Medicine*. 168 (13), 1368–1370.

Hansson, H. (2007) *Driving and restraining forces for economic and technical efficiency in dairy farms*. Swedish University of Agricultural Sciences. Uppsala, Sweden.

Hansson, H. & Ferguson, R. (2011) Factors influencing the strategic decision to further develop dairy production—A study of farmers in central Sweden. *Livestock Science*. 135 (2), 110–123.

Hellerstein, D., Higgins, N. & Horowitz, J. (2013) The predictive power of risk preference measures for farming decisions. *European Review of Agricultural Economics*. 1–27.

Henson, S. & Loader, R. (2001) Barriers to agricultural exports from developing countries: the role of sanitary and phytosanitary requirements. *World Development*. 29 (1), 85–102.

Henson, S., Loader, R., Swinbank, A., Bredahl, M., et al. (2000) *Impact of sanitary and phytosanitary measures on developing countries*. University of Reading, Department of Agricultural & Food Economics.

Henson, S., Masakure, O. & Cranfield, J. (2011) Do fresh produce exporters in sub-saharan Africa benefit from GlobalGAP certification? *World Development*. 39 (3), 375–386.

Heong, K. & Escalada, M. (1999) Quantifying rice farmers' pest management decisions: beliefs and subjective norms in stem borer control. *Crop Protection*. 18 (5), 315–322.

Heong, K., Escalada, M., Sengsoulivong, V. & Schiller, J. (2002) Insect management beliefs and practices of rice farmers in Laos. *Agriculture, Ecosystems & Environment*. 92 (2), 137–145.

Herberich, D.H. & List, J.A. (2012) Digging into background risk: experiments with farmers and students. *American Journal of Agricultural Economics*. 94 (2), 457–463.

Herrero, M., Thornton, P., Notenbaert, A., Wood, S., et al. (2010) Smart Investments in Sustainable Food Production: Revisiting Mixed Crop-Livestock Systems. *Science*. 327 (5967), 822–825.

Hill, R.V. (2010) Investment and abandonment behavior of rural households: an empirical investigation. *American Journal of Agricultural Economics*. 92 (4), 1065–1086.

Hill, R.V. (2009) Using stated preferences and beliefs to identify the impact of risk on poor households. *The Journal of Development Studies*. 45 (2), 151–171.

Hill, V.R. (2006) The role of risk in shaping production decisions: an empirical analysis. *Global Poverty Research Group*. GPRG-WPS-049.

Hindorf, H. & Omondi, C.O. (2011) A review of three major fungal diseases of Coffea arabica L. in the rainforests of Ethiopia and progress in breeding for resistance in Kenya. *Journal of Advanced Research*. 2 (2), 109–120.

Hobbs, J.E. & Kerr, W.A. (2006) Consumer information, labelling and international trade in agri-food products. *Food Policy*. 31 (1), 78–89.

Holt, C.A. & Laury, S.K. (2002) Risk aversion and incentive effects. *The American Economic Review*. 92 (5), 1644–1655.

Horn, H., Mavroides, P.C. & Wijkström, E.N. (2013) In the Shadow of the DSU: Addressing Specific Trade Concerns in the WTO SPS and TBT Committees. *IFN Working Paper*. No. 960.

Horn, H., Mavroidis, P.C. & Nordström, H. (1999) *Is the use of the WTO dispute settlement system biased?* Centre for Economic Policy Research.

Humphrey, S.J. & Verschoor, A. (2004) Decision-making under risk among small farmers in East Uganda. *Journal of African Economies*. 13 (1), 44–101.

IMF (2012) *World Economic Outlook*. [Online] (Available at: http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx), [Accessed: 27 May 2012].

Inkpen, A.C. & Tsang, E.W. (2005) Social capital, networks, and knowledge transfer. *Academy of Management Review*. 30 (1), 146–165.

Inside U.S. Trade (2012) Agriculture, Food Industry Seek WTO-Plus Rules For TPP SPS Chapter . *Inside U.S. Trade's World Trade Online*. [Online] May 16th. (Available at: http://insidetrade.com/201205162399024/WTO-Daily-News/Daily-News/agriculture-food-industry-seek-wto-plus-rules-for-tpp-sps-chapter/menu-id-948.html), [Accessed: 4 August 2014].

Inside U.S. Trade (2013) Food, Agriculture Groups Blast U.S. Approach To SPS Disputes In TPP . *Inside U.S. Trade's World Trade Online*. [Online] May 9th. (Available at: http://insidetrade.com/Inside-US-Trade/Inside-U.S.-Trade-05/10/2013/food-agriculture-groups-blast-us-approach-to-sps-disputes-in-tpp/menu-id-710.html), [Accessed: 4 August

2014].

Isaac, G.E. (2004) The SPS Agreement and Agri-food Trade Disputes: The Final Frontier. *The Estey Centre Journal of Law and Trade Policy*. 5 (1), 43–55.

J.C., B. & Bureau, J.C. (2001) Quantitative policy analysis of sanitary, phytosanitary and technical barriers to trade. *Économie internationale*. 3 (87), 107–130.

James, S. (2000) An economic analysis of food safety issues following the SPS agreement: lessons from the hormones dispute. *CIES Working Paper No. 5*.

Jaramillo, J., Muchugu, E., Vega, F.E., Davis, A., et al. (2011) Some like it hot: the influence and implications of climate change on coffee berry borer (Hypothenemus hampei) and coffee production in East Africa. *PLoS One*. 6 (9), e24528.

Jenkins, S.P. (2008) *Estimation and interpretation of measures of inequality, poverty, and social welfare using Stata*. [Online] Available from: http://EconPapers.repec.org/RePEc:boc:asug06:16.

Jensen, N.M. & Shin, M.J. (2014) Globalization and Domestic Trade Policy Preferences: Foreign Frames and Mass Support for Agriculture Subsidies. *International Interactions*. 40 (3), 305–324.

Johnson, R. (2014) Sanitary and Phytosanitary (SPS) and Related Non-Tariff Barriers to Agriculture Trade. *Congressional Research Service (CRS).* 7-5700, R43450 (Available at: http://nationalaglawcenter.org/wp-content/uploads//assets/crs/R43450.pdf), [Accessed: 4 August 2014].

De Jonge, J., Van Trijp, H., Renes, R.J. & Frewer, L.J. (2010) Consumer confidence in the safety of food and newspaper coverage of food safety issues: a longitudinal perspective. *Risk Analysis*. 30 (1), 125–142.

Jongwanich, J. (2009) The impact of food safety standards on processed food exports from developing countries. *Food Policy*. 34 (5), 447–457.

Just, D.R., Khantachavana, S.V. & Just, R.E. (2010) Empirical challenges for risk preferences and production. *Annual Review of Resource Economics*. 2 (1), 13–31.

Just, D.R., Wolf, S. & Zilberman, D. (2003) Principles of risk management service relations in agriculture. *Agricultural Systems*. 75 (2), 199–213.

Kaaya, N. & Warren, H. (2005) A review of past and present research on aflatoxin in Uganda. *African J. of Food, Agriculture, Nutrition, and Development*. 5 (1).

Kahneman, D. & Tversky, A. (1979) Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*. 263–291.

Kalonji-Mbuyi, A., Tshilenge Djim, P. & Saiba, N.T. (2009) Coffee Wilt Disease in Democratic Republic of Congo. In: Flood, Julie (ed.). *Coffee Wilt Disease*. CAB

International, Wallingford, UK. pp. 7–27.

Kastner, J. & Powell, D. (2002) The SPS Agreement: Addressing historical factors in trade dispute resolution. *Agriculture and Human Values*. 19 (4), 283–292.

Kastner, J.J. & Pawsey, R.K. (2002a) Harmonising sanitary measures and resolving trade disputes through the WTO-SPS framework. Part I: a case study of the US-EU hormone-treated beef dispute. *Food Control*. 13 (1), 49–55.

Kastner, J.J. & Pawsey, R.K. (2002b) Harmonising sanitary measures and resolving trade disputes through the WTO-SPS framework. Part I: a case study of the US-EU hormone-treated beef dispute. *Food Control*. 13 (1), 49–55.

Kearney, S., Fonte, S.J., Salomon, A., Six, J., et al. (2012) Forty percent revenue increase by combining organic and mineral nutrient amendments in Ugandan smallholder market vegetable production. *Agronomy for Sustainable Development*. 32 (4), 831–839.

Kee, H.L., Neagu, C. & Nicita, A. (2013) Is protectionism on the rise? Assessing national trade policies during the crisis of 2008. *The Review of Economics and Statistics*. 95 (1), 342–346.

Kelemen, R.D. & Vogel, D. (2010) Trading places: The role of the United States and the European Union in international environmental politics. *Comparative Political Studies*. 43 (4), 427–456.

Kimbowa, J. (2013) ABi trust supports app to boost produce sale. *The Observer*. [Online] Oct. 17th. (Available at: http://www.observer.ug/index.php?option=com_content&view=article&id=28071&catid=79), [Accessed: 25 Nov 2014].

Kleiber, C. (2008) The Lorenz curve in economics and econometrics. *Advances on Income Inequality and Concentration Measures*. WWZ Working Paper 09/07.

Knight, F.H. (1921) Risk, uncertainty and profit. *New York: Hart, Schaffner and Marx.*

Knight, J., Weir, S. & Woldehanna, T. (2003) The role of education in facilitating risk-taking and innovation in agriculture. *The Journal of Development Studies*. 39 (6), 1–22.

Knowler, D. & Bradshaw, B. (2007) Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*. 32 (1), 25–48.

Kochar, A. (1999) Smoothing consumption by smoothing income: hours-of-work responses to idiosyncratic agricultural shocks in rural India. *Review of Economics and Statistics*. 81 (1), 50–61.

Kono, D.Y. (2006) Optimal obfuscation: Democracy and trade policy transparency. *American Political Science Review*. 100 (3), 369–384.

Kumschick, S. & Richardson, D.M. (2013) Species-based risk assessments for biological invasions: advances and challenges. *Diversity and Distributions*. 19 (9), 1095–1105.

Laird, S. & Yeats, A. (1990) Trends in non-tariff barriers of developed countries. *Weltwirtschaftliches Archiv*. 126 (2), 299–325.

Lamy, P. (2014) Opening Address at FFA 2014. *Forum for the Future of Agriculture (FFA)*. Brussels, Belgium. April 1. Speech. (Video transcript available at: http://www.forumforagriculture.com/ffa-tv.html).

Leach, M.C. & Hobbs, S.L. (2013) Plantwise knowledge bank: delivering plant health information to developing country users. *Learned Publishing*. 26 (3).

Li, Q. & Reuveny, R. (2006) Democracy and environmental degradation. *International Studies Quarterly*. 50 (4), 935–956.

Liu, L. & Yue, C. (2009) Non-tariff barriers to trade caused by SPS measures and customs procedures with product quality changes. *Journal of Agricultural and Resource Economics*. 34 (1), 196–212.

Long, J.S. & Freese, J. (2001) Predicted probabilities for count models. *The Stata Journal*. 1 (1), 51–57.

Loureiro, M.L. & Lotade, J. (2005) Do fair trade and eco-labels in coffee wake up the consumer conscience? *Ecological Economics*. 53 (1), 129–138.

Lunneryd, D. & Öhlmér, B. (2006) Problem detection and definition-the case of farmers' choice of organic milk production. In: *99th EAAE Seminar: Trust and Risk in Business Networks ', Bonn, Germany*. 2006 pp. 8–10.

MacDonald, G.K., Bennett, E.M. & Carpenter, S.R. (2012) Embodied phosphorus and the global connections of United States agriculture. *Environmental Research Letters*. 7 (4), 044024.

MacLeod, A., Pautasso, M., Jeger, M.J. & Haines-Young, R. (2010) Evolution of the international regulation of plant pests and challenges for future plant health. *Food Security*. 2 (1), 49–70.

Mahé, L.P. (1997) Environment and quality standards in the WTO: New protectionism in agricultural trade? A European perspective. *European Review of Agricultural Economics*. 24 (3-4), 480–503.

Malkin, E. (2014) A coffee crop withers: fungus cripples coffee production across Central America. *The New York Times*. [Online] May 5th. (Available at: http://nyti.ms/1kFalIK), [Accessed: 06 June 2014].

Mansfield, E.D. & Busch, M.L. (1995) The political economy of nontariff barriers: a cross-national analysis. *International Organization*. 49 (04), 723–749.

Marshall, M.G. & Gurr, R.T. (2011) *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2011*. [Online] (Available at: http://www.systemicpeace.org/polity/polity4.htm), [Accessed 10 Jan 2013].

Maskus, K.E., Wilson, J.S. & Otsuki, T. (2000) Quantifying the impact of technical barriers to trade: a framework for analysis. *Policy Research Working Paper Series.* WPS 2512.

McElduff, F., Cortina-Borja, M., Chan, S.-K. & Wade, A. (2010) When t-tests or Wilcoxon-Mann-Whitney tests won't do. *Advances in physiology education.* 34 (3), 128–133.

McKee, G.J., Goodhue, R.E., Zalom, F.G., Carter, C.A., et al. (2009) Population dynamics and the economics of invasive species management: the greenhouse whitefly in California-grown strawberries. *Journal of Environmental Management.* 90 (1), 561–570.

Van Mele, P., Cuc, N.T.T. & Van Huis, A. (2001) Farmers' knowledge, perceptions and practices in mango pest management in the Mekong Delta, Vietnam. *International Journal of Pest Management.* 47 (1), 7–16.

Melitz, M.J. (2003) The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica.* 71 (6), 1695–1725.

Mendez, V.E., Bacon, C.M., Olson, M., Petchers, S., et al. (2010) Effects of Fair Trade and organic certifications on small-scale coffee farmer households in Central America and Mexico. *Renewable Agriculture and Food Systems.* 25 (03), 236–251.

Menon, P. (2014) India tops list of countries to export pest-infested fruit: U.K. *The Hindu.* [Online] May 10. (Available at: http://www.thehindu.com/news/international/world/cameron-to-discuss-mango-ban-with-indian-pm/article5993522.ece), [Accessed: 11 May 2014].

Midlarsky, M.I. (1998) Democracy and the environment: An empirical assessment. *Journal of Peace Research.* 35 (3), 341.

Moore, M.O. & Zanardi, M. (2011) Trade liberalization and antidumping: is there a substitution effect? *Review of Development Economics.* 15 (4), 601–619.

Morse, S. & Fraser, E.D.G. (2005) Making "dirty" nations look clean? The nation state and the problem of selecting and weighting indices as tools for measuring progress towards sustainability. *Geoforum.* 36 (5), 625–640.

Mukherjee, S. & Chakraborty, D. (2010) Is environmental sustainability influenced by socioeconomic and sociopolitical factors? cross-country empirical evidence. *Sustainable Development.*

Mumford, J. (2002) Economic issues related to quarantine in international trade. *European Review of Agricultural Economics.* 29 (3), 329.

Mumford, J. & Norton, G. (1984) Economics of decision making in pest management. *Annual Review of Entomology.* 29 (1), 157–174.

Mussatto, S.I., Machado, E.M., Martins, S. & Teixeira, J.A. (2011) Production, composition, and application of coffee and its industrial residues. *Food and Bioprocess Technology*. 4 (5), 661–672.

Mwebaze, P., Monaghan, J., Spence, N., MacLeod, A., et al. (2010) Modelling the risks associated with the increased importation of fresh produce from emerging supply sources outside the EU to the UK. *Journal of Agricultural Economics*. 61 (1), 97–121.

Von Neumann, L.J. & Morgenstern, O. (1947) *Theory of games and economic behavior*. Princeton University Press, Princeton, NJ.

Neumayer, E. (2002) Do democracies exhibit stronger international environmental commitment? A cross-country analysis. *Journal of Peace Research*. 39 (2), 139.

Nicita, A. & Gourdon, J. (2013) A Preliminary Analysis on Newly Collected Data on Non-Tariff Measures. *United Nations Conference on Trade and Development, Policy Issues in International Trade and Commodities Study Series*. (Study Series No. 53).

Niels, G. & Francois, J. (2006) Business cycles, the exchange rate, and demand for antidumping protection in Mexico. *Review of Development Economics*. 10 (3), 388–399.

Ntow, W.J., Gijzen, H.J., Kelderman, P. & Drechsel, P. (2006) Farmer perceptions and pesticide use practices in vegetable production in Ghana. *Pest Management Science*. 62 (4), 356–365.

Nyarko, Y. & Schotter, A. (2002) An experimental study of belief learning using elicited beliefs. *Econometrica*. 70 (3), 971–1005.

NYSE-Euronext (2014) *Robusta Coffee Futures*. [Online]. 2014. Available from: https://globalderivatives.nyx.com/fr/products/commodities-futures/RC-DLON/contract-specification [Accessed: 28 February 2014].

Oerke, E.C. (2006) Crop losses to pests. *The Journal of Agricultural Science*. 144 (01), 31–43.

Öhlmér, B., Olson, K. & Brehmer, B. (1998) Understanding farmers' decision making processes and improving managerial assistance. *Agricultural Economics*. 18 (3), 273–290.

Oppenheim, A.N. (2000) *Questionnaire Design, Interviewing And Attitude Measurement*. Continuum.

Otsuki, T., Wilson, J.S. & Sewadeh, M. (2001) Saving two in a billion: quantifying the trade effect of European food safety standards on African exports. *Food Policy*. 26 (5), 495–514.

Page, S. (1987) The rise in protection since 1974. *Oxford Review of Economic Policy*. 3 (1), 37.

Pellegrini, L. & Gerlagh, R. (2006) Corruption, democracy, and environmental policy: an empirical contribution to the debate. *The Journal of Environment & Development*. 15 (3), 332–354.

Petersmann, E.U. (2006) Ten Years of the WTO Dispute Settlement System: Past, Present and Future. *Journal of International Law & Policy*. 3 (1), 2005–2006.

Peterson, E.B. & Orden, D. (2008) Avocado Pests and Avocado Trade. *American Journal of Agricultural Economics*. 90 (2), 321–335.

Pimentel, D., Zuniga, R. & Morrison, D. (2005) Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological economics*. 52 (3), 273–288.

Pratt, J.W. (1964) Risk aversion in the small and in the large. *Econometrica: Journal of the Econometric Society*. 122–136.

Pugh, D.S., Hickson, D.J., Hinings, C.R., Macdonald, K.M., et al. (1963) A conceptual scheme for organizational analysis. *Administrative Science Quarterly*. 289–315.

Putnam, R.D. (1995) Bowling alone: America's declining social capital. *Journal of democracy*. 6 (1), 65–78.

Rabin, M. (2000) Risk aversion and expected-utility theory: A calibration theorem. *Econometrica*. 68 (5), 1281–1292.

Raj, A. & Arvis, J. (2014) How Social Connections and Business Ties Can Boost Trade: An Application of Social Network Analysis. *The Trade Post (The World Bank Group).* [Online] April 28. (Available at: http://blogs.worldbank.org/trade/how-social-connections-and-business-ties-can-boost-trade-application-social-network-analysis), [Accessed: 30 July 2014].

Rajagopalan, N., Rasheed, A. & Datta, D.K. (1993) Strategic decision processes: Critical review and future directions. *Journal of Management.* 19 (2), 349–384.

Rantamäki-Lahtinen, L. (2009) The success of the diversified farm: resource-based view. *Agricultural and Food Science*. 18 (2009), Supplement 1.

Ray, E.J. (1987) Changing patterns of protectionism: The fall in tariffs and the rise in non-tariff barriers. *Northwestern J. of Int. Law & Business*. 8285.

Reyntjens, F. (1996) Rwanda: genocide and beyond. *Journal of Refugee Studies*. 9 (3), 240–251.

Richards, T.J., Shanafelt, D.W. & Fenichel, E.P. (2014) Foreclosures and Invasive Insect Spread: The Case of Asian Citrus Psyllid. *American Journal of Agricultural Economics.* 96 (3), 615–630.

Roberts, D. & Unnevehr, L. (2005) Resolving trade disputes arising from trends in food safety regulation: the role of the multilateral governance framework. *World Trade Review*. 4 (3), 469.

Rodrik, D. (1995) Political economy of trade policy. *Handbook of international economics.* 31457–1494.

Rosendorff, B.P. (1996) Voluntary export restraints, antidumping procedure, and domestic politics. *The American Economic Review*. 544–561.

Rosenzweig, M.R. & Binswanger, H.P. (1992) *Wealth, weather risk, and the composition and profitability of agricultural investments.* World Bank Publications.

Ruben, R. & Fort, R. (2012) The impact of fair trade certification for coffee farmers in Peru. *World Development*. 40 (3), 570–582.

Rudaheranwa, N., Guloba, M. & Nabiddo, W. (2007) Costs of Overcoming Market Entry Constraints to Uganda's Export-led Growth Strategy. *Economic Policy Research Centre (EPRC)*. Research Series No. 52.

Rueda, X. & Lambin, E.F. (2012) Linking globalization to local land uses: how eco-consumers and gourmands are changing the Colombian coffee landscapes. *World Development*. 41. 286–301.

Runge, C.F. (1990) Trade protectionism and environmental regulations: The new nontariff barriers. *Northwestern Journal of International Law & Business*. 1147–61.

Rutherford, M.A. (2006) Current knowledge of coffee wilt disease, a major constraint to coffee production in Africa. *Phytopathology*. 96 (6), 663–666.

Rutherford, M.A. & Phiri, N. (2006) *Pests and Diseases of Coffee in Eastern Africa: A Technical and Advisory Manual*. CAB International, Wallingford, UK.

Sattler, T. & Bernauer, T. (2010) Gravitation or discrimination? Determinants of litigation in the World Trade Organisation. *European journal of political research.* 50 (2), 143–167.

Schlaepfer, M.A., Sax, D.F. & Olden, J.D. (2011) The Potential Conservation Value of Non-Native Species. *Conservation Biology*. 25 (3), 428–437.

Schlueter, S.W., Wieck, C. & Heckelei, T. (2009) Regulatory SPS instruments in meat trade. In: *Paper at the IATRC Annual Meeting*. 2009 pp. 13–15.

Schoemaker, P.J. (1982) The expected utility model: Its variants, purposes, evidence and limitations. *Journal of Economic Literature*. 529–563.

Segura, H., Barrera, J., Morales, H. & Nazar, A. (2004) Farmers' perceptions, knowledge, and management of coffee pests and diseases and their natural enemies in Chiapas, Mexico. *Journal of economic entomology*. 97 (5), 1491–1499.

Sekamatte, M. & Okwakol, M. (2007) The present knowledge on soil pests and pathogens in Uganda. *African Journal of Ecology*. 45 (s2), 9–19.

Shanghai Daily (2014) S. African trade union threatens mass action against EU. *ShanghaiDaily.com*. [Online] July 1. (Available at:

http://www.shanghaidaily.com/article/article_xinhua.aspx?id=227468), [Accessed: 29 July 2014].

Sick, D. (2008) Coffee, Farming Families, and Fair Trade in Costa Rica: New Markets, Same Old Problems? *Latin American Research Review*. 43 (3), 193–208.

Simberloff, D., Martin, J.-L., Genovesi, P., Maris, V., et al. (2012) Impacts of biological invasions: what's what and the way forward. *Trends in ecology & evolution*. 28 (1), 58–66.

Simon, H.A. (1956) Rational choice and the structure of the environment. *Psychological review*. 63 (2), 129–138.

Simon, H.A. (1959) Theories of decision-making in economics and behavioral science. *The American economic review*. 253–283.

Sinzogan, A., Van Mele, P. & Vayssieres, J.-F. (2008) Implications of on-farm research for local knowledge related to fruit flies and the weaver ant Oecophylla longinoda in mango production. *International Journal of Pest Management*. 54 (3), 241–246.

Bar-Sliira, Z., Just, R. & Zilberman, D. (1997) Estimation of farmers' risk attitude: an econometric approach. *Agricultural Economics*. 17211–222.

Smith, J.F. (2000) From Frankenfood to Fruit Flies: Navigating the WTO/SPS. *UC Davis J. Int. Law & Policy*. 61.

Souchère, V., Millair, L., Echeverria, J., Bousquet, F., et al. (2010) Co-constructing with stakeholders a role-playing game to initiate collective management of erosive runoff risks at the watershed scale. *Environmental Modelling \& Software*. 25 (11), 1359–1370.

Souza, A.G.C., Rodrigues, F.Á., Maffia, L.A. & Mizubuti, E.S.G. (2011) Infection process of Cercospora coffeicola on coffee leaf. *Journal of phytopathology*. 159 (1), 6–11.

Staffin, E.B. (1996) Trade Barrier or Trade Boon-A Critical Evaluation of Environmental Labeling and Its Role in the Greening of World Trade. *Colum. J. Envtl L.* 21205.

Stanton, G.H. (2012) The WTO dispute settlement framework and operation. *The Economics of Quarantine and the SPS Agreement*. 53.

Stonehouse, J.M. (1995) Pesticides, thresholds and the smallscale tropical farmer. *Insect Science and its Application*. 16 (3), 259–262.

Storehouse, J., Gbongboui, C., De Groot, A., Lomer, C., et al. (1997) Grasshopper control in the Sahel: farmer perceptions and participation. *Crop Protection*. 16 (8), 733–741.

Strange, R.N. & Scott, P.R. (2005) Plant disease: a threat to global food security. *Annual Review of Phytopathology*. 43. 83–116.

Sutherland, L.-A. & Burton, R.J. (2011) Good farmers, good neighbours? The role of cultural capital in social capital development in a Scottish farming community. *Sociologia Ruralis*.

51 (3), 238–255.

Swann, G.M.P. (2010) International Standards and Trade: A Review of the Empirical Literature. *OECD Trade Policy Working Papers.*

Tanaka, Y. & Munro, A. (2014) Regional Variation in Risk and Time Preferences: Evidence from a Large-scale Field Experiment in Rural Uganda. *Journal of African Economies.* 23 (1), 151–187.

Taylor, A.W., Coveney, J., Ward, P.R., Dal Grande, E., et al. (2011) The Australian Food and Trust survey: demographic indicators associated with food safety and quality concerns. *Food Control.*

Taylor, P.L. (2005) In the market but not of it: Fair Trade coffee and Forest Stewardship Council certification as market-based social change. *World Development.* 33 (1), 129–147.

Terazono, E. (2013) Armajaro to sell cocoa, coffee and sugar trading arm to Ecom. *Financial Times.* [Online] November 11. (Available at: http://on.ft.com/1eDPg3p), [Accessed: 10 Mar 2014].

Terres, J., Nisini, L. & Anguiano, E. (2013) *Assessing the risk of farmland abandonment in the EU.* European Commission (ed.). JRC Scientific and Policy Reports.

The World Bank (2012) *World Bank Open Data.* [Online]. 2012. Available from: http://data.worldbank.org/ [Accessed: 7 May 2012].

Thiemann, J. (2012) Germany a coffee giant without growing a single bean. *Independent Australia.* [Online] July 17. (Available at: http://www.independentaustralia.net/business/business-display/germany-a-coffee-giant-without-growing-a-single-bean,4302), [Accessed: 25 Feb 2014].

Tobin, D., Thomson, J. & LaBorde, L. (2012) Consumer perceptions of produce safety: a study of Pennsylvania. *Food Control.* 26 (2), 305–312.

Tran, N., Wilson, N.L.W. & Anders, S. (2012) Standard harmonization as chasing zero (tolerance limits): the impact of veterinary drug residue standards on crustacean imports in the EU, Japan, and North America. *American Journal of Agricultural Economics.* 94 (2), 496–502.

Trebeck, D.B. (1971) Spatial diversification by beef producers in the Clarence region. *Review of Marketing and Agricultural Economics.* 39 (03), 15–25.

Tsai, W. & Ghoshal, S. (1998) Social capital and value creation: The role of intrafirm networks. *Academy of management Journal.* 41 (4), 464–476.

Tversky, A. & Kahneman, D. (1981) The framing of decisions and the psychology of choice. *Science.* 211 (4481), 453–458.

UCDA (2014) *Background to the coffee industry*. [Online]. 2014. Available from: http://www.ugandacoffee.org/index.php?page&i=15 [Accessed: 27 May 2014].

Udry, C. (1995) Risk and saving in Northern Nigeria. *American Economic Review*. 85 (5), 1287–1300.

UN COMTRADE (2012) *International Trade Statistics Database*. [Online] (Available at: http://comtrade.un.org/), [Accessed: 20 Aug. 2012].

UN DESA (2010) *World Population Prospects: The 2010 Revision.* [Online] (Available at: http://esa.un.org/unpd/wpp/Excel-Data/population.htm), [Accessed 10 Jan 2013].

Valkila, J. (2009) Fair Trade organic coffee production in Nicaragua—Sustainable development or a poverty trap? *Ecological Economics*. 68 (12), 3018–3025.

Valkila, J. & Nygren, A. (2010) Impacts of Fair Trade certification on coffee farmers, cooperatives, and laborers in Nicaragua. *Agriculture and Human Values*. 27 (3), 321–333.

Vandenbussche, H. & Zanardi, M. (2010) The chilling trade effects of antidumping proliferation. *European Economic Review*. 54 (6), 760–777.

Vetter, D.L. (2014) Session 3: The Transatlantic Trade and Investment Partnership (TTIP) on an Agricultural Perspective. *Forum for the Future of Agriculture (FFA).* Brussels, Belgium. April 1. Speech. (Video transcript available at: http://www.forumforagriculture.com/ffa-tv.html).

Vogel, D. (2012) *The Politics of Precaution: Regulating Health, Safety, and Environmental Risks in Europe and the United States*. Princeton University Press.

Waage, J., Fraser, R.W., Mumford, J., Cook, D., et al. (2005) A new agenda for biosecurity. *DEFRA*.

Waage, J. & Mumford, J. (2008) Agricultural biosecurity. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 363 (1492), 863–876.

Waddington, H. & White, H. (2014) Farmer field schools: from agricultural extension to adult education. 3ie Systematic Review Summary 1. *London: International Initiative for Impact Evaluation (3ie).*

Waller, J.M., Bigger, M. & Hillocks, R.J. (2007a) *Coffee pests, diseases and their management*. CAB International, Wallingford, UK.

Waller, J.M., Bigger, M. & Hillocks, R.J. (2007b) Root- and Collar-feeding Insects. In: *Coffee pests, diseases and their management.* CABI. pp. 145–167.

Walter, I. (1971) Nontariff Barriers and the Export Performance of Developing Economies. *The American Economic Review*. 61 (2), 195–205.

Watson, G.W. & Cox, J.M. (1990) Identity of the African coffee root mealybug, with descriptions of two new species of Planococcus (Homoptera: Pseudococcidae). *Bulletin of* *entomological research*. 80 (01), 99–105.

West, P.C., Gerber, J.S., Engstrom, P.M., Mueller, N.D., et al. (2014) Leverage points for improving global food security and the environment. *Science*. 345 (6194), 325–328.

Whitford, A.B. & Wong, K. (2009) Political and Social Foundations for Environmental Sustainability. *Political Research Quarterly*. 62 (1), 190.

Wilcoxon, F. (1945) Individual comparisons by ranking methods. *Biometrics*. 1 (6), 80–83.

Williamson, S., Ball, A. & Pretty, J. (2008) Trends in pesticide use and drivers for safer pest management in four African countries. *Crop Protection*. 27 (10), 1327–1334.

Williamson, S., Little, A., Ali, M.A., Kimani, M., et al. (2003) Aspects of cotton and vegetable farmers' pest management decision-making in India and Kenya. *International Journal of Pest Management*. 49 (3), 187–198.

Wilson, D.R. (1969) Nontariff barriers to international trade: a survey of current problems. *Journal of Public Law*. 18. 403–470.

Wilson, T. (2010) Green excuses: collusion to promote protectionism? *Melbourne: Institute for Public Affairs (IPA)*.

Wollni, M. & Zeller, M. (2007) Do farmers benefit from participating in specialty markets and cooperatives? The case of coffee marketing in Costa Rica1. *Agricultural Economics*. 37 (2-3), 243–248.

Woolcock, M. & Narayan, D. (2000) Social capital: Implications for development theory, research, and policy. *The World Bank Research Observer*. 15 (2), 225–249.

World Bank (2006a) Uganda - Diagnostic trade integration study (volume 1 of 2). *Washington, DC: World Bank*. <http://documents.worldbank.org/curated/en/2006/11/16597323/uganda-diagnostic-trade-integration-study-vol-1-2-volume-one>.

World Bank (2006b) Uganda - Diagnostic trade integration study (volume 2 of 2). *Washington, DC: World Bank*. <http://documents.worldbank.org/curated/en/2006/11/16597344/uganda-diagnostic-trade-integration-study-vol-2-2-volume-two>.

World Bank (2012) *World Development Indicators*. [Online] (Available at: http://data.worldbank.org/data-catalog/world-development-indicators), [Accessed: 10 Sept. 2012].

World Bank (2011) *World Integrated Trade System (WITS)*. [Online] (Available at: http://wits.worldbank.org/default.aspx), [Accessed: 09 August 2011].

World Bank (2010) *Worldwide Governance Indicators*. [Online] (Available at: http://data.worldbank.org/data-catalog/worldwide-governance-indicators), [Accessed: 10

Sept. 2012].

WTO (2014) *SPS Agreement Training Module*. [Online] (Available at: http://www.wto.org/english/tratop_e/sps_e/sps_agreement_cbt_e/c1s2p1_e.htm), [Accessed: 10 Dec 2013].

WTO, W.T.O. (2012) World Trade Report 2012: trade and public policies. *Geneva, WTO* .

Würtenberger, L., Koellner, T. & Binder, C.R. (2006) Virtual land use and agricultural trade: Estimating environmental and socio-economic impacts. *Ecological Economics*. 57 (4), 679–697.

Yesuf, M. & Bluffstone, R.A. (2009) Poverty, risk aversion, and path dependence in low-income countries: Experimental evidence from Ethiopia. *American Journal of Agricultural Economics*. 91 (4), 1022–1037.

Yu, D. (1994) Free trade is green, protectionism is not. *Conservation biology*. 8 (4), 989–996.

Yu, Z. (2000) A model of substitution of non-tariff barriers for tariffs. *Canadian Journal of Economics/Revue canadienne d'économique*. 33 (4), 1069–1090.

Zheng, S., Wang, Z. & Song, S. (2011) Farmers' behaviors and performance in cooperatives in Jilin province of China: a case study. *The Social Science Journal*. 48 (3), 449–457.

Appendices

A.1. SUMMARY STATISTICS FOR SPS NOTIFICATIONS

Table 63: Summary statistics of all variables used in regressions for SPS measures in Chapter 2

VARIABLE	UNITS	MEAN	SD	MIN	MAX	N	DATA SOURCE
Both SPS	Notifications	0.190	1.050	0	65	101,430	SPS - IMS
Emergency SPS	Notifications	0.037	0.495	0	43	101,430	SPS - IMS
Regular SPS	Notifications	0.153	0.849	0	65	101,430	SPS - IMS
Both SPS > 1	(dummy)	0.073	0.260	0	1	101,430	Authors' own / SPS-IMS
Emergency SPS > 1	(dummy)	0.017	0.128	0	1	101,430	Authors' own / SPS-IMS
Regular SPS > 1	(dummy)	0.065	0.247	0	1	101,430	Authors' own / SPS-IMS
AHS Tariff (wgt. av.)	%	8.671	22.816	0	2,645	64,486	WITS / TRAINS
BND Tariff (wgt. av.)	%	27.869	38.387	0	2,776	59,998	WITS / TRAINS
MFN Tariff (wgt. av.)	%	10.495	23.366	0	2,645	64,459	WITS / TRAINS
BOMFN (wgt. av.)	%	17.475	31.177	-1357	2,604	59,751	Authors' own / WITS
ln(exports)	ln(yr 2000 US$)	16.124	4.769	0	26.71	84,042	UN COMTRADE
ln(imports)	ln(yr 2000 US$)	17.608	3.160	0	27.15	84,111	UN COMTRADE
ln(GDP per capita)	ln(yr 2000 US$ / person)	8.304	1.452	4.96	10.64	99,981	World Bank WDI
Current Account (+)	(dummy)	0.409	0.492	0	1	101,430	World Bank WDI
Exchange Rate Index	ExRate / ExRate('96)	1.757	1.971	0.63	19.04	91,356	World Bank WDI
ln(population)	ln(1,000s people)	9.178	1.786	4.25	14.11	101,430	UN DESA Pop. Div.
% population over 65	%	0.084	0.050	0.0043	0.23	100,395	UN DESA Pop. Div.
Democracy Score	See Source	5.455	6.133	-10	10	94,185	Polity IV Project 2010
Environ. Stringency	See Source	4.270	1.087	2	6.50	75,555	WEF Exec. Opin. Survey
Regulatory Quality	See Source	0.418	0.79	-1.61	2.23	101,430	World Bank WGI
Pesticide Regulation	See Source	15.582	7.877	0	22	101,430	Yale EPI 2010
Biodiversity	See Source	58.538	26.093	0	100	101,430	Yale EPI 2010
Enviro. Health	See Source	70.919	18.818	21.57	95.09	98,325	Yale EPI 2010
Enviro. Governance	See Source	0.287	0.617	-0.75	1.65	87,975	Yale ESI 2005

A.2. SUMMARY STATISTICS FOR TBT NOTIFICATIONS

Table 64: Summary statistics of all variables used in regressions for TBT measures in Chapter 2

VARIABLE	UNITS	MEAN	SD	MIN	MAX	N	DATA SOURCE
Regular TBT	Notifications	0.048	0.448	0	36	121,125	SPS - IMS
Regular TBT > 1	(dummy)	0.027	0.162	0	1	121,125	Authors' own / SPS-IMS
AHS Tariff (wgt. av.)	%	8.310	14.716	0	1358	80,069	WITS / TRAINS
BND Tariff (wgt. av.)	%	25.840	29.294	0	729	74,872	WITS / TRAINS
MFN Tariff (wgt. av.)	%	10.048	15.344	0	1358	79,993	WITS / TRAINS
BOMFN (wgt. av.)	%	15.881	26.456	-1357	729	74,407	Authors' own / WITS
ln(exports)	ln(yr 2000 US$)	16.280	4.853	0	26.90	101,650	UN COMTRADE
ln(imports)	ln(yr 2000 US$)	17.740	3.176	0	27.15	101,745	UN COMTRADE
ln(GDP per capita)	ln(yr 2000 US$ / person)	8.426	1.376	5.46	10.64	119,415	World Bank WDI
Current Account (+)	(dummy)	0.409	0.492	0	1	121,125	World Bank WDI
Exchange Rate Index	ExRate / ExRate('96)	1.014	0.194	0.64	2.49	74,100	World Bank WDI
ln(population)	ln(1,000s people)	9.289	1.852	4.22	14.11	121,125	UN DESA Pop. Div.
% population over 65	%	0.087	0.050	0.0043	0.23	119,700	UN DESA Pop. Div.
Democracy Score	See Source	5.555	6.122	-10	10	112,575	Polity IV Project 2010
Environ. Stringency	See Source	4.331	1.132	2	6.50	99,750	WEF Exec. Opin. Survey
Regulatory Quality	See Source	0.474	0.801	-1.61	2.23	120,935	World Bank WGI
Pesticide Regulation	See Source	15.612	7.993	0	22	121,125	Yale EPI 2010
Biodiversity	See Source	58.590	24.449	0.47	100	121,125	Yale EPI 2010
Enviro. Health	See Source	73.604	15.981	25.91	92.77	116,850	Yale EPI 2010
Enviro. Governance	See Source	0.314	0.632	-0.75	1.62	106,875	Yale ESI 2005

A.3. TOTAL SPS/TBT NOTIFICATIONS BY HS-2 CODE FROM 1996-2010

Table 65: SPS and TBT notification totals by country during sample period (1996 – 2010)

HS Code	Description	Ag. Prod	SPS Reg.	SPS Emer.	SPS Both	TBT
1	Live animals	Yes	678	686	1364	6
2	Meat and edible meat offal	Yes	712	699	1411	46
3	Fish & crustacean, mollusc & other aquatic invert		272	24	296	45
4	Dairy prod; birds' eggs; natural honey; edible pr	Yes	520	369	889	113
5	Products of animal origin, nes or included.	Yes	255	290	545	11
6	Live tree & other plant; bulb, root; cut flowers	Yes	271	26	297	11
7	Edible vegetables and certain roots and tubers.	Yes	328	37	365	65
8	Edible fruit and nuts; peel of citrus fruit or me	Yes	501	41	542	56
9	Coffee, tea, matï and spices.	Yes	145	10	155	39
10	Cereals	Yes	247	15	262	30
11	Prod.mill.indust; malt; starches; inulin; wheat g	Yes	45	1	46	34
12	Oil seed, oleagi fruits; miscell grain, seed, fru	Yes	299	9	308	39
13	Lac; gums, resins & other vegetable saps	Yes	16	0	16	9
14	Vegetable plaiting materials; vegetable products	Yes	15	0	15	9
15	Animal/veg fats & oils & their cleavage products;	Yes	116	19	135	47
16	Prep of meat, fish or crustaceans, molluscs etc	Yes	107	36	143	56
17	Sugars and sugar confectionery.	Yes	28	1	29	35
18	Cocoa and cocoa preparations.	Yes	34	1	35	20
19	Prep.of cereal, flour, starch/milk; pastrycooks'	Yes	123	11	134	60
20	Prep of vegetable, fruit, nuts or other parts of	Yes	71	5	76	60
21	Miscellaneous edible preparations.	Yes	74	8	82	82
22	Beverages, spirits and vinegar.	Yes	135	1	136	122
23	Residues & waste from the food indust; prepr ani	Yes	240	205	445	17
24	Tobacco and manufactured tobacco substitutes	Yes	15	0	15	47
25	Salt; sulphur; earth & stone; plastering mat; lime		18	1	19	36
26	Ores, slag and ash.					9
27	Mineral fuels, oils & product of their distillati		4	0	4	134
28	Inorgn chem; compds of prec mtl, radioactive		15	1	16	52
29	Organic chemicals.	Partial	36	3	39	68
30	Pharmaceutical products.		219	13	232	107
31	Fertilisers.		32	4	36	46
32	Tanning/dyeing extract; tannins & derivs; pigm et		9	0	9	35
33	Essential oils & resinoids; perf, cosmetic/toilet	Partial	13	6	19	40
34	Soap, organic surface-active agents, washing		2	0	2	45
35	Albuminoidal subs; modified starches; glues	Partial	31	5	36	18
36	Explosives; pyrotechnic prod; matches; pyrop allo					30
37	Photographic or cinematographic goods.					1
38	Miscellaneous chemical products.	Partial	7	1	8	85
39	Plastics and articles thereof.		45	1	46	119
40	Rubber and articles thereof.		3	0	3	97
41	Raw hides and skins (other than furskins)	Partial	19	5	24	1
42	Articles of leather; saddlery/harness; travel goo		5	0	5	20
43	Furskins and artificial fur; manufactures thereof	Partial	5	0	5	7
44	Wood and articles of wood; wood charcoal.		119	17	136	42
45	Cork and articles of cork.		4	0	4	4
46	Manufactures of straw, esparto/other plaiting mat		5	0	5	0
47	Pulp of wood/of other fibrous cellulosic mat; was		2	0	2	5
48	Paper & paperboard; art of paper pulp		5	1	6	30
49	Printed books, newspapers, pictures & other					5
50	Silk.	Partial	2	0	2	8
51	Wool, fine/coarse animal hair, horsehair yarn & f	Partial	9	1	10	9
52	Cotton.	Partial	23	0	23	16

HS Code	Description	Ag. Prod	SPS			TBT
			Reg.	Emer.	Both	
53	Other vegetable textile fibres; paper yarn & wove	Partial	7	0	7	10
54	Man-made filaments.					8
55	Man-made staple fibres.					20
56	Wadding, felt & nonwoven; yarns; twine, cordage,					22
57	Carpets and other textile floor coverings.					8
58	Special woven fab; tufted tex fab; lace; tapestri					7
59	Impregnated, coated, cover/laminated textile fabr					10
60	Knitted or crocheted fabrics.					6
61	Art of apparel & clothing access, knitted or croc					18
62	Art of apparel & clothing access, not knitted/cro					20
63	Other made up textile articles; sets; worn clothi		0	1	1	36
64	Footwear, gaiters and the like; parts of such art					24
65	Headgear and parts thereof.					22
66	Umbrellas, walking-sticks, seat-sticks, whips, et					2
67	Prepr feathers & down; arti flower; articles huma		5	2	7	1
68	Art of stone, plaster, cement, asbestos, mica/sim					55
69	Ceramic products.		3	0	3	40
70	Glass and glassware.		1	0	1	39
71	Natural/cultured pearls, prec stones & metals, co		1	0	1	20
72	Iron and steel.					64
73	Articles of iron or steel.		2	0	2	167
74	Copper and articles thereof.		1	0	1	19
75	Nickel and articles thereof.					7
76	Aluminium and articles thereof.		1	0	1	64
78	Lead and articles thereof.					9
79	Zinc and articles thereof.		1	0	1	9
80	Tin and articles thereof.		1	0	1	7
81	Other base metals; cermets; articles thereof.					4
82	Tool, implement, cutlery, spoon & fork, of base m		1	0	1	7
83	Miscellaneous articles of base metal.					44
84	Nuclear reactors, boilers, machinery		4	2	6	446
85	Electrical mchy equip parts thereof; sound record					595
86	Railw/tramw locom, rolling-stock & parts thereof;		1	0	1	18
87	Vehicles, parts & accessories		2	1	3	375
88	Aircraft, spacecraft, and parts thereof.		3	0	3	14
89	Ships, boats and floating structures.		3	0	3	12
90	Optical, photo, cine, meas, checking, precision,		5	0	5	151
91	Clocks and watches and parts thereof.					2
92	Musical instruments; parts and access of such art					1
93	Arms and ammunition; parts and accessories					12
94	Furniture; bedding, mattress, matt support, cushi		4	0	4	101
95	Toys, games & sports requisites; parts & access t		1	0	1	91
96	Miscellaneous manufactured articles.					30
97	Works of art, collectors' pieces and antiques.		2	0	2	

A.4. TOTAL SPS/TBT NOTIFICATIONS BY COUNTRY FROM 1996-2010

Table 66: SPS and TBT notification totals by country during sample period (1996 – 2010)

	SPS			
Country	**Reg.**	**Emer.**	**Both**	**TBT**
Albania	13	380	393	1
Antigua and Barbuda	16	0	16	
Argentina	120	27	147	2
Armenia	38	12	50	96
Australia	174	27	201	22
Bahrain	71	5	76	40
Barbados	0	1	1	1
Belize	1	0	1	3
Benin	4	4	8	
Bolivia	12	22	34	13
Botswana	3	0	3	
Brazil	396	12	408	281
Brunei Darussalam	0	4	4	
Cambodia				1
Canada	155	29	184	10
Chile	261	35	296	2
China	286	36	322	505
Colombia	152	93	245	96
Costa Rica	105	14	119	105
Croatia	2	0	2	
Cuba	18	2	20	2
Dominica				3
Dominican Republic	27	0	27	23
Ecuador	69	13	82	70
Egypt	27	21	48	
El Salvador	99	13	112	120
European Union	771	311	1082	129
Fiji	4	0	4	1
Gambia	1	0	1	
Georgia	29	4	33	
Guatemala	177	44	221	16
Honduras	27	12	39	10
Hong Kong	12	16	28	45
Iceland	1	29	30	
India	34	18	52	3
Indonesia	23	13	36	41
Israel	9	7	16	587
Jamaica	2	17	19	1
Japan	530	23	553	376
Jordan	9	42	51	9
Kenya	2	103	105	176
Korea, Republic of	178	31	209	43
Kuwait	0	7	7	52
Kyrgyz Republic				23
Macao SAR, China	2	25	27	
Macedonia	1	8	9	7
Madagascar	7	1	8	
Malawi	2	0	2	
Malaysia	16	28	44	13
Mauritius	9	12	21	
Mexico	179	34	213	2
Mongolia	0	2	2	35

	SPS			
Country	**Reg.**	**Emer.**	**Both**	**TBT**
Morocco	31	11	42	1
Nepal	18	3	21	
New Zealand	274	86	360	58
Nicaragua	44	0	44	28
Norway	10	10	20	2
Oman	24	43	67	7
Pakistan	0	3	3	1
Panama	48	6	54	2
Paraguay	19	6	25	3
Peru	329	149	478	92
Philippines	114	362	476	1
Qatar	15	0	15	4
Republic of Moldova	3	0	3	45
Saudi Arabia	3	3	6	45
Senegal	3	0	3	
Singapore	16	24	40	21
South Africa	15	6	21	205
Sri Lanka	21	3	24	14
St. Lucia				12
St. Vincent and the G.				1
Swaziland	0	2	2	
Switzerland	75	25	100	23
Taiwan	105	2	107	77
Tanzania				35
Thailand	140	62	202	389
Trinidad and Tobago	0	21	21	6
Turkey	3	6	9	2
Ukraine	31	46	77	39
United Arab Emirates	3	42	45	1
United States	446	92	538	650
Uruguay	21	9	30	
Venezuela	22	0	22	15
Viet Nam	15	0	15	1
Zambia	6	0	6	

A.5. SPS STC BY RAISING MEMBER AND HS-2 CODE

Table 67: Totals of SPS STC by raising WTO member country and HS-2 code

	HS-2 Code																						
RAISING MEMBER	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**16**	**17**	**18**	**20**	**21**	**22**	**23**	**30**	**33**	**44**	**88**	**TOTAL**
Argentina	2	4	8		1		1	2	5		2								1			1	1	**28**
Australia	2	2																			1			**5**
Brazil	2	1	10			1	1	1	4								1							**21**
Canada	3	2	7					1			1											1		**15**
Certain Members	4	1	4	2	1	2	1	4	1	1							1					1		**23**
Chile		1	1				1		1															**4**
China	2			2			1		2	1			2				4		2			2		**18**
Hong Kong																						1		**1**
Colombia	1		1							1														**3**
Costa Rica			1		1		1																	**3**
Cote d'Ivoire								1																**1**
Cuba					1																			**1**
Ecuador									3						1									**4**
Egypt								1																**1**
European Union	7	6	17	1	7	1	4	4	1								1	1	1		1	2		**54**
Fiji										1														**1**
Hungary		1	1						1										1					**4**
India	2	1							1															**4**
Indonesia				1										1										**2**
Israel																1								**1**
Mexico		2	2						2									1						**7**
Morocco	1																							**1**

RAISING MEMBER	HS-2 Code 0	1	2	3	4	5	6	7	8	9	10	11	16	17	18	20	21	22	23	30	33	44	88	TOTAL
New Zealand								1	2															**3**
Nicaragua		1							1															**2**
Pakistan											1													**1**
Philippines							1		1				1				1							**4**
Republic of Moldova			1																					**1**
Saint Vincent & the G.									1															**1**
Senegal									1															**1**
Slovenia			1																					**1**
South Africa			1																					**1**
Sri Lanka										1														**1**
Switzerland	1		2																					**3**
Taiwan							1																	**1**
Thailand			3						1		1		1				1							**7**
United States	9	3	15	2	3	5		2	6		6	1	1	1					3	1		1		**59**
Uruguay			2						1															**3**
Venezuela									1															**1**
TOTAL	**36**	**25**	**77**	**8**	**14**	**9**	**12**	**17**	**36**	**5**	**11**	**1**	**5**	**2**	**1**	**1**	**9**	**2**	**8**	**1**	**2**	**9**	**1**	**292**

A.6. SPS STC BY MAINTAINING MEMBER AND HS-2 CODE

Table 68: Totals of SPS STC by maintaining WTO member country and HS-2 code

	HS-2 Code																							
MAINTAIN MEMBER	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**16**	**17**	**18**	**20**	**21**	**22**	**23**	**30**	**33**	**44**	**88**	**TOTAL**
Argentina		1	3			1																		**5**
Australia	2		2	2				1	5								1							**13**
Barbados									1															**1**
Bolivia	1	1	1																					**3**
Brazil	4	3	1				1	1				1						1						**12**
Canada			2		1		1		1										1					**6**
Certain Members	6	1	7		1		1															2		**18**
Chile			1								1								1				1	**4**
China	1	1	5	2	1				2				1					1			1	1		**16**
Colombia			2			1																		**3**
Costa Rica									1															**1**
Croatia		1	1																					**2**
Cuba			1						1															**2**
Czech Republic			1					1											1					**3**
Dominican Republic								1																**1**
Egypt			1										1											**2**
El Salvador			3																					**3**
European Union	8	6	3	2	2	6	1	2	8	5	2		1	1	1	1	3		2		1	2		**57**
France									1															**1**
Guatemala			1						1															**2**
Honduras			1								1													**2**
Hungary			2																					**2**

	HS-2 Code																							
MAINTAIN MEMBER	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**16**	**17**	**18**	**20**	**21**	**22**	**23**	**30**	**33**	**44**	**88**	**TOTAL**
Iceland			1																					**1**
India		2			2			1												1				**6**
Indonesia		2	2		1			1	2															**8**
Israel		1	2				1																	**4**
Japan	4		3	1				3	5		1			1			4		1					**23**
Korea	1		5						1		1													**8**
Malaysia	1						1																	**2**
Mexico		1	5					1			2													**9**
New Zealand							1																	**1**
Norway																	1							**1**
Panama	2	1	1		2						1													**7**
Philippines			1																					**1**
Poland					2						1													**3**
Romania			2																					**2**
Senegal			1																					**1**
Slovakia								1	1															**2**
South Africa			2																					**2**
Switzerland			1								1													**2**
Taiwan	1		2			1		1											1					**6**
Thailand	1	1																						**2**
Trinidad and Tobago			1																					**1**
Turkey	1								1										1					**3**
Ukraine		1																						**1**
United States	3	2	6	1	2		5	1	5				2									4		**31**
Venezuela			4					2																**6**
Total	**36**	**25**	**77**	**8**	**14**	**9**	**12**	**17**	**36**	**5**	**11**	**1**	**5**	**2**	**1**	**1**	**9**	**2**	**8**	**1**	**2**	**9**	**1**	**292**

A.7. STC RE-RAISE SAMPLING METHOD

A component of the analysis was the number of time a concern has been re-raised after the original date. Since a claim raised more recently has had less time to possibly be re-raised, it is important to account for this dynamic. First, the number of years it takes to re-raise a claim is investigated.

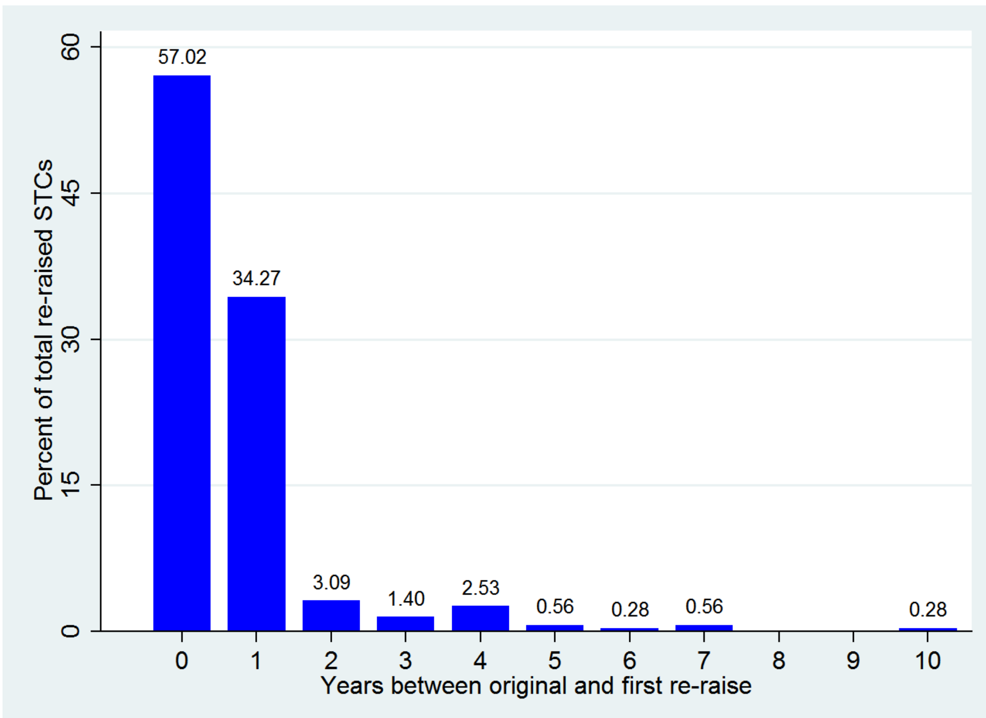


Figure 88: Years between original and second raising of the same specific trade concern for the 356 TBT and SPS concerns that are re-raised at least once

From the data sample of STCs from the TBT (282 concerns) and SPS (292 concerns) systems, 356 out of 574 trade concerns (62%) raised originally from 1996 to 2010 are re-raised at least once before 2012. As shown in Figure 88, 57% are re-raised at a subsequent meeting within the same year as the original raising. A further 34% are re-raised in the following year and 3% are re-raised for the first time two years after the original date. Only ~5% of all concerns that are ever re-raised are done so for the first time after two years. As a result, analysis of the sample from 1996 to 2010 with additional data through end of 2012 for concerns that were re-raised would likely account for the majority of the dynamics of the regulatory system.

A.8. TOTAL SPS STC BY RAISING COUNTRY

Table 69: STCs summary statistics by raising member country with resolution status

Raising Member	Num. STC Raise	Num. STC Resolve	(mean) Years until Resolve	(mean) Num. Times Raised	% of STC with Support	(max) Num. of Supporters	(Total) SPS Notification of Raising Member	(mean) SPS Notif.'s of Maintaining Members
United States	59	15	3.8	2.5	51%	11	538	455
European Union	54	27	5.6	2.3	31%	4	1,082	290
Argentina	28	14	3.3	2.5	39%	4	147	337
Certain Members	23	5	4.4	5.4	74%	13		670
Brazil	21	4	1.8	2.8	29%	7	408	309
China	18	2	3.0	6.0	33%	3	322	618
Canada	15	8	3.9	1.9	60%	5	184	490
Thailand	7	3	2.3	8.0	43%	4	202	326
Mexico	7	0			43%	5	213	256
Australia	5	0			60%	3	201	802
Chile	4	2	1.5	3.5	50%	2	296	258
Ecuador	4	1	3.0	3.0	50%	2	82	589
India	4	0			75%	3	52	818
Philippines	4	1	3.0	5.0	75%	7	476	473
Hungary	4	2	3.5	3.5	50%	2		6
New Zealand	3	2	1.5	2.0	33%	3	360	115
Uruguay	3	2	2.0	2.5	67%	3	30	403
Costa Rica	3	1	2.0	3.0	67%	5	119	210
Colombia	3	0			33%	10	245	504
Switzerland	3	2	1.5	6.0	0%	0	100	538
Nicaragua	2	0			0%	0	44	166
Indonesia	2	0			0%	0	36	818
Taiwan	1	1	3.0	2.0	0%	0	107	184
Fiji	1	0			0%	0	4	1,082
Israel	1	0			0%	0	16	1,082
South Africa	1	0			0%	0	21	1,082
St. Vincent & G.	1	0			100%	12		1,082
Sri Lanka	1	1	1.0	2.0	100%	1	24	1,082
Cote d'Ivoire	1	0			0%	0		1,082
Venezuela	1	0			0%	0	22	1
Senegal	1	0			0%	0	3	1,082
Morocco	1	0			100%	1	42	408
Slovenia	1	0			0%	0		2
Hong Kong	1	0			100%	1	28	538
Egypt	1	0			0%	0	48	1,082
Moldova	1	0			100%	1	3	
Cuba	1	0			0%	0	20	1,082
Pakistan	1	1	2.0	4.0	0%	0	3	213
ALL COUNTRIES	292	94	3.8	3.0	44%	13		444

Note: EU members will show blank for Total SPS Notifications since all are assigned to the EU as the country reporter. However, the other blanks like for Cote d'Ivoire indicate that the member has reported no SPS notifications, but has registered SPS trade concerns against other members.

A.9. TOTAL SPS STC BY MAINTAINING MEMBER

Table 70: STC summary statistics by member maintaining the SPS measure under dispute, with resolution status and tariff BO information.

Maintain Member	Num. STC Against	Num. STC Resolve	(mean) Years until Resolve	(mean) Num. Times Raised	% of STC with Support	(max) Num. of Supporters	(total) SPS Notif's of Maintain Member	(median) Binding Overhang w/ STC	(median) Binding Overhang w/ SPS
European Union	57	9	5.5	3.6	60%	13	1,082	1.7	1.0
United States	31	6	3.3	3.3	32%	5	538	1.7	0.5
Japan	23	4	3.5	4.0	57%	7	553	2.2	0.4
certain members	18	5	4.4	4.0	39%	6			
China	16	6	2.3	2.5	31%	3	322	-0.1	0.2
Australia	13	7	4.6	3.0	85%	7	201	1.2	3.4
Brazil	12	4	3.8	2.3	33%	5	408	21.0	21.3
Mexico	9	3	3.3	7.3	22%	2	213	19.5	26.1
Indonesia	8	2	1.5	4.0	38%	3	36	42.3	34.4
Korea	8	2	1.0	3.0	38%	5	209	6.8	3.9
Panama	7	6	5.5	2.0	43%	5	54	-1.2	12.4
Canada	6	3	5.7	1.3	33%	2	184	1.4	2.3
Venezuela	6	1	2.0	2.0	33%	2	22	29.5	22.8
Taiwan	6	2	2.0	1.0	50%	5	107	0.0	0.0
India	6	0			50%	3	52	51.1	26.7
Argentina	5	4	6.3	3.0	60%	3	147	23.6	24.0
Chile	4	4	4.0	2.3	50%	2	296	19.3	19.0
Israel	4	2	4.0	3.5	50%	2	16	131.4	11.0
Colombia	3	1	1.0	6.0	0%	0	245	88.0	29.1
Turkey	3	2	3.5	3.0	33%	3	9		16.6
El Salvador	3	1	1.0	2.0	0%	0	112	77.0	31.5
Bolivia	3	2	1.5	2.0	0%	0	34	30.4	30.4
Czech Rep.	3	3	3.3	2.7	33%	1			
Poland	3	2	5.0	2.5	33%	2			
South Africa	2	0			0%	0	21	46.9	10.1
Croatia	2	0			50%	1	2		4.3
Hungary	2	2	3.0	1.0	0%	0			
Switzerland	2	2	6.5	3.0	50%	8	100	10.1	2.3
Thailand	2	0			50%	2	202	9.5	15.8
Guatemala	2	0			50%	1	221	128.8	36.1
Romania	2	0			50%	1			
Cuba	2	1	2.0	2.0	0%	0	20	30.1	3.2
Malaysia	2	0			100%	4	44		6.5
Egypt	2	0			0%	0	48	10.2	11.6
Honduras	2	1	4.0	2.0	50%	3	39	13.8	23.3
Slovakia	2	2	4.5	4.0	100%	3			
France	1	0			0%	0			
Philippines	1	1	1.0	2.0	100%	5	476	21.2	18.6

Maintain Member	Num. STC Against	Num. STC Resolve	(mean) Years until Resolve	(mean) Num. Times Raised	% of STC with Support	(max) Num. of Supporters	(total) SPS Notif's of Maintain Member	(median) Binding Overhang w/ STC	(median) Binding Overhang w/ SPS
Dominican Rep.	1	0			0%	0	27	49.3	25.8
Costa Rica	1	0			0%	0	119	22.3	37.6
New Zealand	1	1	1.0	2.0	100%	1	360		5.8
Barbados	1	0			0%	0	1		64.8
Trinidad & Tob.	1	0			0%	0	21	78.5	47.2
Iceland	1	1	4.0	1.0	0%	0	30		9.9
Senegal	1	0			0%	0	3	10.0	17.7
Norway	1	1	2.0	3.0	0%	0	20	125.3	1.8
Ukraine	1	1	1.0	2.0	100%	4	77	6.4	0.3
ALL COUNTRIES	292	94	3.8	3.0	44%	13		3.0	1.0

Note: The last two columns report the median binding overhang tariff information. The first is for all the HS-2 codes of the relevant member country with a Specific Trade Concern raised against it. The last column is the median binding overhang tariff for all SPS measures notified by the maintaining member from 1996 to 2010 (from the data used in Chapter 2).

A.10. TOTAL TBT STC BY MAINTAINING MEMBER

Table 71: STCs by member country maintaining the TBT measure under dispute

Rank	Maintaining Member	Num. STC Against	(mean) Num. Times Raise w/o Resolve	(total) TBT Notifications of Maintain Member
1	European Union	62	4.5	129
2	China	34	2.9	505
3	United States	33	2.4	650
4	Korea, Republic of	19	2.7	43
5	India	15	4.9	3
6	Brazil	14	3.5	281
7	Japan	11	2.1	376
8	Canada	9	3.3	10
9	Indonesia	9	2.7	41
10	Argentina	7	2.7	2
11	Mexico	7	1.7	2
12	Colombia	6	3.8	96
13	Thailand	6	4.2	389
14	Taiwan	5	1.4	77
15	Egypt	4	2.3	
16	Turkey	4	3.8	2
17	Israel	3	3.7	587
18	Peru	3	2.0	92
19	South Africa	3	1.3	205
20	Chile	2	2.5	2
21	Hong Kong	2	1.0	45
22	Ecuador	2	2.0	70
23	Malaysia	2	2.0	13
24	New Zealand	2	5.0	58
25	Norway	2	8.0	2
26	Republic of Moldova	2	1.5	45
27	Bahrain	1	1.0	40
28	*certain members*	1	1.0	
29	Croatia	1	1.0	
30	Jordan	1	1.0	9
31	Kuwait	1	1.0	52
32	Philippines	1	3.0	1
33	Qatar	1	1.0	4
34	Saudi Arabia	1	7.0	45
35	Switzerland	1	7.0	23
36	Tunisia	1	1.0	
37	United Arab Emirates	1	2.0	1
38	Uruguay	1	3.0	
39	Venezuela	1	2.0	15
40	Viet Nam	1	2.0	1
	ALL COUNTRIES	282	3.3	

A.11. NET AGRICULTURAL EXPORTS/IMPORTS BY COUNTRY IN 2011

Table 72: Net agricultural trade from top net exporter to top net importer in 2011

Rank	Countries	Export Value (1000 US$)	Import Value (1000 US$)	Net Export (+) or Net Import (-) in 1000 US$
1	Brazil	79,630,341	10,908,333	68,722,008
2	Argentina	43,206,677	2,005,262	41,201,415
3	United States of America	139,891,089	107,109,145	32,781,944
4	Netherlands	89,329,878	57,833,353	31,496,525
5	Thailand	36,779,807	9,794,454	26,985,353
6	Indonesia	41,867,553	18,338,684	23,528,869
7	Australia	32,655,860	11,687,339	20,968,521
8	France	73,960,489	55,611,260	18,349,229
9	Malaysia	35,709,575	18,579,490	17,130,085
10	India	30,288,815	17,246,819	13,041,996
11	New Zealand	15,215,480	2,802,298	12,413,182
12	Canada	41,041,943	31,000,458	10,041,485
13	Spain	40,915,988	32,930,037	7,985,951
14	Denmark	19,203,452	11,982,161	7,221,291
15	Ukraine	12,679,998	5,770,402	6,909,596
16	Cote d'Ivoire	6,613,446	1,438,855	5,174,591
17	EU(12)ex.int	163,011,187	157,965,153	5,046,034
18	Chile	10,374,887	5,330,276	5,044,611
19	Belgium	42,909,630	39,102,640	3,806,990
20	Hungary	9,165,422	5,440,327	3,725,095
21	Ireland	12,057,308	8,420,322	3,636,986
22	Poland	19,422,095	16,251,101	3,170,994
23	Ecuador	4,880,824	1,944,919	2,935,905
24	Uruguay	4,046,142	1,331,341	2,714,801
25	Paraguay	3,622,870	920,259	2,702,611
26	Guatemala	4,503,414	2,251,697	2,251,717
27	Costa Rica	3,648,262	1,608,627	2,039,635
28	Colombia	6,844,410	5,050,491	1,793,919
29	Bulgaria	4,418,491	3,038,688	1,379,803
30	Serbia	2,700,808	1,362,030	1,338,778
31	Viet Nam	13,527,573	12,276,349	1,251,224
32	Ghana	3,008,021	1,759,978	1,248,043
33	Honduras	2,528,071	1,460,168	1,067,903
34	Malawi	1,144,870	338,143	806,727
35	Nicaragua	1,587,229	870,971	716,258
36	Lithuania	4,145,933	3,504,615	641,318
37	Bolivia	1,260,425	637,315	623,110
38	Ethiopia	2,154,207	1,565,452	588,755
39	Belarus	3,723,709	3,156,732	566,977
40	Kenya	2,618,683	2,091,507	527,176
41	Papua New Guinea	1,055,425	541,948	513,477

Rank	Countries	Export Value (1000 US$)	Import Value (1000 US$)	Net Export (+) or Net Import (-) in 1000 US$
42	Peru	4,541,972	4,039,381	502,591
43	Turkey	14,228,577	13,748,485	480,092
44	Uganda	1,180,328	767,509	412,819
45	Zambia	759,452	356,737	402,715
46	South Africa	6,913,921	6,533,679	380,242
47	Republic of Moldova	924,922	642,286	282,636
48	Sri Lanka	2,748,223	2,494,721	253,502
49	Togo	351,208	172,998	178,210
50	Guyana	379,851	243,603	136,248
51	Cameroon	1,105,986	981,450	124,536
52	Guinea-Bissau	209,103	104,737	104,366
53	Uzbekistan	1,378,395	1,293,162	85,233
54	Burkina Faso	477,874	397,220	80,654
55	Belize	162,413	106,176	56,237
56	Liberia	312,690	259,420	53,270
57	Swaziland	277,486	234,345	43,141
58	Burundi	83,093	78,096	4,997
59	British Virgin Islands	-	-	-
60	Falkland Islands	-	-	-
61	Norfolk Island	-	-	-
62	Niue	168	1,372	(1,204)
63	Nauru		1,818	(1,818)
64	Tuvalu	-	2,918	(2,918)
65	Guam	-	3,212	(3,212)
66	Solomon Islands	89,171	96,218	(7,047)
67	American Samoa	3	12,623	(12,620)
68	St Pierre and Miquelon	5	15,767	(15,762)
69	Cook Islands	626	25,773	(25,147)
70	Dominica	9,199	38,148	(28,949)
71	Vanuatu	40,673	69,721	(29,048)
72	Sao Tome and Principe	6,592	39,282	(32,690)
73	Kiribati	6,126	40,521	(34,395)
74	Tonga	7,671	42,696	(35,025)
75	Saint Kitts and Nevis	4,098	40,373	(36,275)
76	Cambodia	370,089	412,319	(42,230)
77	Central African Republic	21,977	65,914	(43,937)
78	Saint Vincent and the G.	19,048	64,562	(45,514)
79	Comoros	22,053	68,117	(46,064)
80	Bhutan	31,400	81,499	(50,099)
81	Grenada	8,710	61,650	(52,940)
82	Cayman Islands		60,384	(60,384)
83	Fiji	268,015	328,933	(60,918)
84	Samoa	5,672	78,213	(72,541)
85	Rwanda	155,881	230,016	(74,135)
86	Chad	80,891	162,043	(81,152)
87	Seychelles	4,134	92,175	(88,041)

Rank	Countries	Export Value (1000 US$)	Import Value (1000 US$)	Net Export (+) or Net Import (-) in 1000 US$
88	Saint Lucia	14,936	104,624	(89,688)
89	Timor-Leste	12,324	113,343	(101,019)
90	Faroe Islands	19,151	124,491	(105,340)
91	Antigua and Barbuda	1,782	107,295	(105,513)
92	Gambia	24,506	135,110	(110,604)
93	Suriname	97,734	232,872	(135,138)
94	Bermuda	3,100	138,926	(135,826)
95	Zimbabwe	1,150,401	1,286,232	(135,831)
96	Tanzania	982,513	1,120,943	(138,430)
97	Namibia	224,107	375,585	(151,478)
98	Eritrea	660	156,354	(155,694)
99	Madagascar	345,617	503,024	(157,407)
100	Mali	323,358	483,567	(160,209)
101	Lesotho	2,374	162,662	(160,288)
102	Benin	710,513	878,451	(167,938)
103	Turkmenistan	165,578	340,297	(174,719)
104	Niger	123,120	304,154	(181,034)
105	Equatorial Guinea	1,970	185,584	(183,614)
106	Macedonia	640,178	829,921	(189,743)
107	Barbados	90,700	309,664	(218,964)
108	Aruba	117,877	341,628	(223,751)
109	Sierra Leone	35,236	263,329	(228,093)
110	Cabo Verde	1,010	238,169	(237,159)
111	Latvia	1,788,224	2,033,066	(244,842)
112	Laos	116,028	365,551	(249,523)
113	Maldives	-	281,534	(281,534)
114	Iceland	99,409	414,844	(315,435)
115	Guinea	180,244	502,064	(321,820)
116	Mauritania	26,825	355,495	(328,670)
117	Estonia	1,148,762	1,487,653	(338,891)
118	Mongolia	104,263	461,716	(357,453)
119	Tajikistan	170,642	531,186	(360,544)
120	Mozambique	575,867	941,093	(365,226)
121	French Polynesia	22,567	393,605	(371,038)
122	New Caledonia	4,206	375,711	(371,505)
123	Brunei Darussalam	3,119	384,555	(381,436)
124	Bahamas	10,503	392,613	(382,110)
125	Somalia	266,176	650,068	(383,892)
126	Mauritius	403,675	813,474	(409,799)
127	Dem. Rep. of Korea	32,101	465,686	(433,585)
128	Kyrgyzstan	261,696	701,078	(439,382)
129	Occupied Palestine	53,206	496,451	(443,245)
130	Gabon	84,436	597,576	(513,140)
131	Montenegro	79,192	595,383	(516,191)
132	El Salvador	1,235,781	1,761,879	(526,098)
133	Malta	109,085	638,781	(529,696)

Rank	Countries	Export Value (1000 US$)	Import Value (1000 US$)	Net Export (+) or Net Import (-) in 1000 US$
134	Dominican Republic	1,455,767	2,010,967	(555,200)
135	Romania	5,463,428	6,018,732	(555,304)
136	Armenia	207,333	771,348	(564,015)
137	Congo	25,177	597,270	(572,093)
138	Myanmar	782,477	1,355,505	(573,028)
139	Jamaica	295,655	912,763	(617,108)
140	Botswana	140,250	758,997	(618,747)
141	Azerbaijan	727,070	1,372,260	(645,190)
142	Trinidad and Tobago	184,859	833,757	(648,898)
143	Nepal	195,610	891,110	(695,500)
144	Georgia	427,718	1,143,555	(715,837)
145	Djibouti	63,601	787,294	(723,693)
146	Haiti	28,282	802,410	(774,128)
147	Albania	84,355	876,491	(792,136)
148	Panama	307,138	1,249,214	(942,076)
149	Cyprus	310,286	1,271,666	(961,380)
150	Dem. Rep. of the Congo	68,380	1,108,127	(1,039,747)
151	Bahrain	417,624	1,479,519	(1,061,895)
152	Croatia	1,406,270	2,475,401	(1,069,131)
153	Senegal	503,901	1,601,387	(1,097,486)
154	Tunisia	1,620,193	2,771,952	(1,151,759)
155	China, Macao SAR	21,160	1,176,609	(1,155,449)
156	Pakistan	5,181,303	6,355,761	(1,174,458)
157	Luxembourg	1,700,834	2,913,222	(1,212,388)
158	Austria	12,827,146	14,087,373	(1,260,227)
159	Qatar	28,480	1,303,759	(1,275,279)
160	Slovenia	1,862,456	3,204,427	(1,341,971)
161	Afghanistan	242,962	1,669,632	(1,426,670)
162	Cuba	720,637	2,169,504	(1,448,867)
163	Slovakia	3,867,330	5,367,003	(1,499,673)
164	Bosnia and Herzegovina	458,380	1,999,971	(1,541,591)
165	Jordan	1,256,688	2,898,119	(1,641,431)
166	Oman	921,107	2,566,247	(1,645,140)
167	Sudan (former)	521,698	2,282,508	(1,760,810)
168	Philippines	4,588,536	6,452,843	(1,864,307)
169	Kazakhstan	1,840,852	3,920,497	(2,079,645)
170	Czech Republic	6,746,358	9,116,906	(2,370,548)
171	Lebanon	580,930	3,042,981	(2,462,051)
172	Libya	5,262	2,534,057	(2,528,795)
173	Israel	2,371,461	5,044,538	(2,673,077)
174	Greece	5,418,062	8,092,616	(2,674,554)
175	Kuwait	153,223	2,868,125	(2,714,902)
176	Finland	2,854,251	5,720,958	(2,866,707)
177	Syrian Arab Republic	948,111	3,814,962	(2,866,851)
178	Yemen	296,751	3,169,380	(2,872,629)
179	Morocco	2,182,062	5,286,521	(3,104,459)

Rank	Countries	Export Value (1000 US$)	Import Value (1000 US$)	Net Export (+) or Net Import (-) in 1000 US$
180	Switzerland	8,866,329	12,087,792	(3,221,463)
181	Angola	11,009	3,313,118	(3,302,109)
182	Singapore	8,181,043	11,517,859	(3,336,816)
183	Portugal	5,622,476	10,369,773	(4,747,297)
184	EU(15)ex.int	151,501,718	156,419,242	(4,917,524)
185	Mexico	20,997,304	26,035,799	(5,038,495)
186	EU(25)ex.int	136,379,636	141,703,647	(5,324,011)
187	Iran (Islamic Republic of)	4,847,022	10,171,414	(5,324,392)
188	Nigeria	1,551,308	6,899,254	(5,347,946)
189	Venezuela	41,907	5,393,141	(5,351,234)
190	Norway	832,550	6,592,783	(5,760,233)
191	EU(27)ex.int	132,996,344	138,834,143	(5,837,799)
192	Sweden	5,610,674	12,117,045	(6,506,371)
193	Bangladesh	474,461	7,373,491	(6,899,030)
194	Iraq	57,974	7,061,240	(7,003,266)
195	Italy	40,992,469	49,937,030	(8,944,561)
196	Egypt	5,194,233	14,686,163	(9,491,930)
197	Taiwan	2,102,817	11,976,355	(9,873,538)
198	Algeria	352,654	10,789,342	(10,436,688)
199	United Arab Emirates	2,862,721	13,780,101	(10,917,380)
200	Hong Kong	7,917,170	20,045,763	(12,128,593)
201	Germany	80,321,346	94,997,392	(14,676,046)
202	Saudi Arabia	3,482,995	19,492,724	(16,009,729)
203	Republic of Korea	4,302,135	23,129,073	(18,826,938)
204	Russian Federation	9,215,159	37,233,201	(28,018,042)
205	United Kingdom	28,822,398	59,786,884	(30,964,486)
206	China, mainland	42,304,534	95,066,246	(52,761,712)
207	Japan	3,272,542	68,470,353	(65,197,811)
208	China	52,345,681	128,264,973	(75,919,292)
209	China ex.int	41,094,890	122,563,082	(81,468,192)

Note: Data from FAOSTAT (2014) for Agricultural Product (Total +) in 2011 by value

A.12. RELATIONSHIP BETWEEN SPS TOTALS AND STCS BY HS CODE

Table 73: Percentage of total SPS measures with STCs raised against them by HS code from 1996 to 2010

HS Code	Total SPS Notifications	Total STCs	% SPS Raised as STC
88	3	1	33.3%
21	82	9	11.0%
33	19	2	10.5%
17	29	2	6.9%
8	542	34	6.3%
44	136	7	5.1%
2	1411	65	4.6%
7	365	15	4.1%
10	262	10	3.8%
6	297	11	3.7%
16	143	5	3.5%
9	155	5	3.2%
18	35	1	2.9%
3	296	8	2.7%
11	46	1	2.2%
1	1364	24	1.8%
5	545	9	1.7%
23	445	7	1.6%
22	136	2	1.5%
20	76	1	1.3%
4	889	11	1.2%
30	232	1	0.4%
12	308	0	0.0%
13	16	0	0.0%
14	15	0	0.0%
15	135	0	0.0%
19	134	0	0.0%
24	15	0	0.0%
25	19	0	0.0%
27	4	0	0.0%
28	16	0	0.0%
29	39	0	0.0%
31	36	0	0.0%
32	9	0	0.0%
34	2	0	0.0%
35	36	0	0.0%
38	8	0	0.0%
39	46	0	0.0%
40	3	0	0.0%
41	24	0	0.0%
42	5	0	0.0%
43	5	0	0.0%
45	4	0	0.0%
46	5	0	0.0%
47	2	0	0.0%
48	6	0	0.0%
50	2	0	0.0%
51	10	0	0.0%
52	23	0	0.0%
53	7	0	0.0%

HS Code	Total SPS Notifications	Total STCs	% SPS Raised as STC
63	1	0	0.0%
67	7	0	0.0%
69	3	0	0.0%
70	1	0	0.0%
71	1	0	0.0%
73	2	0	0.0%
74	1	0	0.0%
76	1	0	0.0%
79	1	0	0.0%
80	1	0	0.0%
82	1	0	0.0%
84	6	0	0.0%
86	1	0	0.0%
87	3	0	0.0%
89	3	0	0.0%
90	5	0	0.0%
94	4	0	0.0%
95	1	0	0.0%
97	2	0	0.0%

Note: STCs included are those with named maintaining members excluding the category "certain members" and individual EU members. See description in section 3.6.1 (beginning on page 98). Total SPS notifications for Regular and Emergency measures in the EU aggregate dataset (see page 39 for explanation on the treatment of the EU).

A.13. ARE STCS MORE LIKELY TO OCCUR ON LESS USED HS CODES?

No.

Table 74: Cross-sectional correlates of total SPS notifications by maintaining country and HS code using negative binomial estimator without HS-2 code dummies

	STC (Present Year SPS)		STC (Last Notified SPS)	
	(1)	(2)	(3)	(4)
BND Tariff (wgt. av.)	0.00751*	0.00705*	0.00621	0.00568
	(0.00300)	(0.00297)	(0.00331)	(0.00330)
Log Imports	-0.00399	0.0249	-0.0263	-0.00330
	(0.0691)	(0.0693)	(0.0772)	(0.0781)
Log Exports	-0.0971*	-0.110*	-0.0702	-0.0824
	(0.0464)	(0.0460)	(0.0545)	(0.0542)
Log GDP	0.467**	0.475**	0.478**	0.478**
	(0.0808)	(0.0821)	(0.0900)	(0.0919)
Total SPS	0.0266**	0.0260**	0.0302**	0.0297**
	(0.00546)	(0.00530)	(0.00608)	(0.00597)
Enviro. governance		-0.286		-0.167
		(0.198)		(0.227)
ln(α)[216]	0.913**	0.862**	1.023**	0.996**
Observations	868	834	868	834

Note: * p < 0.05, ** p < 0.01
Standard errors in brackets. Coefficients reported.

[216] The value of α confirmed significant over-dispersion in the data (i.e. $\alpha \neq 0$), hence the choice of the NB estimator over Poisson.

A.14. SUMMARY STATISTICS FOR STC REGRESSION MODELS

Table 75: Summary statistics for variables used in cross-section models of section 3.6.2

VARIABLE	UNITS	MEAN	SD	MIN	MAX	N	DATA SOURCE
STC (present SPS)	Num. Concerns	0.21	0.76	0	8.00	1,080	Author's own / SPS - IMS
STC (last SPS)	Num. Concerns	0.17	0.70	0	8.00	1,080	Author's own / SPS - IMS
BND Tariff (wgt. av.)	%	31.06	34.07	0	316.97	915	WITS / TRAINS
ln(imports)	ln(yr 2000 US$)	18.24	2.69	0	26.83	1,009	UN COMTRADE
ln(exports)	ln(yr 2000 US$)	17.28	3.95	0	26.44	1,013	UN COMTRADE
ln(GDP)	ln(yr 2000 US$)	25.26	2.30	20.23	30.09	1,076	World Bank WDI
Total Both SPS	Num. Notifications	7.86	16.61	0	205.00	1,080	Author's own / SPS - IMS
Enviro. Governance	See source	0.24	0.56	-0.75	1.65	1,000	Yale ESI 2005

Table 76: Summary statistics for variables used in time-series models of section 3.6.3

VARIABLE	UNITS	MEAN	SD	MIN	MAX	N	DATA SOURCE
STC (present year SPS)	Num. Concerns	0.069	0.283	0	4.00	3345	Author's own / SPS - IMS
STC (last notified SPS)	Num. Concerns	0.081	0.311	0	4.00	2265	Author's own / SPS - IMS
L.D. BND Tariff (wgt. av.)	%	-0.237	8.118	-114.15	188.36	2078	WITS / TRAINS
L2.D. Log Imports	ln(yr 2000 US$)	0.141	0.986	-17.32	18.88	2543	UN COMTRADE
L2.D. Log Exports	ln(yr 2000 US$)	0.104	1.134	-18.46	12.14	2540	UN COMTRADE
D. Log Exchange Rate	ExRate / ExRate('96)	0.002	0.068	-0.24	0.28	1763	World Bank WDI
D. Current Account (+)	(dummy)	-0.007	0.314	-1.00	1.00	3235	World Bank WDI
D. ln(GDP per capita)	ln(yr 2000 US$ / person)	0.025	0.038	-0.15	0.22	3196	World Bank WDI
D. ln(population)	ln(1,000s people)	0.013	0.015	-0.01	0.17	3235	UN DESA Pop. Div

Table 77: Summary statistics for variables used in resolution logistic models of section 4.4.2

VARIABLE	UNITS	MEAN	SD	MIN	MAX	N	DATA SOURCE
Resolved?	(dummy)	0.33	0.47	0	1	253	SPS - IMS
# Supporting	Num. WTO Members	1.04	1.87	0	12	253	Author's own / SPS - IMS
Raise Count	Num. Times STC raised	2.36	1.74	1	15	253	Author's own / SPS - IMS
Raise ln(GDP)	ln(yr 2000 US$)	27.76	2.19	19.82	30.09	253	World Bank WDI
Maintain Developing?	(dummy)	0.45	0.50	0	1	253	World Bank WDI
Raise Developing?	(dummy)	0.47	0.50	0	1	253	World Bank WDI
Diff. ln(GDP)	ln(Constant 2000 US$)	0.32	3.00	-10.04	7.17	253	Author's own / WB WDI
Maintain ln(GDP)	ln(yr 2000 US$)	27.44	2.22	21.63	30.09	253	World Bank WDI
Raise ln(GDP per capita)	ln(yr 2000 US$ / person)	9.13	1.21	6.01	10.56	253	World Bank WDI
Maintain ln(GDP per capita)	ln(yr 2000 US$ / person)	9.10	1.22	6.09	10.60	253	World Bank WDI
Joint Democracy Score	See source	15.55	5.87	1	20	249	Author's own / Polity IV
Diff. Democracy Score	See source	0.068	6.86	-17	17	249	Author's own / Polity IV
Maintain Democracy Score	See source	7.76	4.50	-7	10	251	Polity IV
Raise Democracy Score	See source	7.80	4.50	-7	10	251	Polity IV
Diff. Regulatory Quality	See source	0.01	1.16	-2.83	2.49	253	Author's own / WB WGI
Maintain Regulatory Quality	See source	0.72	0.74	-1.54	1.74	253	World Bank WGI
Raise Regulatory Quality	See source	0.73	0.86	-1.31	1.93	253	World Bank WGI
Diff. Enviro. Governance	See source	0.06	0.83	-1.67	1.99	249	Yale ESI
Maintain Enviro. Governance	See source	0.47	0.55	-0.58	1.65	252	Yale ESI
Raise Enviro. Governance	See source	0.40	0.56	-0.58	1.39	250	Yale ESI

A.15. PLANT HEALTH SPS STCS SUMMARY TABLES

Table 78: Use of plant health related STCs by maintaining country and UN region

Maintaining UN Region	Maintaining Member	Num. STCs	% Regional Total	% World Total
East Asia		**21**	**100.0%**	**19.4%**
	Japan	13	61.9%	12.0%
	China	4	19.0%	3.7%
	Taiwan	2	9.5%	1.9%
	Korea	2	9.5%	1.9%
North America		**18**	**100.0%**	**16.7%**
	United States	17	94.4%	15.7%
	Canada	1	5.6%	0.9%
Latin America		**17**	**100.0%**	**15.7%**
	Brazil	5	29.4%	4.6%
	Mexico	4	23.5%	3.7%
	Venezuela	2	11.8%	1.9%
	Chile	2	11.8%	1.9%
	Panama	1	5.9%	0.9%
	Guatemala	1	5.9%	0.9%
	Honduras	1	5.9%	0.9%
	Costa Rica	1	5.9%	0.9%
Europe		**16**	**100.0%**	**14.8%**
	European Union	9	56.3%	8.3%
	Switzerland	2	12.5%	1.9%
	Poland	2	12.5%	1.9%
	Slovakia	2	12.5%	1.9%
	France	1	6.3%	0.9%
Australasia		**11**	**100.0%**	**10.2%**
	Australia	9	81.8%	8.3%
	New Zealand	2	18.2%	1.9%
SE Asia		**10**	**100.0%**	**9.3%**
	Indonesia	8	80.0%	7.4%
	Malaysia	1	10.0%	0.9%
	Philippines	1	10.0%	0.9%
Certain Members		**4**	**100.0%**	**3.7%**
South Asia		**4**	**100.0%**	**3.7%**
	India	4	100.0%	3.7%
West Asia		**4**	**100.0%**	**3.7%**
	Israel	3	75.0%	2.8%
	Turkey	1	25.0%	0.9%
Caribbean		**3**	**100.0%**	**2.8%**
	Cuba	1	33.3%	0.9%
	Dominican Republic	1	33.3%	0.9%
	Barbados	1	33.3%	0.9%
TOTAL		**108**		**100%**

Table 79: Use of plant health related STCs by maintaining country and RPPO

Maintaining RPPO	Maintaining Member	Num. STCs	% Regional Total	% World Total
APPPC		**31**	**100.0%**	**28.7%**
	Australia	9	29.0%	8.3%
	Indonesia	8	25.8%	7.4%
	India	4	12.9%	3.7%
	China	4	12.9%	3.7%
	New Zealand	2	6.5%	1.9%
	Korea	2	6.5%	1.9%
	Philippines	1	3.2%	0.9%
	Malaysia	1	3.2%	0.9%
EPPO		**20**	**100.0%**	**18.5%**
	European Union	9	45.0%	8.3%
	Israel	3	15.0%	2.8%
	Switzerland	2	10.0%	1.9%
	Slovakia	2	10.0%	1.9%
	Poland	2	10.0%	1.9%
	Turkey	1	5.0%	0.9%
	France	1	5.0%	0.9%
Independent		**19**	**100.0%**	**17.6%**
	Japan	13	68.4%	12.0%
	certain members	4	21.1%	3.7%
	Taiwan	2	10.5%	1.9%
NAPPO		**18**	**100.0%**	**16.7%**
	United States	17	94.4%	15.7%
	Canada	1	5.6%	0.9%
OIRSA		**9**	**100.0%**	**8.3%**
	Mexico	4	44.4%	3.7%
	Honduras	1	11.1%	0.9%
	Panama	1	11.1%	0.9%
	Dominican Rep.	1	11.1%	0.9%
	Guatemala	1	11.1%	0.9%
	Costa Rica	1	11.1%	0.9%
COSAVE		**7**	**100.0%**	**6.5%**
	Brazil	5	71.4%	4.6%
	Chile	2	28.6%	1.9%
CPPC		**4**	**100.0%**	**3.7%**
	Venezuela	2	50.0%	1.9%
	Cuba	1	25.0%	0.9%
	Barbados	1	25.0%	0.9%
TOTAL		**108**		**100.0%**

Table 80: Use of plant health related STCs by raising country and UN region

Raising UN Region	Raising Member	Num. STCs	% Regional Total	% World Total
North America		**36**	**100.0%**	**33.3%**
	United States	32	88.9%	29.6%
	Canada	4	11.1%	3.7%
Latin America		**26**	**100.0%**	**24.1%**
	Argentina	11	42.3%	10.2%
	Chile	3	11.5%	2.8%
	Brazil	3	11.5%	2.8%
	Ecuador	2	7.7%	1.9%
	Uruguay	2	7.7%	1.9%
	Costa Rica	2	7.7%	1.9%
	Venezuela	1	3.8%	0.9%
	Mexico	1	3.8%	0.9%
	Nicaragua	1	3.8%	0.9%
Europe		**19**	**100.0%**	**17.6%**
	European Union	18	94.7%	16.7%
	Hungary	1	5.3%	0.9%
East Asia		**9**	**100.0%**	**8.3%**
	China	7	77.8%	6.5%
	Hong Kong	1	11.1%	0.9%
	Taiwan	1	11.1%	0.9%
Australasia		**8**	**100.0%**	**7.4%**
	New Zealand	5	62.5%	4.6%
	Australia	3	37.5%	2.8%
SE Asia		**6**	**100.0%**	**5.6%**
	Philippines	4	66.7%	3.7%
	Thailand	2	33.3%	1.9%
South Asia		**2**	**100.0%**	**1.9%**
	India	1	50.0%	0.9%
	Pakistan	1	50.0%	0.9%
Northern Africa		**1**	**100.0%**	**0.9%**
	Egypt	1	100.0%	0.9%
West Asia		1	100.0%	0.9%
	Israel	1	100.0%	0.9%
TOTAL		**108**		**100.0%**

Table 81: Use of plant health related STCs by raising country and RPPO

Raising RPPO	Raising Member	Num. STCs	% Regional Total	% World Total
NAPPO		**36**	**100.0%**	**33.3%**
	United States	32	88.9%	29.6%
	Canada	4	11.1%	3.7%
APPPC		**22**	**100.0%**	**20.4%**
	China	7	31.8%	6.5%
	New Zealand	5	22.7%	4.6%
	Philippines	4	18.2%	3.7%
	Australia	3	13.6%	2.8%
	Thailand	2	9.1%	1.9%
	India	1	4.5%	0.9%
EPPO		**20**	**100.0%**	**18.5%**
	European Union	18	90.0%	16.7%
	Hungary	1	5.0%	0.9%
	Israel	1	5.0%	0.9%
COSAVE		**19**	**100.0%**	**17.6%**
	Argentina	11	57.9%	10.2%
	Brazil	3	15.8%	2.8%
	Chile	3	15.8%	2.8%
	Uruguay	2	10.5%	1.9%
OIRSA		**4**	**100.0%**	**3.7%**
	Costa Rica	2	50.0%	1.9%
	Nicaragua	1	25.0%	0.9%
	Mexico	1	25.0%	0.9%
CAN		**2**	**100.0%**	**1.9%**
	Ecuador	2	100.0%	1.9%
NEPPO		**2**	**100.0%**	**1.9%**
	Egypt	1	50.0%	0.9%
	Pakistan	1	50.0%	0.9%
Independent		**2**	**100.0%**	**1.9%**
	Taiwan	1	50.0%	0.9%
	Hong Kong	1	50.0%	0.9%
CPPC		**1**	**100.0%**	**0.9%**
	Venezuela	1	100.0%	0.9%
TOTAL		**108**		**100.0%**

A.16. AGENDA FOR FARMER/TRADER WORKSHOP

RASD Farmer and Trader Meeting

RASD Resource Centre

1/11/2014

10am – 6pm

Part 1: Understanding Other Market Opportunities

10am – Introduction – Ignitius Bwoogi

10:10am – Prayer – Paul Kisseki

10:30am – Welcome from Village Chief

11am – Break-up into 5 focus groups to discuss questions

12:30pm – Return to discuss in big group

1pm – Lunch catered from Bonnie's Restaurant

Part 2: Pests and Diseases of Coffee and Responses

2pm – Large group discussion of problems faced by coffee farmers

2:30pm – Break-out into 5 focus groups to discuss questions

3:30pm – Large group discussion about pathways forward

4pm – Small break

Part 3: Market Connections Trading Game

4:30pm – Review the day and explain game

5pm – Game starts: each breakout group needs to decide whether to sell to Neil, Lee, or Igntiius for each of the 10 simulated coffee years. They will each have a different price list to simulate the market. Paul will enter data on the laptop

5:45pm – Game ends and winner announced

6pm – Closing

A.17. CONSENT PAGE FOR SURVEYS

Brief of survey:

The point of this survey is to understand how coffee pests and diseases have affected your farm and your region. This study is undertaken by the Rural Agency for Sustainable Development (RASD) in Nkokonjeru as well as research collaborators at the University of California Davis in the USA and Imperial College London in England.

Procedures:

We will ask you questions about pests, your farm, and your family. All answers will be recorded. At the end of the survey you will be paid for your time—as there are no right or wrong answers. With your permission, your photo and photos of your coffee plot may be taken.

Risks:

This interview is not expected to cause you harm, but if you feel uncomfortable with some of the questions you can choose not to answer them and continue the interview or stop the interview as you wish. You will still be given the opportunity to receive the benefits of the survey, even if you decide to end the interview.

Benefits:

You will be compensated for your time via a brief risk-aversion game at the end of the interview. You will be awarded an amount between 2,000-7,000 USh depending on the outcome of the game.

Confidentiality:

You name will be taken at the time of interview, but will be changed to an ID number and nothing will be associated with your real name once the data is saved digitally.

Whom to contact:

If you want to find more information about the study, or make a complaint, please contact Dr. Neil McRoberts (nmcroberts@ucdavis.edu) (+1 530-752-3248) at University of California at Davis, or Lee Pearson (L.Pearson10@imperial.ac.uk) (+44 7532 003 029) at Imperial College London.

____

Subject's signature or fingerprint

______________________________ _________________

Signature of interviewer Date

A.18. INSTRUCTION PAGE FOR RISK-AVERSION GAME

Instructions:

1. Before showing the sheet, explain:
   - You will play a game with 2 bags A and B.
   - In each bag there are 4 marbles, you will draw 1.
   - Each marble is worth some amount money.

2. In bag A, there are 4 red marbles each worth 4,000 USh. (***Demonstrate with marbles in bag***).

3. In bag B, there are 3 red marbles and 1 white marble, but the value of each will vary on each row.

4. (***show sheet and explain briefly the pay-out possibilities again with the numbers in front of them. Do a practice with the bag***)

5. Demonstrating on sheet, explain there are 8 rounds/rows and for each they choose whether they prefer to draw one marble from bag A or B.

6. Explain that after they have filled out all 8 rows, one row will be chosen and played for real.

7. Questions?

(Interviewer should answer questions and then report the outcome below: which of the 8 rows was selected, the amount paid, and signature of volunteer indicating they were paid. Save sheet in safe place and bring back to RASD.)

END OF INTERVIEW

Row Randomly Chosen: ___________

Paid:____________________________ Signature: ___________________________

A.19. SURVEY FORM FOR FARMERS

Coffee Production Questions:

1. What do you produce in addition to coffee? (e.g. matoke, chicken…)	
2. Total size of farm land	(acres)
3. Size of coffee plot	(acres)
4. Number of coffee trees (#)	(trees)
5. How many years have you been growing coffee?	(years)
6. Have you planted seedlings in the past 5 years a. When? b. How many?	(yes / no) (years) (trees)
7. Amount of coffee produced a. This year? b. Last year? c. Typical year in past?	(kg) (kg) (kg)
8. What do you sell?	(*Mwanyi mbisi* / *Mwanyi Nkalu* / *Kase*)
9. Do you dry your coffee on the ground or on a tarpaulin?	(ground / tarpaulin / other)
10. Do you think you could produce more with your plot? a. What limits your production? (e.g. pests, old trees, etc.)	(yes / no)
11. Has quality been a problem?	(yes / sometimes / no)
12. Has the price been adequate a. 2013 price? b. 2012 price? c. "fair" price?	(yes / no) (USh/kg) (USh/kg) (USh/kg)
13. What are your total estimated costs for producing coffee each year? a. What are the 3 biggest expenses? (e.g. pesticides, seedlings, harvesting etc.)	(USh/year) 1. 2. 3.

Network Questions:

14. Who do you go to help make decisions on your coffee plot (from planting through to sale)? a. Spouse? b. Extension agent? c. Input salesperson? d. Neighbour? e. Coffee trader? f. Friend? g. Community leader?	 (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no)
15. Do you apply fertilizer or growth treatments to your coffee trees? What? Who do you get it from?	(yes / no) (what?) (who?)
16. Do you apply pesticides, fungicides, or other treatments against diseases/pests? What? Who do you get it from?	(yes / no) (what?) (who?)
17. Who do you talk to when deciding how to treat a pest/disease?	(who?)
18. Who do you sell your coffee to? Where does it go next?	(who?) (where?)
19. What other options are there for selling coffee? - Who does neighbour sell to?	
20. Are you a member of a Co-op or other coffee farmer group? Which one? Why?	(yes / no) (which?) (why?)
21. Why did you start growing coffee? - Who did you talk to about that decision?	
22. Have you attended a course: a. At RASD? b. Other agency? Which?	 (yes / no) (yes / no) (which?)

Pest Questions:

23. What are the most significant pest problems you've faced this year?

25. What were the most significant pest problems last year?

26. If coffee pests/disease got very bad such that you couldn't grow it:
    a. What other crops would you grow instead (e.g. matoke, beans)?

    b. Would you consider a non-planting activity to make money (e.g. waaragi brewing, chicken raising, craft making, etc.)?

Pest/Disease Image Survey:

27. Tick the box after showing pictures of each

		Name of it	YES	NO
27.A.	Have you seen A before?			
27.B.	Have you seen B before?			
27.C.	Have you seen C before?			
27.D.	Have you seen D before?			
27.E.	Have you seen E before?			

28. How severe do you think the impact would be from A,B,C,D,E on your plot?

	DESCRIPTION	A	B	C	D	E
NONE	It does nothing to the coffee when it comes					
LOW	Very minor change to yield or quality					
MED.	I earn less money due to impact on yield or quality					
HIGH	I lose about half of my crop earning from loses to yield or quality					
VERY HIGH	Losses are substantial (more than half) and it may impact my ability to grow coffee following years					

29. How frequently do you observe A,B,C,D,E on your plot?

	DESCRIPTION	**A**	**B**	**C**	**D**	**E**
NEVER	I've never seen this on my plot in the past 5 years					
SELDOM	I've seen this in 1 year of the past 5 years					
OFTEN	I've seen this in 2 to 4 years of the past 5 years					
ANNUAL	I see this every year at some point on my plot					
ALWAYS	This is essentially always present on my plot. Throughout the year, I'll see it many times.					

30. What do you do to prevent and treat A, B, C, D, E on your farm?

Describe measures	Rate the effectiveness of each from 1-5 (1-not very, 5-super effective)

31. What are the barriers you face to dealing with coffee pests/diseases?

32. What do others (e.g. neighbours) do to prevent A, B, C, D, E on their plots?

Describe measures	Why don't you use these measures?

33. Are there other pests/disease problems with coffee that we have not talked about so far? How frequently do they occur? How severe is their impact?

Household Questions:

34. Sex	(male / female)
35. Age	
36. Highest education of head of house	(none / primary / secondary / higher)
37. Number of children	
38. Married	(yes / no)
39. Total household size including relatives or friends living with you	
40. Estimate yearly or monthly income?	(USh/month) or (USH/year)
41. How many times a day do you eat?	(<1 / 1 / 2 / 3 / 3+)
42. Do you own a cellphone?	(yes / no)
43. Do you own a motorcycle/vehicle?	(yes / no)
44. Do you have electricity?	(no / solar / grid / generator / battery)
45. Do you own the land you grow on?	(yes / no)
46. Do you own a watch or clock?	(yes / no)
47. In addition to coffee, how else does your family make money?	
48. How important is coffee to your income?	not important less than half of income more than half of income sole income source

A.20. SURVEY FORM FOR TRADERS

Coffee Trading Questions:

1. What do you trade in addition to coffee?		
2. How many coffee growers did you buy from in 2013? a. How many in 2012? b. Typically how many?	(growers) (growers) (growers)	
3. Travel how far to buy coffee?	(miles or km)	
4. How many people do you employ to buy on your behalf?	(traders)	
5. Typical purchase size from one coffee grower	(kgs)	
6. Coffee bought: a. Variety of coffee b. Cherry? c. *Kase*? d. *Mwanyi Nkalu* how? e. Certifications?	(Robusta / Arabica / Koronal / other) (*Mwanyi Nkalu* / *Mwanyi mbisi*) (yes / no) (ground / tarp / both / other) (none / fair-trade / Nucafe / other)	
7. Percentage coffee bought from other traders?	______% from traders _______% from growers	
8. What do you mainly sell? a. 2013 price? b. 2012 price? c. Fair price?	(*Kase* / *Mwanyi Nkalu* / *Mwanyi mbisi*) (USh/kg) (USh/kg) (USh/kg)	
9. How many years have you been trading coffee?	(years)	
10. Amount of coffee bought a. In 2013? b. In 2012? c. Typical year?	<u>*Mwanyi Nkalu*</u> (tonnes) (tonnes) (tonnes)	<u>*Mwanyi mbisi*</u> (tonnes) (tonnes) (tonnes)
11. Do you think you could trade more coffee? a. What limits you? (e.g. pests, credit, etc.)	(yes / no)	
12. Has quality been a problem?	(yes / sometimes / no)	
13. What price do you pay farmers: a. In 2013? b. In 2012? c. What is a fair price?	<u>*Mwanyi Nkalu*</u> (USh/kg) (USh/kg) (USh/kg)	<u>*Mwanyi mbisi*</u> (USh/kg) (USh/kg) (USh/kg)

14. What are your total costs for trading coffee each year? a. What are the 3 biggest costs? (e.g. transport, processing, etc.)	(USh/year) 1. 2. 3.
15. Cost at mill to process *Mwanyi Nkalu* to *Kase* (remove husk)?	(USh/kg)
16. Drying 10kg *Mwanyi mbisi* makes what kg *Mwanyi Nkalu*?	(kgs)
17. Milling 10kg of *Mwanyi Nkalu* makes how many kgs *Kase*?	(kgs)

Network Questions:

18. Who do you go to help make decisions about your business: h. Spouse? i. Exporter of coffee? j. Coffee mill? k. Neighbour? l. Mill owner? m. Coffee grower? n. Friend? trades coffee? o. Community leader? trades coffee?	 (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no)
19. Do you give advice to coffee growers? a. New varieties of coffee? b. Where to get seedlings? c. Pesticides? d. Fertilizers? e. Drying/process methods? f. How to improve quality? g. Other?	(yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) (yes / no) ____________________
20. Who do you sell your coffee to? Where does it go next? (Top 3 buyers and places)	(who?) (where?) 1. 2. 3.
21. What other options are there for selling coffee, or who do other traders sell to?	(what?) (who?)
22. Do you buy as a part of a coffee trading group?	(yes / no) (which?) (why?)

23. Why did you start trading coffee? Who did you talk to about that decision?	(why?) (who?)
24. Do you grow coffee as well? How much in 2013? a. If you did in past, but not now, why did you stop?	(yes / no) _______kgs *Mwanyi mbisi* in 2013 (why?)
25. Have you attended a course: a. At RASD? b. Other agency? Which?	 (yes / no) (yes / no) (which?)

Pest Questions:

26. What are the most significant pest problems coffee growers had in 2013?

27. What were the most significant pest problems in 2012?

28. If coffee pests/disease got very bad, such that you couldn't trade coffee:
    a. What would you do instead to make money? (e.g. raise chickens, trade other crops, grow *matooke*, etc.)

    b. How likely do you think this is to happen in the next 5 years?

1 – Very unlikely 2 – Unlikely 3 – Possible 4 – Likely 5 – Very likely

Pest/Disease Image Survey:

29. Tick the box after showing pictures of each

		Name of it	YES	NO
27.A.	Have you seen A before?			
27.B.	Have you seen B before?			
27.C.	Have you seen C before?			
27.D.	Have you seen D before?			
27.E.	Have you seen E before?			

30. Rank the severity of each pest/disease for coffee growers starting with worst:

1_____ 2_____3_____ 4_____5_____

31. What makes #1 so bad?

32. What do growers do to prevent and treat A, B, C, D, E on their plots?

Describe measures taken	How effective is it?

33. What are the barriers coffee growers face to deal with coffee pests/diseases?

34. Are there other pests/disease problems with coffee that we have not talked about so far? How frequently do they occur? How severe is their impact?

Household Questions:

35. Sex	(male / female)
36. Age	
37. Highest education of head of house	(none / primary / secondary / higher)
38. Number of children	(kids)
39. Married	(yes / no)
40. Total household size including relatives or friends living with you	(people)
41. What is your operation capital?	(USh)
42. Estimate yearly or monthly income?	(USh/month) or (USH/year)
43. How many times a day do you eat?	(<1 / 1 / 2 / 3 / 3+)
44. Do you own a cellphone?	(yes / no)
45. Do you own a motorcycle/vehicle?	(yes / no)
46. Do you have electricity?	(no / solar / grid / generator / battery)
47. Do you own land?	(yes / no)
48. Do you own a watch or clock?	(yes / no)
49. In addition to trading coffee, how else does your family make money?	
50. How important is coffee to your income?	*(check one)* not important less than half of income more than half of income sole income source

A.21. MPL DESIGN FOR IMPERIAL FESTIVAL IN LONDON

#	Bag A	Bag B		Pick a marble from A or B?
	4 red marbles ●●●●	3 red marbles ●●●	1 white marble ○	
1	£4.00	£4.00	£2.00	
2	£4.00	£4.50	£2.00	
3	£4.00	£5.00	£2.00	
4	£4.00	£5.50	£2.00	
5	£4.00	£6.00	£2.00	
6	£4.00	£7.00	£2.00	
7	£4.00	£7.00	£3.00	
8	£4.00	£7.00	£4.00	

Compare your risk aversion to growers in Buikwe:

http://bit.ly/impfest2014

Based on the methodology of: Tanaka, Y. and A. Munro (2014) Regional Variation in Risk and Time Preferences: Evidence from a Large-scale Field Experiment in Rural Uganda. *Journal of African Economies*, 23(1). pp 151-187.

A.22. ROBUSTA COFFEE PESTS AND DISEASES OF UGANDA

A.22.1. Coffee Wilt Disease (CWD)

Tracheomycosis—Coffee Wilt Disease (CWD)—is caused by the anamorph *Fusarium* fungal pathogen *F. xylarioides* (*Gibberella xylarioides* in the sexual, teleomorph stage) (Hakiza, DT, Musoli, et al., 2009; Flood, 2009). The fungus blocks water and nutrient transport in the tree causing wilting and eventual death. While it was detected in coffee in the early 1900s, the biological understanding of the disease is still improving. Recent work has found isolates of other associated *Fusarium* species (*F. lateritium*) on CWD infected coffee plants in Uganda, but it is thought these could be secondary invaders of plants injured by an initial *F. xylarioides* infection (Geiser, Ivey, Hakiza, et al., 2005). Coffee wilt can affect a coffee plant at any stage in its life cycle from seedling to mature plant. The fungus has also been found to host in tomatoes in Nigeria and recently, in bananas in Uganda—an important find for management as often coffee is intercropped with bananas in Uganda farming systems (Waller, Bigger & Hillocks, 2007a). Once affected by CWD, mortality rate for plants is considered to be nearly 100% (Geiser, Ivey, Hakiza, et al., 2005). The high mortality rate for this fungal pathogen makes it a serious threat to coffee production once it has established a strong presence in a given field or region.

CWD was first detected in 1939 on *C. excelsa* coffee (synonymously *C. liberica*) samples collected from plantations at a town called Aba in the Democratic Republic of Congo (DRC) near the border of South Sudan (Kalonji-Mbuyi, Tshilenge Djim & Saiba, 2009). The detection was just subsequent to the scaling up of coffee production in the DRC; commercial-level growing began between 1924 and 1930 (Kalonji-Mbuyi, Tshilenge Djim & Saiba, 2009). However, others credit the first detection of CWD to a source in the Central Africa Republic. There is a reference to a wilt disease affecting coffee first observed in 1927 near Bangui in the Central African Republic (Waller, Bigger & Hillocks, 2007a). The disease spread quickly among the large plantations of *C. excelsa* coffee in Central African Republic such that be the end of the 1930s, CWD was found throughout the country. By 1945 was found to affect other coffee varieties (specifically Robusta, *C. canephora*) (Waller, Bigger & Hillocks, 2007a).

CWD is now present in coffee growing areas throughout Africa, but it is especially severe in Uganda as shown in Figure 89.

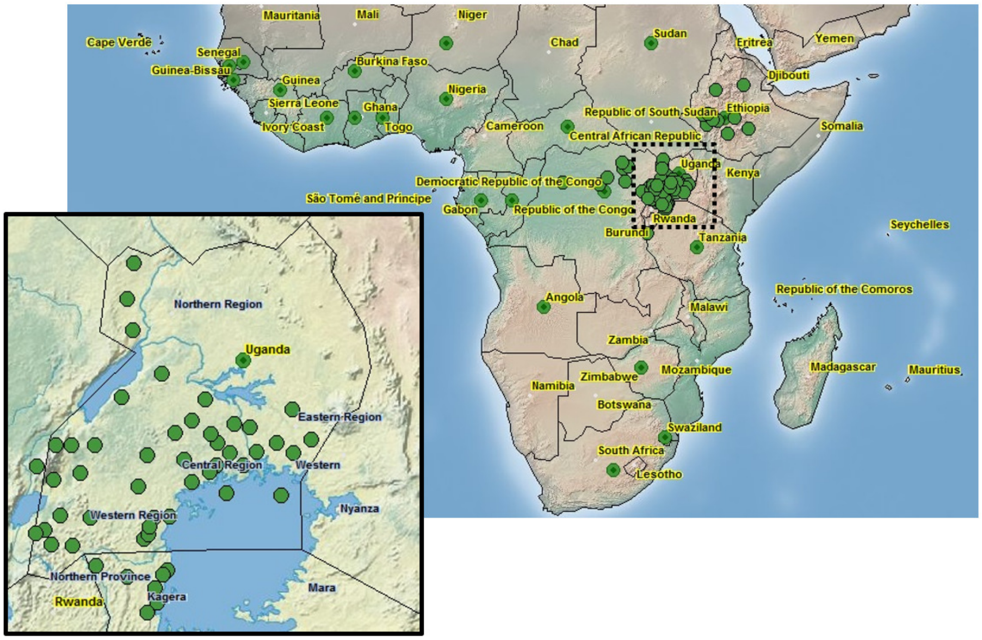


Figure 89: Coffee Wilt Disease (*G. xylarioides*) is widespread in Africa, with a concentrated presence in East Africa (see inset of Uganda) (Leach & Hobbs, 2013). [217]

Due to the diseases' impact on production, Uganda has had various projects from domestic and international institutions to control the disease (Rutherford, 2006). Management practices on the farm have encouraged farmers to be more careful about cross-field contamination from spreading soil and there have been measures put in place to raise awareness about burning infected trees. However, one of the more successful efforts have been the development and distribution of CWD-resistant seedlings. Rutherford (2006) reviews the current state of the knowledgebase on CWD in East Africa including resistant seedling development. The NaCCRI/COREC[218] Senior Scientist interviewed (interviewee #15) as a part of this research confirmed they have developed seven different resistant varieties of Robusta coffee, which have been widely distributed in the past decade or more to control the severity of CWD on farmers' production. Despite the advancements to get CWD under control, it is still a major constraint on farmers' production as evidence from the pest survey (see section 6.4.1).

[217] Data available through CABI Plantwise Pest Distribution Map database: http://www.plantwise.org/KnowledgeBank/ Map/ GLOBAL/ Gibberella_xylarioides/

[218] NaCCRI is the National Crops Research Institute and a part of this research group is the Coffee Research Centre or COREC, both are under the National Agricultural Research Organization or NARO in Uganda.

A.22.2. Black Twig Borer (BTB)

BTB (*Xyleborus ferrugineus*) is an ambrosia beetle with a wide range of distribution across the world as well as a wide variety of host plants. The distribution of the beetle across Africa is shown in Figure 90. In Uganda, it is often called the Coffee Twig Borer as well (CTB). Like most ambrosia beetles, the BTB lives in symbiosis with a fungus that the beetle infects the twig with when it burrows a tunnel. The fungus digests the xylem tissue of the plant and then the beetle consumes the fungus. Unlike the majority of ambrosia beetles though, the BTB attacks healthy trees and not dead wood or damaged trees—although anecdotally in Uganda, it is thought that coffee trees already under stress (e.g. from lack of nutrients, water, or CWD) may be more susceptible to attack from BTB (personal conversation, interviewee #15).

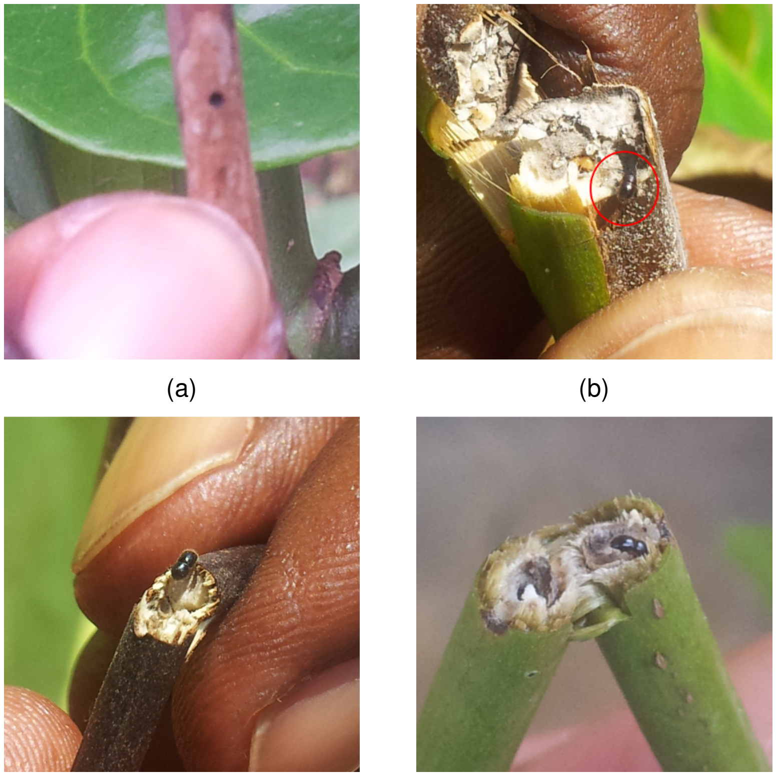
Figure 90: Black Twig Borer (Xyleborus ferrugineus) is present (green dot) in most countries in sub-Saharan Africa including Mali and Sudan to the north (Leach & Hobbs, 2013).

A NaCCRI/COREC Senior Scientist confirmed that BTB is the pest they are currently most concerned about for coffee production (personal conversation, interviewee #15). It came as early as 1993 they believe. Like CWD, it came from the Democratic Republic of Congo, but it only became a real problem for coffee production in several districts of Uganda in the past five years. The NaCCRI/COREC scientist do not know the true extent of severity of the pest, but last year reports showed that 25 out of 26 coffee districts surveyed were affected to some extent, with the southern and central districts thought to be the worst impacted (personal conversation, interviewee #15). The interviewee also noted that BTB spread to Kenya across the Nile in 2011.

The institute's consensus belief is that Uganda is still on an upward trend with the worst years yet to come for BTB. Interviewee #15 had many estimates they were using in their work in studying the BTB's biology and ecology.[219] The data would be helpful in developing a spread model for BTB to help with control planning, but this application was saved for future research.

NaCCRI/COREC is planning national surveys to get a better idea of the extent of the problem—though currently interviewee #15 estimated that nationwide perhaps 8% of branches are affected. In Uganda, they have confirmed that the insect can host on over 40 crops commonly grown. As such, this makes it a very difficult pest to tackle since it can live on host shade trees surrounding coffee plots or on neighbouring cocoa or avocado trees that a farmer may have in his or her garden. They believe the shade also helps the borer with lower temperatures. Interestingly though, the damage anecdotally seems to be more severe in the dry season (personal conversation, interviewee #15). The reason for this discrepancy was thought to be that the tree is stressed more in the dry season and is thus more susceptible to damage from the fungus that the borer spreads. Some of the clonal varieties developed to resist CWD are also more vulnerable to BTB than others; however, interviewee #15 believed that all cultivars are ultimately susceptible to some extent.

[219] Interviewee #15 from NaCCRI/COREC reported that the BTB female can fly up to 200m in a day, can infest approximately 10 twigs in her lifetime, and produce around 20 eggs per twig she infests. It takes around 1 month from boring the twig to hatching. Interviewee was unsure about mortality rates, gender dynamics, and predation as much more research is needed into the ecology of the BTB in Uganda.



(a) (b) (c) (d)

Note: (a) entry hole for BTB; (b) mature BTB (red circle) in thicker twig and fungus clearly visible in split open gallery; (c) BTB in mature, brown twig; (d) BTB in young, green twig. All photos taken by author.

Figure 91: Examples of BTB present in twigs in coffee trees found during household surveys

The senior scientist also reiterated the importance of checking for signs of BTB (e.g. small holes in the twigs of the coffee tree) and then pruning and burning any infected branches. While most farmers know this based on the grower/trader workshop in Nkokonjeru that the research team conducted, the HH survey confirmed that few were actually following this practice (see section 7.2.1 beginning on page 276). Interview #15 also observed that if farmers were more diligent about pruning to keep the coffee tree from getting too "bushy" and fertilized regularly, the tree health would be improved and the vigour might help it to survive localized infestations by BTB. Many farmers visited during household surveying were able to identify an infestation of BTB on their trees once shown a picture during the pest survey, even when they did not have a name for it (see examples in Figure 91 above).

Other treatment methods include alcohol-based traps (personal conversation, interviewee #15 and #14). The manager of a coffee supply chain training organization (interviewee #14) thought that alcohol-based traps worked well, except that farmers may drink the alcohol. However, the senior scientist at NaCCRI/COREC (interviewee #15) found that even in their controlled experiments at their field test site in Mukono, they were only capturing a maximum of five beetles per week. This rate of capture was thought far too low to affect seriously the spread of the insect on a farmer's plot (personal conversation, interviewee #15). As well, the Regional Sustainability Manager (interviewee #8) who worked with farmers on behalf of Exporter B, also reported that their trials of alcohol-based traps were not successful; interviewee #8 reported capturing more wasps than BTB.

Despite the only government research agency for coffee as well as a major exporter not recommending traps, several other stakeholders were still actively promoting them. RASD as well as NGO B had active programs to teach coffee growers how to construct and use alcohol-based traps. The local NAADS officers also talked about the need for funding to construct more alcohol-based trap interventions as an extension service (personal conversation, interviewee #16). While this discrepancy was not fully explored, it appeared that there was a lot of latency in communication between stakeholders further removed from the farmers with those that are meant to interface with them directly. The NGOs were still working on promoting alcohol-based traps, while the research agency and exporters had already done controlled scientific experiments to show they do not work effectively and had moved on to new ideas. Given that no one from the research team saw one trap in use during all of the household surveys, it was likely that farmers as well had realized the traps were ineffective.

Moving beyond chemical attractants, NaCCRI/COREC had also done some limited testing on chemical control agents (personal conversation, interviewee #15). They had found that "E-max" a pesticide[220] when applied along with tebuconazole (a triazole fungicide) worked to some extent to control BTB populations in their field, but they had yet to do extensive controlled experiments to confirm best practice on using pesticide/fungicide combinations. These tests were seen as low priority as the vast majority of Uganda's coffee growers would be unable to afford pesticide/fungicide treatment regimens due to the high costs (personal conversation, interviewee #15).

[220] Interviewee #15 was unsure what chemical was in it, and the author could not find it on the market when he interviewed the inputs store employee, interviewee #13

In the course of the surveys, the team found that ants sporadically inhabited the inside of twigs that looked like they had been infested by the BTB based on the entry hole of the twig and symptoms of the tree. A few images from one case found at the beginning of the household surveys is shown in Figure 92.

Note: the red circle (right) shows what looks like ant larva in the gallery of the twig

Figure 92: Examples of black ants (unknown spp) inhabiting a likely former Black Twig Borer gallery

The contact at NaCCRI/COREC had not heard of ants interfering with BTB and was interested by the anecdotal evidence we had from the surveys. The Senior Scientist (interviewee #15) however thought that finding a natural predator of the BTB would be the best control strategy for BTB given the lack of cash farmers have for pesticides and ineffectiveness of alcohol-based traps. In conversation with the Regional Sustainability Manager for Exporter B (interviewee #8), the author found that interviewee #8 as well had seen ants in a BTB gallery. Interviewee #8 was excited that someone else had found this as well. Interviewee #8 had thought the ants might be predatory and eating the eggs of the BTB, but could not find any research on the topic (personal conversation, interviewee #8). Although, unconfirmed by this present survey, the investigation into the species of ant present in the coffee twigs as well as confirming if it interacts with BTB would be a fruitful area of future research. Identification of other possible natural enemies based on surveys in the DRC where BTB likely originated before entering Uganda could also possibly point to some biological control strategies that may help reduce the impact from BTB in Uganda.

A.22.3. Coffee Berry Borer (CBB)

Coffee Berry Borer (*Hypothenemus hampei*) is one of the most important pests found at coffee plantations worldwide accounting for severe yield losses in some areas, but with presence in almost every coffee producing country in the world (Damon, 2000). Considering its extensive range, it is believed that Coffee Berry Borer (CBB) was one of the first pests associated with coffee in its infancy of international trade during the 16^{th} and 17^{th} century as coffee production spread beyond Ethiopia (Damon, 2000).

Figure 93: Coffee Berry Borer (Hypothenemus hampei) is present (green dot) on mainland sub-Sarahan Africa, as far south as Mozambique (Leach & Hobbs, 2013).

Within Africa, CBB is found in many countries as shown in Figure 93 above. Unfortunately, the expected impact of CBB in East Africa is expected to become much worse under various climate change scenarios (Jaramillo, Muchugu, Vega, et al., 2011). CBB damages the output of coffee in different ways compared to CWD or BTB. CBB enters into the coffee cherry either on the tree or after harvest and feeds on the bean inside as well as laying eggs. It is one of the most devastating pests in Colombia and as a result many IPM (Integrated Pest Management) strategies have been developed as, like Uganda, it is a critical part of the economy of Colombia. Given the effectiveness of some of the measures, the adoption rate reported by Chaves & Riley (2001) are much higher than the adoption of best practices for coffee plot maintenance found in Uganda (see section 7.2.1). The importance of learning from the experience of CBB in Colombia is that one might be able to predict the uptake of IPM strategies if similar methods could be found to control BTB. Additionally, many of the strategies discussed in Chaves & Riley (2001) were not being used in Uganda. Considering the severity of the pest reported by farmers (see section 6.4.1), it could be a useful area of extension work to apply lessons to a new, African context.

A.22.4. Red Blister Disease (RBD)

Red Blister Disease (RBD) is the fungal pathogen *Cercospora coffeicola* (*Mycosphaerella coffeicola* in the sexual, teleomorph stage) and is synonymously referred to as Brown Eye Spot Disease[221] (Rutherford & Phiri, 2006). The fungus is present in many countries of sub-Saharan Africa, as well as warmer climates in Sudan and Yemen (see Figure 94 below).

Only recently has the mechanism of infection of the coffee trees been clearly examined (Souza, Rodrigues, Maffia, et al., 2011). The disease is observed on the top (adaxial) surface of the leaves as red/brown circular spots surrounded by a yellow halo. Interestingly though, it has been shown that the conida of the fungus can only penetrate and cause disease development via open stomata or cracks in the epicuticular wax in the lower (abaxial) surface of the leaves (Souza, Rodrigues, Maffia, et al., 2011). Several growers interviewed during the HH survey showed us the signs of RBD on their plots (see Figure 95).

[221] The fungal pathogen also goes by berry blotch, berry spot disease, coffee leaf spot, and Cercospora spot, but these names are less common than the two that will be used in this text.

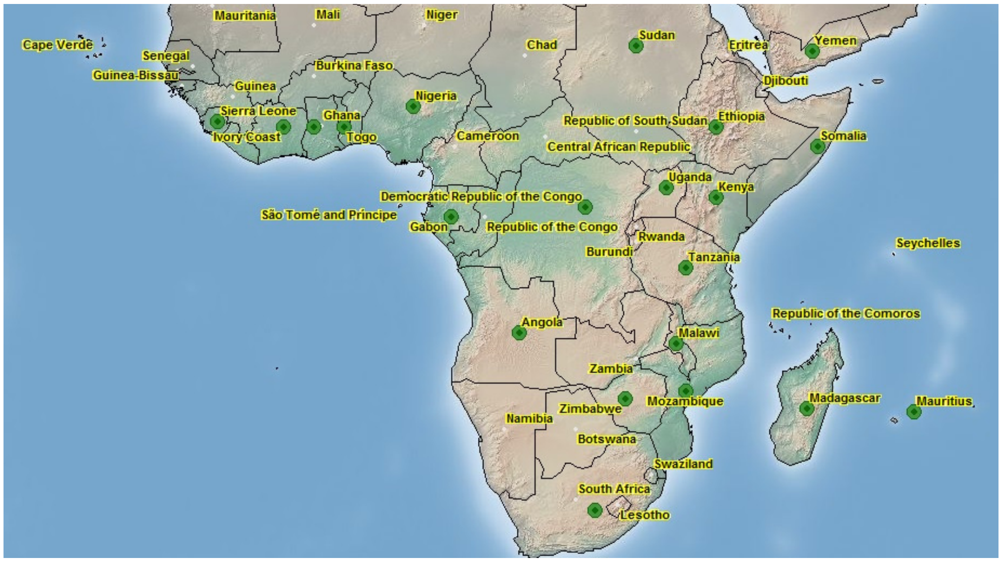


Figure 94: Red Blister Disease or Brown Eye Spot (*Cercospora coffeicola*) is present (green dot) throughout sub-Sarahan Africa including Sudan (Leach & Hobbs, 2013).

Figure 95: Examples of Red Blister Disease from household surveys on berries and leaves of coffee trees

It is thought that RBD does not have much of an impact on the yields of coffee plants (particularly of Arabica coffee trees however, Robusta are more susceptible to damage from the fungus). The main impact is on tree rigour often causing defoliation. It can be especially harmful to seedlings and young trees (Rutherford & Phiri, 2006). Despite the understanding among experts that the damage from Red Blister/Brown Eye Spot Disease is limited if the tree is mature, the farmers reported rather high severity and frequency of the fungal pathogen on their coffee plots (see results in section 6.4.1). Anecdotally, the farmers and traders during the workshop reported that RBD reduced the weight and the quality of the bean and as such, both the weight and price offered for the coffee would decrease. The discrepancy between the consensus opinion of farmers surveyed in Uganda and that of field manuals based on expert experience is worthy of further exploration, but will not be discussed in the present work.

A.22.5. Root Mealybug (RMB)

Root Mealybug (*Planococcus fungicola*) is a small pest that is found in groups on the roots of the coffee tree and is associated with a fungus (*Polyporus coffeae*[222] synonymously in an updated nomenclature *Diacanthodes novoguineensis*[223].) which forms a protective brown layer with white mycelium over the clumps of Mealybugs (Watson & Cox, 1990). As stated by Waller, Bigger & Hillocks (2007b), the Root Mealybugs (RMBs) of East Africa are often confused with *Planococcus citri* and the associated fungus *Polyporus spp.*, and even recent literature including the most recent 2007 survey of Ugandan soil organisms and pests continues with this incorrect identification (Sekamatte & Okwakol, 2007). CABI Plantwise as a result does not have detailed presence information for *P. fungicola* and as such, *P. citri* is used to construct the distribution map displayed in Figure 96.

[222] Mycobank number: 185071 (Crous, Gams, Stalpers, et al., 2004)
[223] Mycobank number: 329835 (Crous, Gams, Stalpers, et al., 2004)

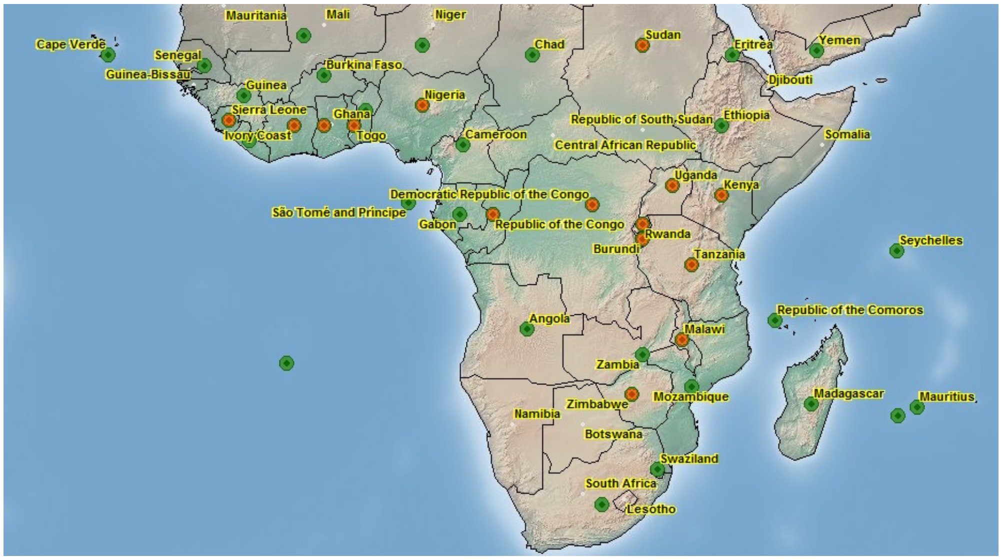


Figure 96: Root Mealybug (*Planococcus citri*) is present (green dot) almost ubiquitously across sub-Saharan Africa. Kenya (Coffee) Mealybug (Planococcus kenyae) is present (orange dot) along with Root Mealybug (Leach & Hobbs, 2013).

Other Mealybugs like the Kenya or Coffee Mealybug (*Planococcus kenyae*) are also found in Uganda, but attack the aerial parts of the plant including the berries and leaves. An example of a Mealybug found during the household survey is shown in Figure 97.

(a) (b) (c)

Note: (a) red circle around Mealybug; (b) example of the fungus covering the Mealybugs; (c) Mealybugs on surface of twig of the coffee tree

Figure 97: Example of Mealybugs on the aerial portion of the coffee tree identified during household surveys

RMB is usually considered a minor pest of Robusta coffee in Uganda (Rutherford & Phiri, 2006). The damage can be extensive if the infestation rate is high and not effectively controlled. In January of 2014, The Uganda Radio Network carried a story of an Australian firm that had a large plantation of coffee in the Rakai district[224] of Uganda which Mealybugs had destroyed 30 of the some 130 acres of coffee (Bindhe, 2014). While many farmers surveyed had aerial Mealybugs (likely Kenya/Coffee Mealybugs, but unconfirmed), there were relatively few that reported having RMB. Those that did report having them, they came infrequently, but were reported to be quite damaging when they were present. Further discussion on the reported severity and frequency of these pests is analysed against the other pests in the survey in section 6.4.1 starting on page 238.

A.22.6. Other coffee pests and diseases

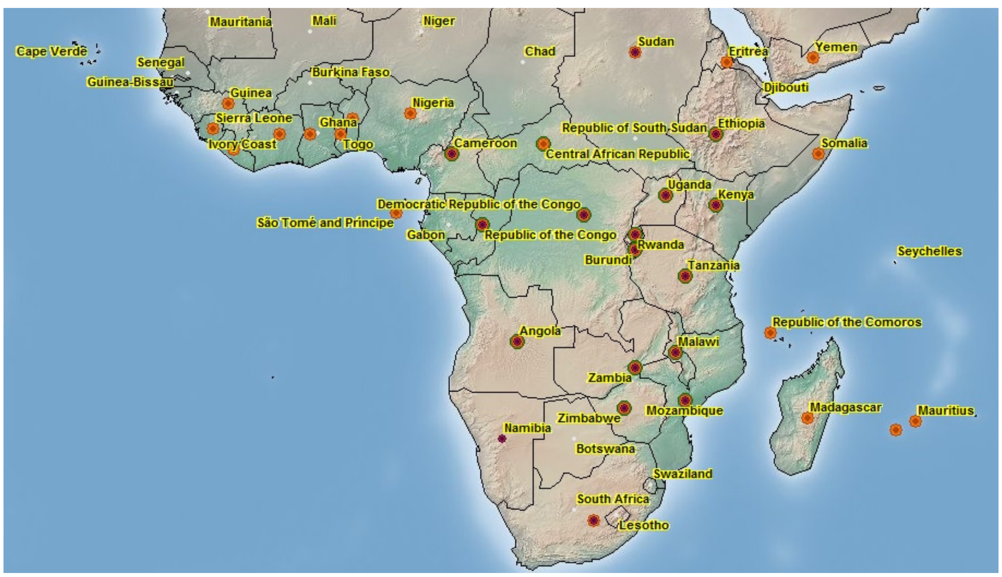


Figure 98: Coffee Berry Disease and Coffee Leaf Rust are present (in orange) throughout sub-Saharan Africa. In addition, White Stem Borer is present as well (in purple) on the mainland excluding most of West Africa (Leach & Hobbs, 2013).

Coffee Leaf Rust (CLR) is one of the most widely found coffee diseases in the world and caused by the fungal pathogen *H. vastatrix* (Hindorf & Omondi, 2011). It has caused extensive damage in the 2012 coffee season in Central America. The damage to farmers' plots was

[224] The Rakai District is in the south-west part of Uganda partially touching Lake Victoria and the border of Tanzania.

perhaps in excess of $1B USD and will be felt in the industry for decades (Malkin, 2014). Fortunately for Uganda, this fungus is not a major issue.

(a)

(b)

(c)

(d)

Note: (a) only one instance of coffee leaf rust was encountered on the household surveys; (b) one household also had evidence of coffee leaf miner; (c) green scale with associated black sooty mould was found at several households, but never reported by the farmers; (d) another sucking insect pest on a coffee berry cluster. All photos by author.

Figure 99: Examples of other coffee pests that were found but not reported as issues by the farmers surveyed

Another major disease worth mentioning in the context of coffee diseases is Coffee Berry Disease (CBD). CBD is caused by the fungal pathogen *Colletotrichum kahawae*, which is currently confined to the African continent and effects Arabica coffee plants strongly (Hindorf & Omondi, 2011). It was first detected and characterized in Kenya in 1922 (Rutherford & Phiri, 2006). However, in Uganda, since the Arabica production is a small part of the industry and isolated on the western and eastern mountainous areas, it is relatively protected from major crises. According to Rutherford & Phiri (2006), Coffee Berry Disease has not been observed on Robusta (*C. canephora*) or *C. liberica* coffee outside of controlled lab conditions. However, NGO stakeholders involved with the fieldwork were not aware of this and several of our survey team members often thought they might be seeing CBD. During the HH survey, several samples looked like they could be CBD, but when other parts of the tree were observed it was clear that it had been an earlier outbreak of RBD that, in the latter stages, had formed dark lesions on the berries. Some examples of RBD infection were not as vividly bright and spotty as others (see an example in side (b) of Figure 100 as compared to Figure 94). The difference between these two funguses is most apparent by the lack of sporulation on the surface of the lesions of berries infected with RBD. The lesion site also appears to be a darker black in the typical CBD infection; however, in a mixed Robusta and Arabica context it would be difficult for a non-expert to identify the correct infection.

Note: images included for examiners' copies, but removed for the online, publically available version on Imperial College Spiral due to copyright regulations.

(a)

(b)

Note: (a) example images of CBD from Rutherford & Phiri (2006) with lesions marked; (b) likely RBD without as many bright spots as typical infections (photo by author).

Figure 100: CBD photos compared to RBD on immature, green coffee berries

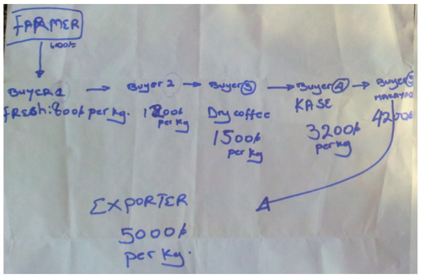
The last pest worth mentioning is the White Stem Borer (*Monochamus leuconotus*), a beetle, that has periodically been an issue for coffee production in East Africa. In southern Africa it has lowered yields by some 25% affecting over half of farms in some areas (Rutherford & Phiri, 2006). However, it was not mentioned in the open-ended part of the current pest survey and was not reported as a major issue in Uganda by a workshop held by the Coffee Research Network (CORNET) in 2004 (Rutherford & Phiri, 2006).

Figure 101: Young coffee tree attacked by unknown pest causing necrosis on the outside of the main stem. On the interior of the main stem, there was evidence of fungal infection and insect burrowing (photos by author).

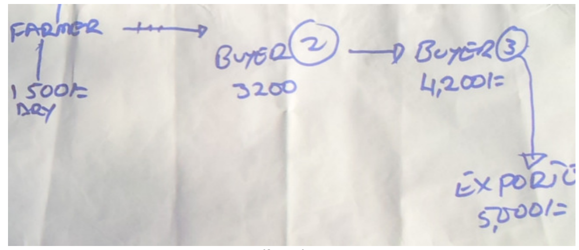
After the workshop in Kamuli District, the research team visited a farmer's home who pointed out a dying coffee sapling that the NGO's extension agent thought could potentially be a White Stem Borer issue. The farmer had a young tree that had been attacked by an unknown insect that seemed to have built a gallery within the main stem of the tree (see images in Figure 101 above). Although the stem borer does prefer young trees, the tree lacked the characteristic signs of multiple tunnels from larvae or necrotic rings on the stem (Rutherford & Phiri, 2006). The research team was unable to identify the pest, but it could have potentially been a BTB that attacked a larger than usual stem, based on the gallery and fungus inside the young tree.

A.23. ORIGINAL POSTERS FROM SUPPLY CHAIN QUESTION AT WORKSHOP

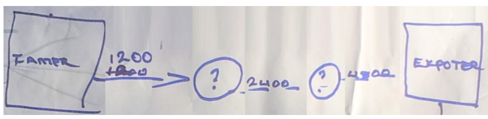
Current Supply Chain	Ideal Supply Chain



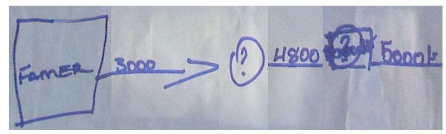
(a.1)



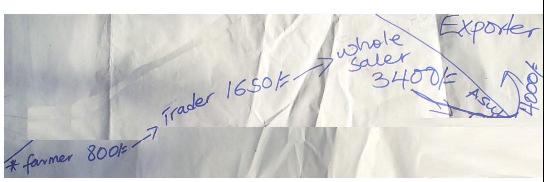
(b.1)



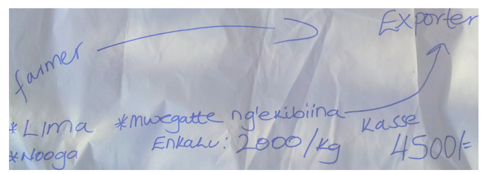
(a.2)



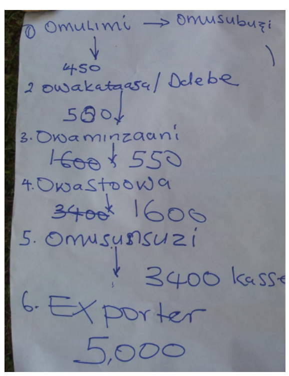
(b.2)



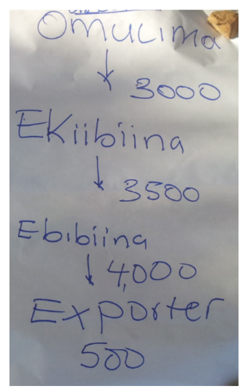
(a.3)



(b.3)

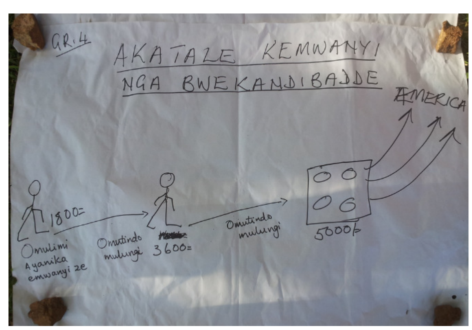


(a.4)



(b.4)

(a.5)



(b.5)

Note: All photos by author.

A.24. ANECDOTE OF GROWER WHO ABANDONED COFFEE PRODUCTION

She had just a few coffee trees left near her house which she used for home consumption of coffee (not a common practice, but she was producing too little to sell). Her typical year in the past produced 180 kg of coffee and even in 2012 before the worst of the BTB hit, she produced 50 kg of wet cherry on her half acre. She was already losing trees due to CWD and then to make matters even worse, the BTB quickly infested and destroyed every tree in the half acre; all that was left were five trees near her house. As recently as 2011, she had planted 80 seedlings to increase her production of coffee and replace some old trees. She had said that there was not anyone in the village to talk to about pests/diseases and so she and her husband figured it out themselves, but never invested much in pruning or trying to treat their trees. She had never attended a course at RASD or any other agency in the area. Cattle and maize is what the household had decided to focus on after losing the ability to produce coffee. They decided not to acquire more seedlings and start in coffee again; the devastation from that year was too great.

She had never seen any RMB or CBB, but in addition to the CWD and BTB that destroyed their plot, they had seen RBD annually on their plot, but could not be sure what damage it really did. The neighbours do nothing to control pests and diseases she said, but she felt helpless in controlling the rapid scourge of "tree drying".[225] Luckily, they were not among the areas poorest, she had been to secondary school, and they had diversified into other income-generating activities. In addition to the maize and cattle they invested in to replace coffee, her family of six also grew cassava, beans, and *matooke*. They also managed a few goats. They maintained a greater than 75th percentile income of all the other farmers surveyed, earning an estimated 3.6M USh per year. Despite these occurrences, her answers to the risk-aversion game put her well within the risk-seeking category. She switched to B in the 2nd row in the risk game, which was the first rational place to switch.

[225] Tree drying is the common phrase given to a coffee tree when it dies from wilt or twig borer infestation as the branches and leaves seem to wilt, turn black, and die in a way that looks like it has dried up in the sun

A.25. GREEN COFFEE EXPORT MARKET

Coffee is grown around the world in a band of favourable climate conditions just north or south of the equator—roughly from the Tropic of Cancer to the Tropic of Capricorn. Though 103 species are identified in the family, there are three major varieties of coffee grown commercially: *Coffea arabica* (Arabica coffee), *Coffea canephora* (Robusta Coffee), and *Coffea liberica* (Liberian or excelsa coffee) (Davis, Govaerts, Bridson, et al., 2006). Robusta coffee does well in lowland environments and is a heartier species of coffee, while Arabica is typically grown in altitude ranges of 1,400 to 1,800 meters, often shade grown. Robusta as well is easier to grow: higher yields, minimal maintenance, and on the whole, a target for fewer pests than Arabica coffee trees (Kalonji-Mbuyi, Tshilenge Djim & Saiba, 2009). The main difference in the final marketable product comes to the "cup test" and perceived high-quality taste to the palette. Arabica coffees are typically less bitter, lower acidity, more mellow, and have a "higher quality" flavour profile as a drinkable coffee than Robusta coffees, which have more caffeine and are more "harsh" (personal conversation, interviewee #14). Robusta does however have redeeming features that make it a good blend coffee for espressos. Robusta beans produce a good *crema*—the frothy, creamy foam on top of a freshly brewed espresso that is created from high-pressure steam flowing through the packed coffee grounds. As well, the strength and full-bodied flavour of Robusta provide it the opportunity to be mixed well with "Italian" blends of filter coffee (personal conversation, interviewee #14).

Some of these characteristics like acidity or caffeine content can be scientifically measured, and indeed are tracked in each batch shipped from exporters in Kampala (personal conversation, interviewee #3). Many of the usual descriptors of Robusta coffees (e.g. "full-bodied", "harsh", "lower quality taste") come from taste tests done in coffee cuppings from quality professionals as well as word of mouth at international coffee exhibitions (personal conversation, interviewee #14). While certainly there is training and skill involved in being a coffee cupper, it is difficult to assess the characteristics one perceives on their palate quantitatively. These quality perceptions from the cup tests form strong market perceptions that some of those interviewed in the Ugandan coffee industry believe form a significant barrier to creating a wider market for their Robusta (personal conversation, interviewee #3).

Despite the generalized perception of Robusta as an inferior coffee on the market, one can process a quality Robusta to use as a substitute for a medium-grade Arabica. As the price differential between the London commodity exchange for Robusta and the New York commodity exchange for Arabica becomes quite large, roasters substitute in "washed" Robustas for their blends replacing the commodity Arabica coffees (see section 5.5.6). In the overall global market for coffee, Robusta coffee accounts for about 40% of coffee consumption though there is year-to-year variation (40% in 2010; 41% in 2011; 42% in 2012) (Almeida, 2012).

A.25.1. Global coffee exports

Coffee has a long history: it is a beverage that has been consumed for over 1,000 years, and it is one of the earliest traded commodities (Mussatto, Machado, Martins, et al., 2011). As a result of this history, it is not too surprising that today coffee is one of the most consumed beverages in the world and as a result is the 2nd largest traded commodity after oil (Mussatto, Machado, Martins, et al., 2011). Given the large market in the developed world and the climate conditions conducive to tropical environments near the equator, coffee is well suited for generating foreign exchange in the developing world. The production and trading of coffee is a crucial economic activity for dozens of emerging economies, and a core economic activity for millions of people from South America, to Africa, to Asia.

Commodity green coffee is an actively traded product on the LIFFE (London International Financial Futures and Options Exchange).[226] There are two financial instruments that are used to trade Robusta coffee on the exchange: future contracts for delivery in a specified month (exchange contract no. 409) and options on futures contracts which allow an investor to hedge against price fluctuations (exchange contract no. 501). These exchanges are used by every large exporter in Uganda to hedge against price risk and ensure their business viability if output from Uganda is low (personal conversation, interviewee #10). The quality requirements of these contracts traded on the exchange in Europe flow down throughout the Robusta production system such that farmers and traders in Uganda are aware of how their product will be assessed by the exporters. The exchange trades coffee based on a grade of "Class 1" and then classes

[226] LIFFE was taken over by Euronext in 2002, which was bought out by NYSE in 2007, and as of 2013 became part of the Intercontinental Exchange (ICE) group of exchanges. As such data on commodity futures available on the LIFFE are easily found at NYSE Euronext Global Derivatives website: https://globalderivatives.nyx.com/

below are taken at a discount from Class 1 and any higher quality lots are given a premium over the Class 1 price. These discounts or premiums are often referred to as "allowances" on commodity coffee[227]. The range of quality classes available on the international market is shown in Table 82. The screen categories refer to the size of the holes where coffee beans cannot pass through, where a larger screen has larger beans and thus is higher quality. Given the price for Robusta has typically varied between $1,000 and $2,000 per tonne, the allowances for higher quality classes are small percentage of the total price per tonne (see last column of Table 82). This lack of strong incentive for producing the highest quality Robusta (if it requires refined maintenance, harvesting, and sorting costs) carries through to the behaviour of the farmers and traders.

Table 82: Quality classes traded on the LIFFE for Robusta futures contracts

Class	Defects	Foreign Matter	Screen 15	Screen 14	Screen 13	Screen 12	Allowance
Premium	<0.5%	<0.2%	>90%		>96%		+ $30/tonne
1	<3.0%	<0.5%		>90%		>96%	$0/tonne
2	<5.0%	<1.0%			>90%	>96%	- $30/tonne
3	<7.5%	<1.0%			>90%	>96%	- $60/tonne
4	<8.0%	<1.0%				>90%	- $90/tonne

Note: All standards by weight in 300g sample
Data: (NYSE-Euronext, 2014)

Although there is a long history of growing, trading, and drinking coffee, there has been a significant shift in the export market over the course of the last half century that has affected in many ways the market for Ugandan coffee. As shown in Figure 102, the rise of Asia as a major region for coffee exports has been steady since the mid-1970s. This rocketing rise in production and export has almost solely been driven by Vietnam, the 3rd largest coffee exporting country in Figure 104. Vietnam is a major producer of Robusta coffee, which has a significant effect on the market for Ugandan coffee exports. As Asia has become a larger player in the export market, Africa has been crowded out and represents a much smaller portion of the market than it did in the mid-20th century (from a high of 32% in the 1970s to an average of around just 10% in the 2000s). The Americas (mainly Central and South America) have

[227] For specialty, sustainability certified, or Arabica coffee the grading/quality sorting system is different and specific lots may have a "premium", "micolot" or other term attached to the price to signify the extra money paid over the standard commodity price.

remained strong, exporting over half of the world's green coffee exports throughout the last 50 years; however, they have declined slightly with the growth of Asia and Europe from 68% in 1961 to 52% in 2011. An interesting feature of the figure is the growth of the European regional segment for green coffee "exports" since Europe does not have a suitable climate for producing coffee.

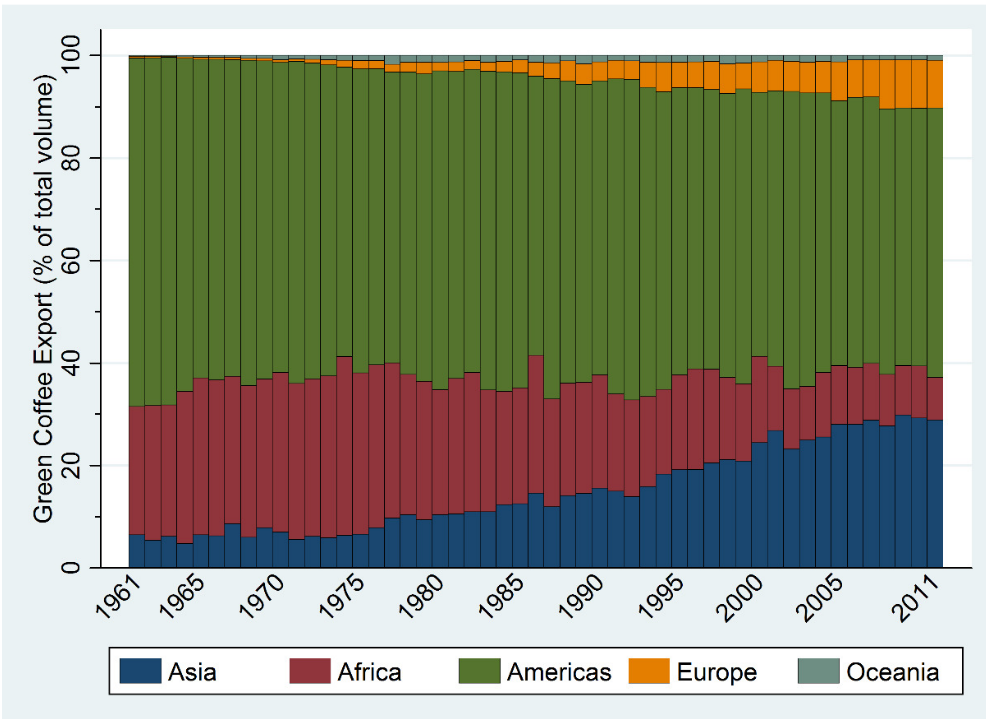


Figure 102: Percentage of green coffee export (by volume) from world regions from 1961 to 2011 (FAOSTAT, 2014)

Europe did not reach even 1% of total world exports until 1973, but by 2011, 9% of all coffee exported internationally was at one point exported from Europe (see Figure 102). Obviously, coffee does not grow in Europe, but the European market has become a hub of international trade to other destinations. As an example, there is a significant market internationally for German processed coffee (Thiemann, 2012). The large commodity-trading group Neumann Kaffee Gruppe, based in Hamburg, imports and then re-exports coffee beans used in one out of every ten cups of coffee consumed globally (Terazono, 2013). A large share of this is coffee sourced from Vietnam or Brazil for instance and then further sorted in Germany as well as being chemically processed to remove caffeine (producing decaffeinated green coffee) which is then exported to the USA for roasting and local consumption. The addition value from decaffeination, branding, or further sorting for quality in developed economies like Europe appears in the unit value (roughly understood as a "price") as well.[228]

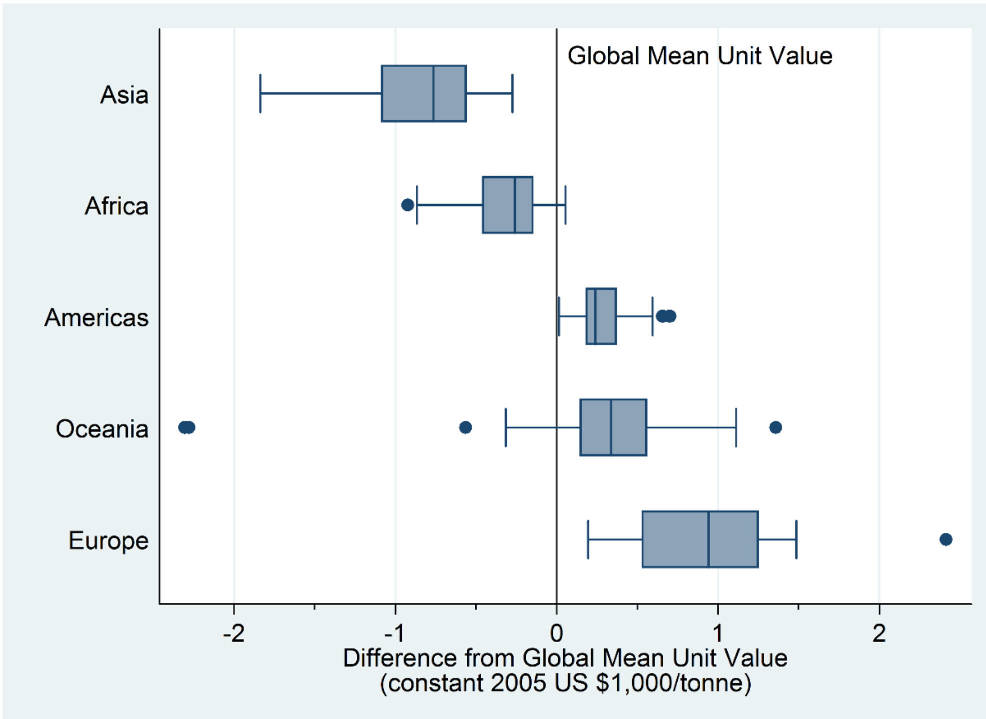


Figure 103: Regional unit value differences from global mean unit value from 1961 to 2011 (FAOSTAT, 2014)

As shown in Figure 103, the unit value for green coffee exports from Europe in the period 1961-2011 was on average around $1,000 above the global unit value each year.[229] At the other end of the spectrum, the median unit value for green coffee exports from Asia were around $750 less per tonne than the global value. There are many outlier years (with values below 1.5 times the inter-quartile range, IQR, of the bottom quartile or above 1.5 times the IQR for the upper quartile). For Oceania, these outlier years could be a data quality issue as Oceania is such a small regional exporter of coffee that some years may be missing either value or quantity information from some of the small island countries that make up the region resulting in a

[228] Unit value is reported by FAO and is the reported value of exports ($1,000 US) divided by the quantity (tonnes) by year. It is converted to constant 2005 USD as explained in more detail in footnote 231 on page 415. It represents an average price for the year, though the spot price at which the green coffee lot was sold will vary widely over the course of the year.

[229] The global unit value or regional unit value are a weighted mean of the unit values from each constituent country in the group. The equivalent is the total value ($1,000 US) for all exports from the countries of the region divided by the total quantity (tonnes) from the region in the given year.

skewed unit value for the region as a whole. While the regional view gives a high level picture of the green coffee market, further analysis of the unit values for coffee are explored in section A.25.4 where Uganda is compared to its East African neighbours.

A.25.2. Top coffee exporting nations

While dozens of countries produce coffee, there are some major players in the market that account for a large portion of the total coffee exported around the world. Brazil is the largest exporter of coffee with some 53 million tonnes sold in the period 1961-2010. By itself, Brazil accounts for an astonishing 24% of the total volume of green coffee exported by every country in the past 5 decades (1961-2010); as a comparison, the collective exports from the entire continent of Africa only account for around 20% of total world volume exported. The top ten countries by exported volume in the 1961-2010 period are shown below in Figure 104. In addition to Brazil, Colombia is the 2nd largest exporter by volume which accounted for just over 12% of global exports—more than all countries combined of East Africa which exported just under 11% of the global total. That does not however mean that East Africa is irrelevant as a source of green coffee exports. In addition to Uganda at number seven, many East African countries are in the upper half of global exporters: Ethiopia (12th), Kenya (17th), Tanzania (22nd), Burundi (28th), and Rwanda (30th).

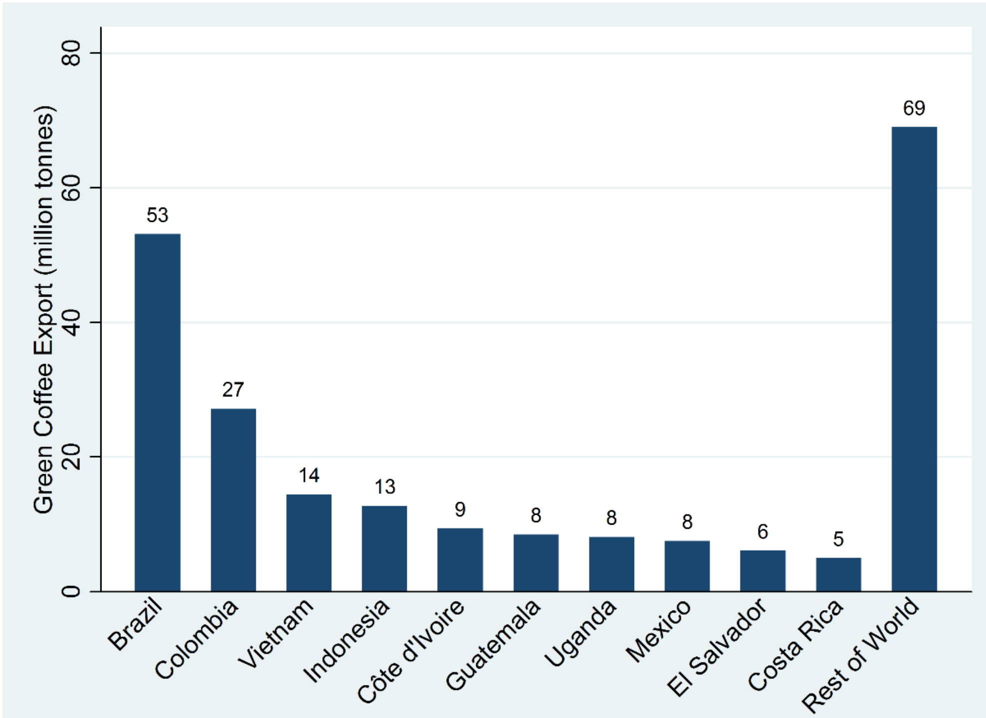


Figure 104: Top 10 world exporters by total volume exported 1961 to 2010 (FAOSTAT, 2014)

The top five exporters by volume from the last five decades have evolved over time (see Figure 105). Vietnam has emerged as a major player in green coffee exports only since the 1980s with rapid growth continuing throughout the 2000s. The top five represent roughly half of the total global exports of green coffee throughout the period (ranging from a low of 42% in 1977 to a high of 62% in 2007). Interestingly the 1960s and the 2000s are similar in the contribution of the top five to the total global exports, but the decline of Brazil has been compensated for by growth from Vietnam. This is not to suggest that production from Brazil has declined, the growth from Brazil's exports has just not kept pace with the global growth in the export market for green coffee.

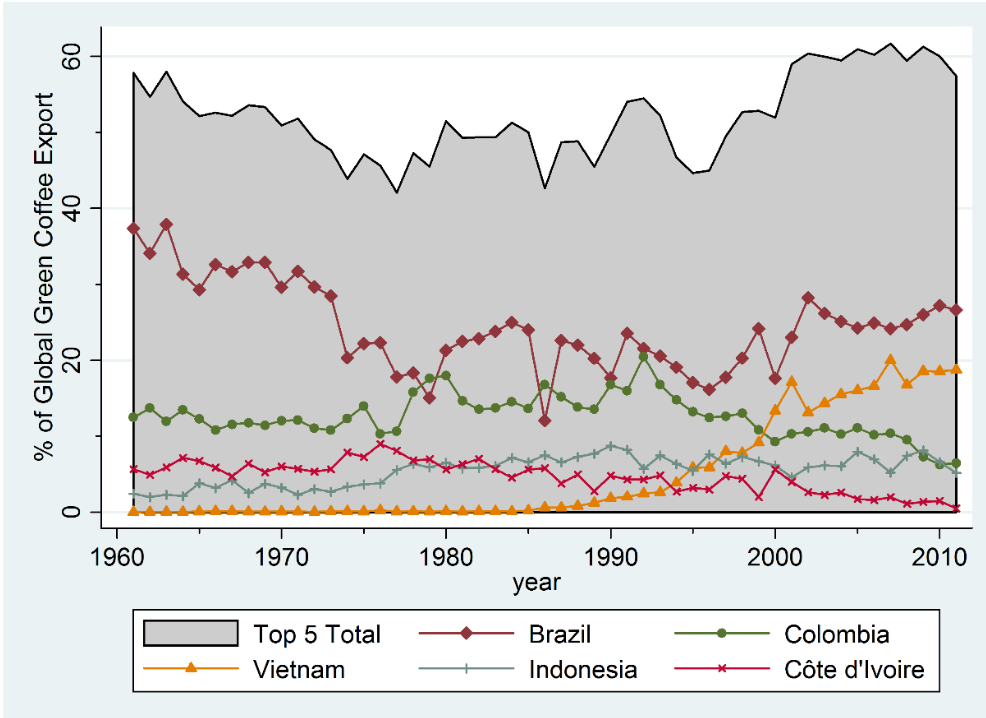


Figure 105: Percentage contribution to global exports from top five exporters by volume (lines) and the total contribution of the top five to global exports (area) (FAOSTAT, 2014)

As suggested by Figure 105 above, the late 1990s through the 2000s became a period of concentration in the global green coffee export market of major coffee exporters as they started accounting for a larger percentage of total coffee exports than any other year (surpassing the previously highest years in 1961 and 1963). Despite the growth in the market share of the top five countries, it is unclear up until this point what the other roughly 40% of the export market looks like. Have small exporting countries grown as well along with global growth trends? Have the middle tier exporters grown or shrunk because of the top five taking a larger share of the market?

One way to consider these questions about the distribution between small and large exporters of green coffee is to consider the Lorenz curve and related Gini coefficient of the export values by year. Although the Lorenz curve and Gini coefficient are traditionally used as index measures of income inequality, the mathematics can also be used in this case to reveal the export value share inequality by year. There are several different ways to calculate measures of income inequality, but the present method follows the methodology used by Jenkins (2008).

The Lorenz curve is a graphical way to show what percentage of a population accounts for what percentage of a given value (e.g. income or export value). First the countries are ordered in terms of ascending order of export value for each year. Formally, each country (x) and associated export value (y) are ordered as in equation 1 and 2 for all (n) countries.

$$x_i = (x_1, x_2, x_3 \dots x_n), \qquad i = 0,1, \dots n \; and \; n > 0 \tag{6}$$

$$y_i = (y_1, y_2, y_3 \dots y_n)\,, \qquad y_i < y_{i+1} \; and \; \sum_{i=1}^{n} y_i > 0 \tag{7}$$

Following generally the derivation of the discrete case from Kleiber (2008) the Lorenz curve plots for each point the share of total export value $L\left(\frac{k}{n}\right)$ taken by the $\frac{k}{n} * 100\%$ smallest exporters for all values of k from $0 \; to \; n$. The discrete Lorenz curve of a set of data with n points arranged in ascending order such that y satisfies equation (7) is then given by equation (8) below:

$$L\left(\frac{k}{n}\right) = \frac{\sum_{i=1}^{k} y_i}{\sum_{i=1}^{n} y_i}\,, k = 0,1, \dots, n \tag{8}$$

In the present example, the curve is a plot of the cumulative share of the smallest 100*p% of total export value against the cumulative share of the total number of countries exporting green coffee for a given year. As such the Lorenz Curve ranges from 0 to 1 on both the y and x axis. If every exporter were exporting the same value of coffee each year, then the Lorenz curve would be a straight 45 degree line (e.g. 10% of exporters would account for 10% of export value, 40% would account for 40% of export value etc.).

The Lorenz curve plots confirm the suggestive results from looking at the top five exporters in Figure 105. The distribution of coffee exports from 1961 through the mid-1990s was one of more equal contributions from each coffee exporting country (see (b) of Figure 105). There were certainly large players—as noticed by the major difference from the line of equality—but, small and medium size countries experienced more growth during that period as overall global coffee volumes grew. Since 2000, however, each year in the sample shows that the larger exporters are taking a larger piece of the global growth than small and medium sized exporting countries (see (a) of Figure 105). Shown another way, dividing exporters into three different group sizes by the amount of coffee exported per year, the resulting number of countries fitting that category as well as their mean and median export are displayed in Figure 106. Confirming the results of the Lorenz curves, it is clear from Figure 106 that the reason for the increasing inequality of export values is due to both more small countries entering the export market with small volumes as well as the set of large exporting countries growing even larger in terms of their export volumes. The fact that the mean is so much higher than the median for the large country exporters also suggests that a few dominate coffee exporting nations dominate the global export market. While the trend is clear, the cause of this concentration is not. One possibility is that larger exporters have focused on volume growth with lower cost coffee.

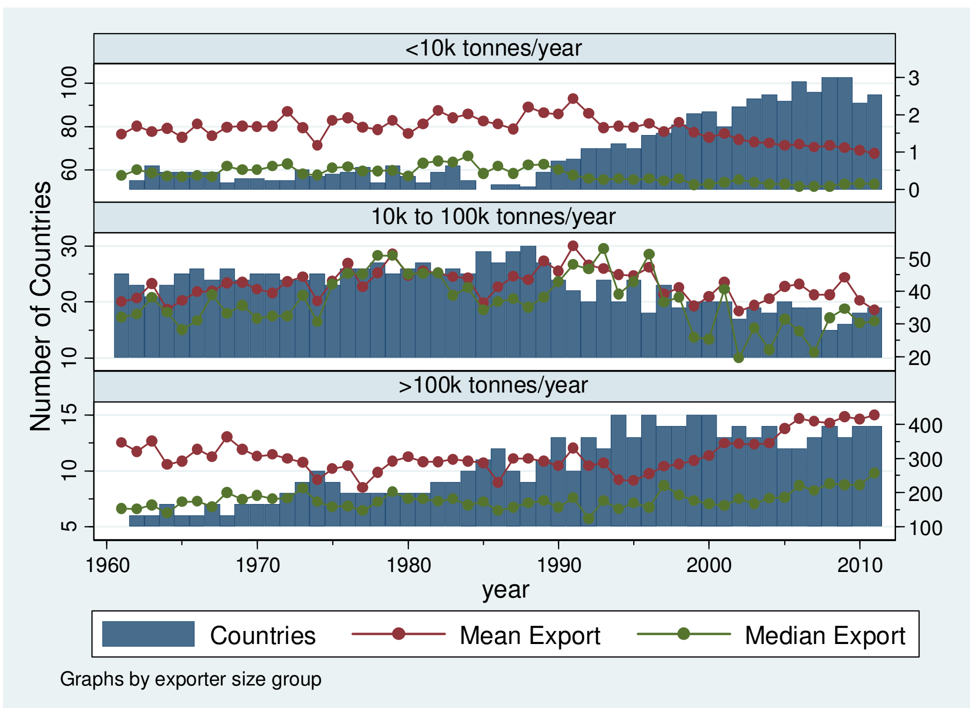
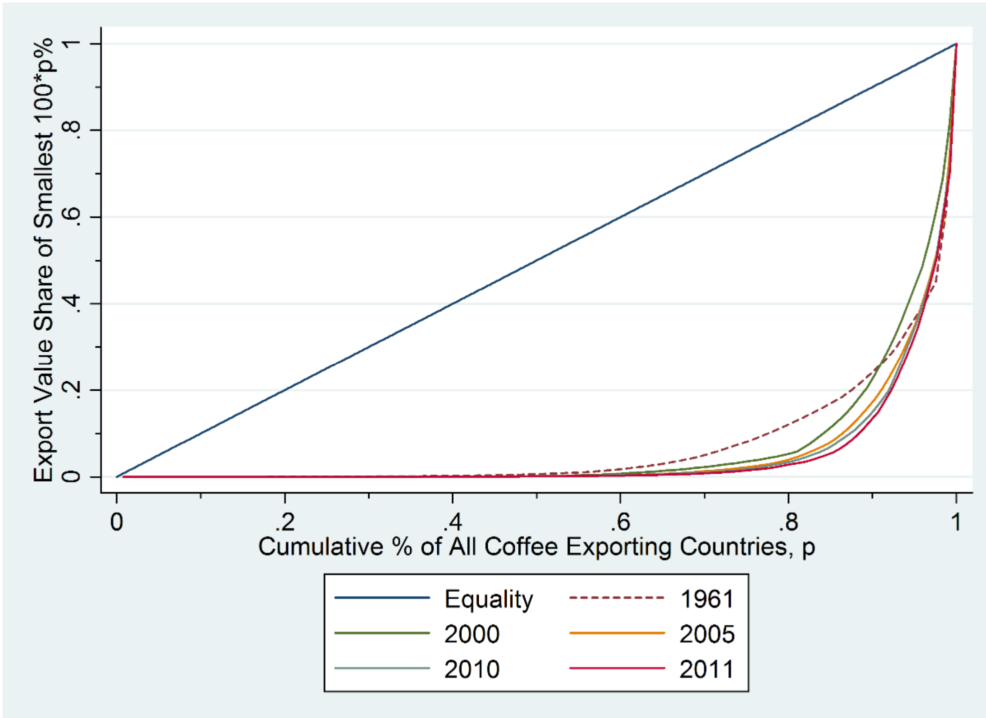
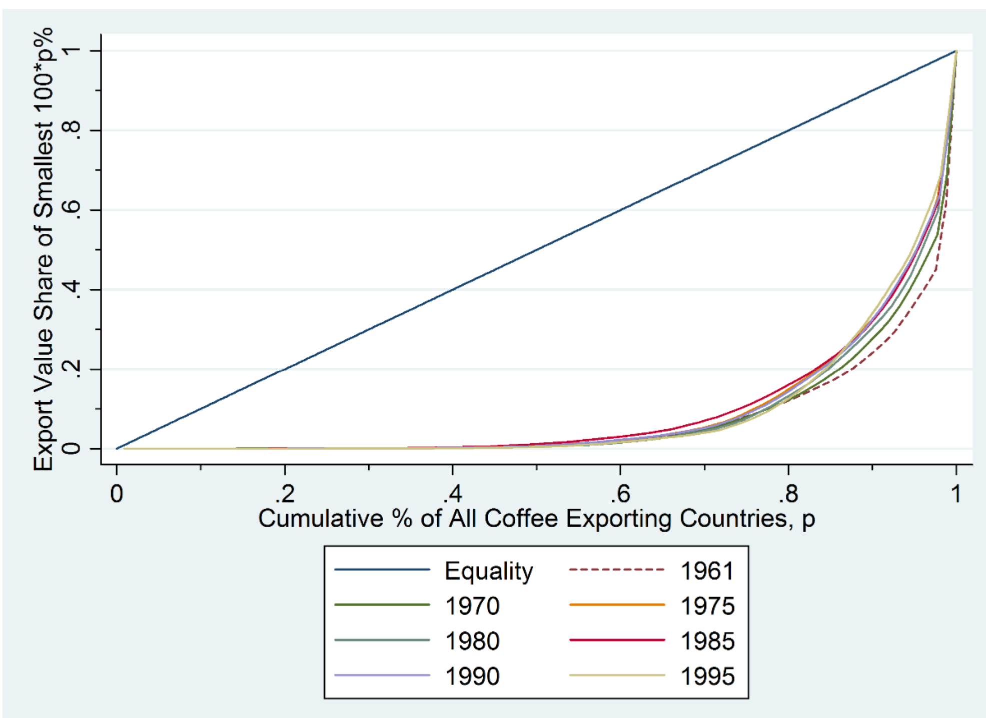


Figure 106: Since 1990 there are more small exporters entering coffee export and the larger exporters are exporting even more leading to a more unequal distribution of global coffee export



(a)



(b)

Figure 107: Lorenz curves by year for all green coffee exporting nations (a) for past decade since 2000 and (b) for 1961 to 1995

By unit value, similar to the regional results in Figure 103, Asian countries in the top 10 exporters have the lowest unit values for coffee from 1961-2011. Vietnam and Indonesia for more than 75% of years on record are consistently below the global weighted mean price for green Robusta coffee exports (Figure 108). Similarly for Côte d'Ivoire (Ivory Coast) and Uganda, both African countries have export earnings per tonne of green coffee which are over $500/tonne below the global price for at least half of the years from 1961 to 2011. Brazil's unit values for the period are grouped rather tightly near the global mean unit value, likely reflecting its position as the largest exporter of green coffee and thus determining largely the global mean unit value for green coffee. The other countries in the Americas (Guatemala, El Salvador, Mexico, Costa Rica, and Colombia) all receive earnings per tonne on average well above the global unit price most years—though Mexico in particular has had several outlier good years and bad years in the period.

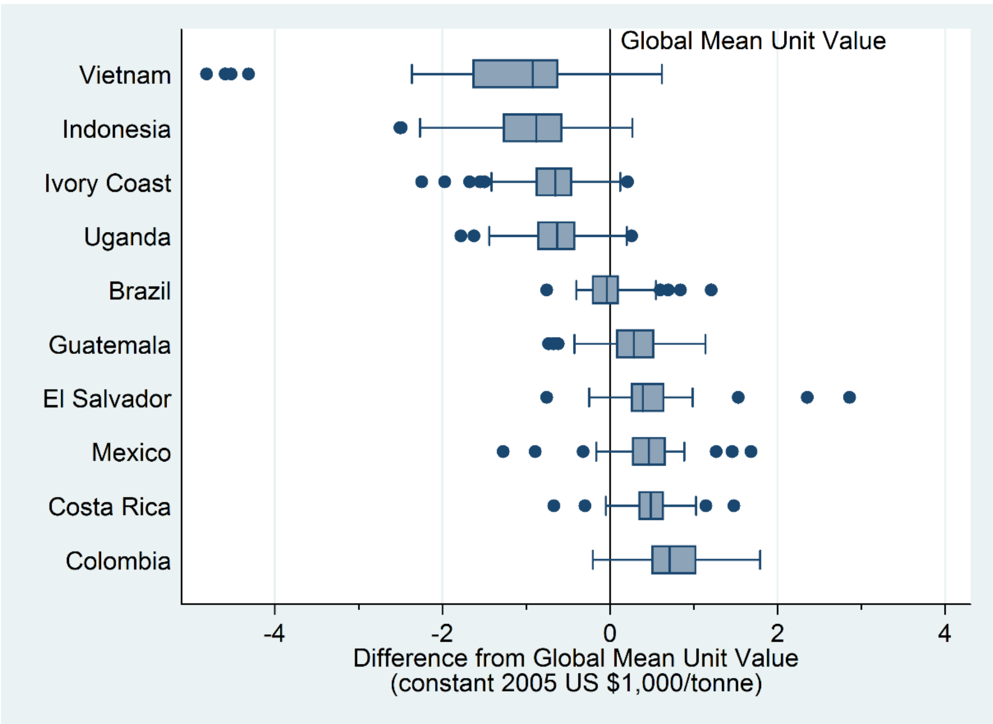


Figure 108: Difference from global mean unit value for top ten exporters from 1961-2011 (FAOSTAT, 2014)

A.25.3. East African coffee exports

Prior to the most recent decades, there was limited growth in coffee production in East Africa from the late 1970′s to the mid 1990′s, but the same period for Uganda was marked by moderate decline and volatility of year-on-year exports (see Figure 109). This is especially unfortunate for the region, given the context that global coffee production experienced a doubling in total exports (from around 4 million tonnes to 8 million, see line in Figure 109) over the past four decades (1970-2010). During that period, exports from Eastern Africa did not make significant gains—the peak in exports in 1996 was higher than any other year through 2010.

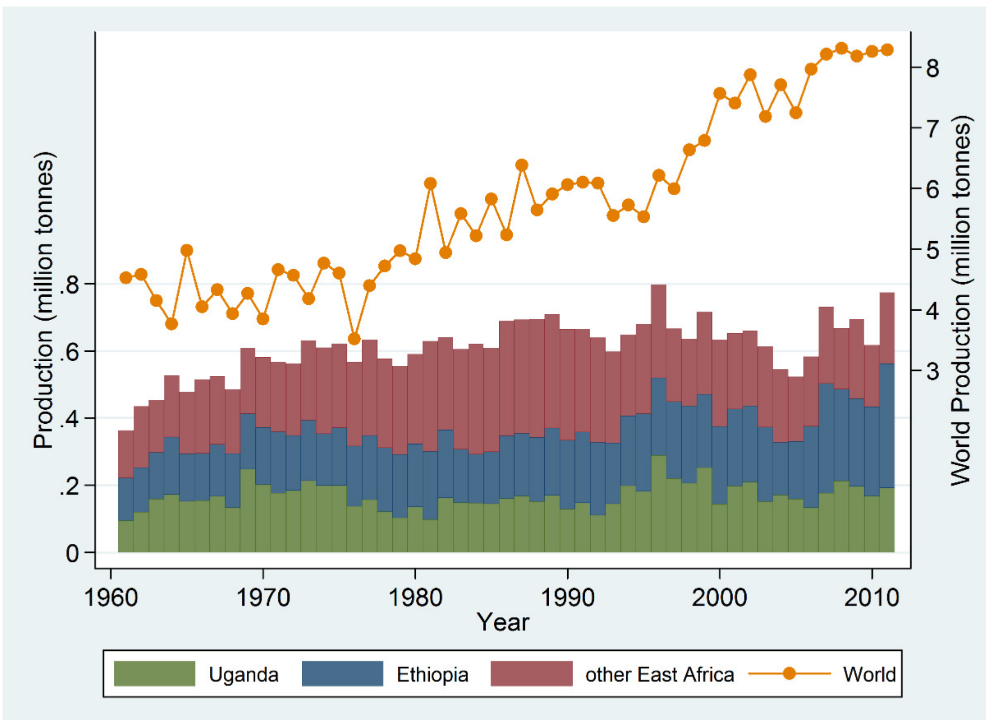


Figure 109: East African and world production of green coffee from 1961 to 2011 (FAOSTAT, 2014)

Uganda has historically made up a large portion of the total value from East African[230] exports of coffee: from a low of 15% of total East African export value in 1981, to a high of 41% in 1969 (see Figure 109). In recent years, Ethiopia has come to take the largest export share (by

[230] This chapter will follow the definition of East Africa from FAOSTAT (2014) database which includes the following countries: Burundi, Comoros, Djibouti, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Uganda, Tanzania, Zambia, and Zimbabwe. By definition Eritrea and South Sudan are also included, but do not have any data available for green coffee exports so will not be mentioned.

export value) of green coffee from East Africa—in 2010 Ethiopia made up nearly half of the total value of green coffee exports from East Africa (see Figure 110). Another strong trend through the decades has been that other East African nations are becoming even smaller players as Uganda, Kenya, and Ethiopia make up the majority of green coffee exports from this part of the continent (see Figure 110). The underlying economic or geopolitical cause of this trend are not clear, but visibly, there has been a drop in exports from Burundi and Madagascar during the 2000s which are the key drivers of the trend (see Figure 111).

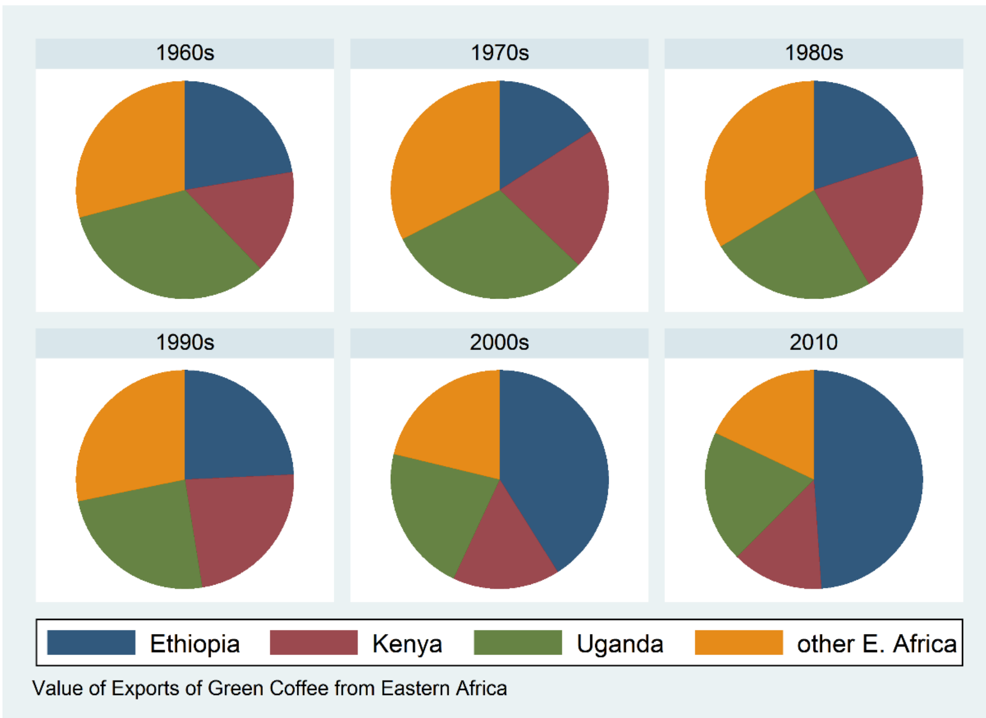


Figure 110: Export share of East African exports by decade from 1961 to 2010 (FAOSTAT, 2014)

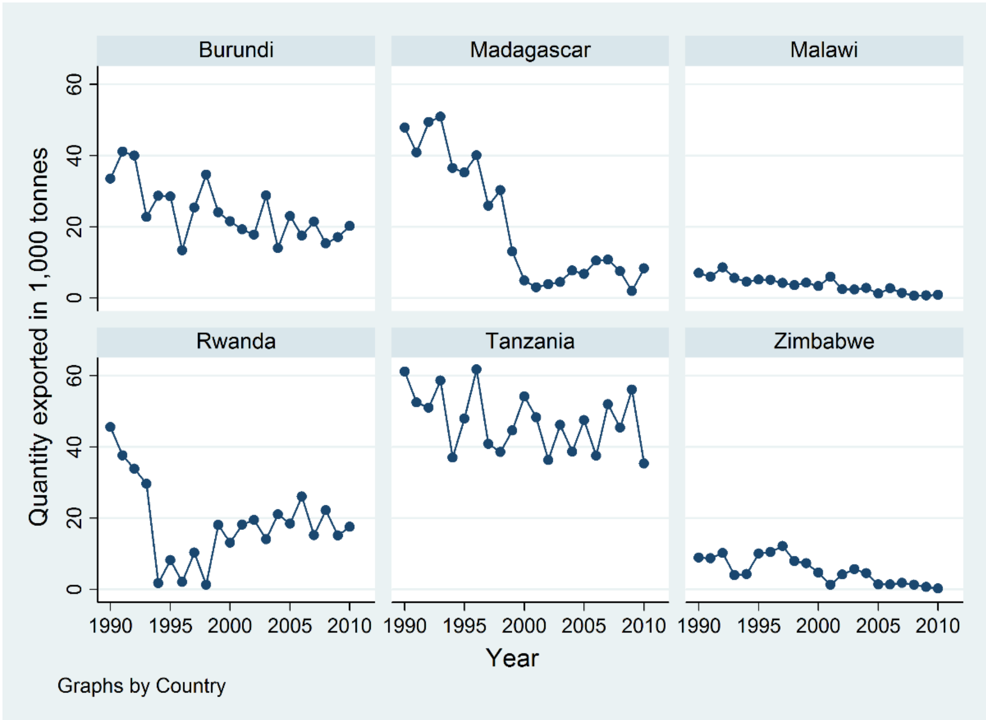


Figure 111: Exports of green coffee from other East African countries decline in 2000s (FAOSTAT, 2014)

Given the production system for coffee depending on the cherries coming from the millions of smallholder farmers, one likely cause for drops are conflict within the rural areas of the given country. The precipitous drop in exports in Rwanda in 1994 (a 94% drop compared to 1993) coincides with the massive genocide the same year in that country, when up to an estimated 1 million Tutsi were killed in a 4-month period (Reyntjens, 1996). Similarly the coffee export drop for Burundi in 1993 (44% less than 1992) coincides with a recognized genocide in that nation (Bhavnani & Backer, 2000). However, the continuing decline of coffee exports in the 2000s during a period of more relative stability cannot be explained away by conflict. Additionally, the 1992 to 2010 period in Madagascar is known as the Third Republic of Madagascar corresponding to the end of a socialist regime (Barrett, 1994). This transition process coincided with a huge decline in coffee exports (see Figure 111), but while economic reforms were ushered in, it is not readily apparent why there was such a drastic decline in coffee exports. Was there a shift away from coffee to other crops? Did economic reforms away from a socialist system discourage the production of coffee? The causes of these declines and the possible relationship to political stability or economic reforms are left to further research.

A.25.4. Uganda coffee exports vs. neighbours

Uganda has historically been East Africa's dominant producer of coffee by volume, exporting on average over 150,000 tonnes of green coffee annually as shown in Figure 112. However, looking just at this figure highlights another feature of this high median export: there is great year-on-year variation in export output.

As shown in Figure 112, 1996 was one of the best years for Ugandan coffee export at nearly twice the median and well outside 1.5 times the inter-quartile range (IQR) of the upper quartile (the top "whisker" of the box plot for Uganda). However, in the country's worst year (2003), it exported less than the distant second place competitor (Ethiopia) has ever experienced. Uganda's variance is higher than any other country in East Africa in terms of the export output. While exporters may try to smooth out year-to-year variations through storage of export-grade coffee, it is clear that the production is so variable that is difficult for the export at a national level to be smoothed to any significant degree.

While Uganda has been the largest exporter of coffee in East Africa, as shown in Figure 113 it has been losing this position over time, especially since the precipitous drop from the peak of 1996. This was no doubt in a large part due to the struggle with CWD that heavily affected the majority of growers throughout the country from the mid-1990s throughout the early 2000s (see section A.22.1). However, the other regional players (namely Kenya) faced declines as well which could not be attributed to CWD. Fafchamps & Hill (2008) show that price transmission from the world market down to the first level of processing is quite robust, especially when prices fall at the international level. As such, the volume declines co-current in Kenya and Uganda around the year 2000 could reflect the farmers attributing less effort to production or exporters making similar decisions about storage and exporting. Since the present purpose is to present just a snapshot of the national exports against the regional players, robustly analysing the determinants behind the movements are left to future research.

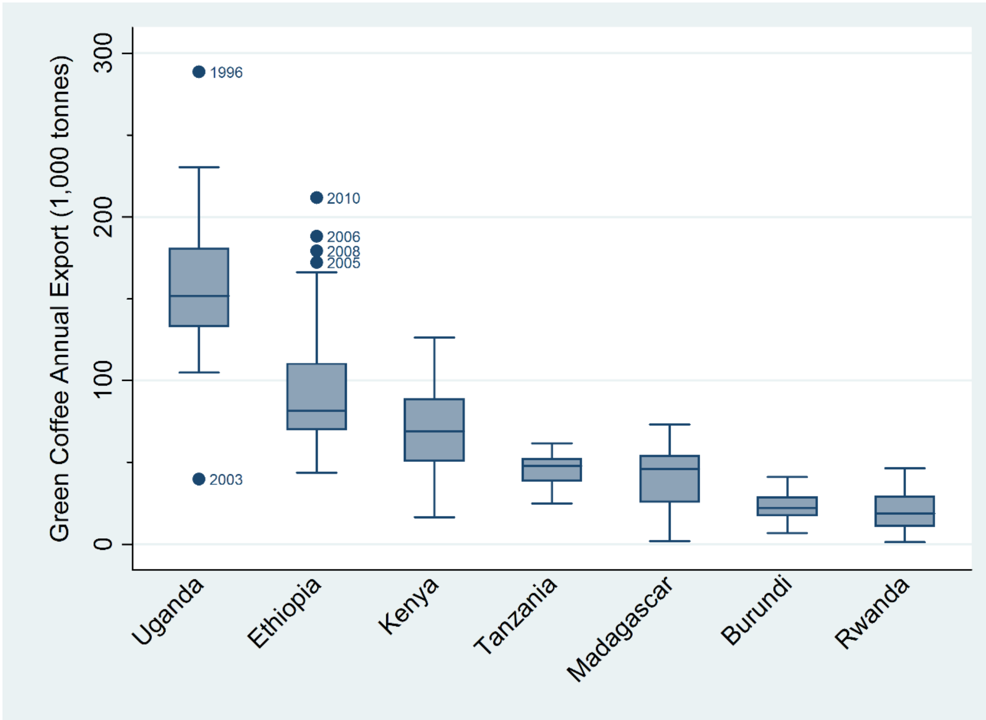


Figure 112: Box plots of annual (1961-2010) export volumes of green coffee for top seven (by volume) East African countries. Outliers labelled with the year of export.

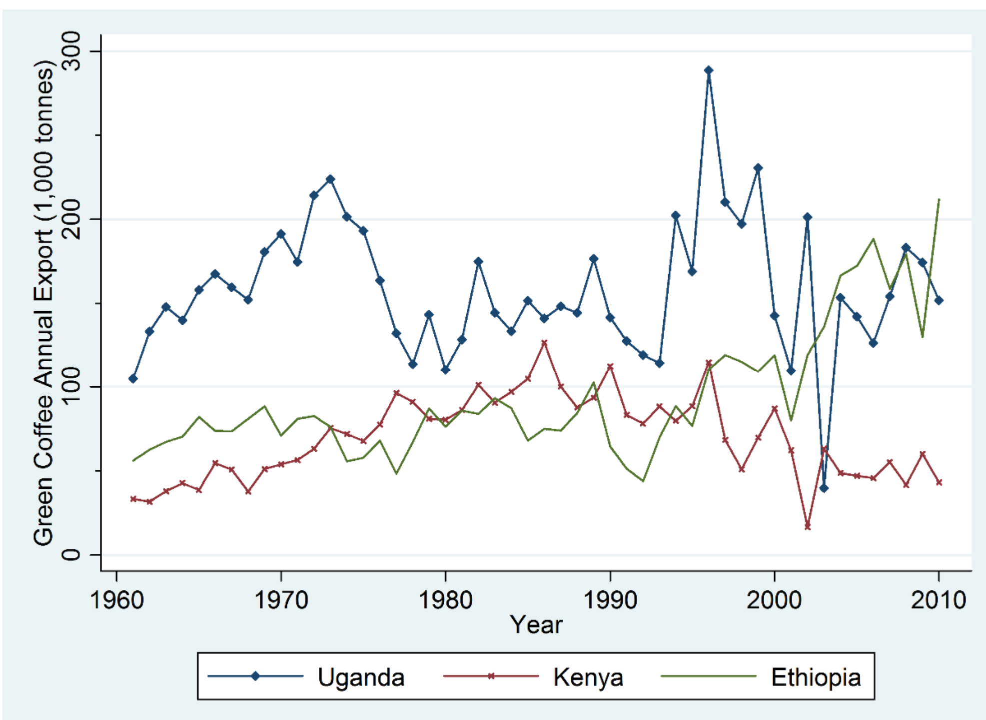


Figure 113: Top three (by volume) East African countries' green coffee exports from 1961-2010

Ugandan coffee commands a lower price in the international market compared to its East African neighbours, largely due to its bulk production of lower value Robusta as opposed to higher value Arabica coffees. The unit value is in constant[231] 2005 $1,000 US per tonne as shown in Figure 114. Ethiopia and Kenya, both the closest by volume to Uganda's exports, both command a significantly higher unit value for each tonne of green coffee exported compared to Uganda. As is clear from looking at the top-end outliers in the figure, the final years of the 1970s were particularly good for the coffee exporters of East Africa. The price spike is even clearer in the time series plot (Figure 115) for the top 3 East African coffee exporting countries by volume (Uganda, Kenya, Ethiopia).

[231] FAO unit value data is given in nominal $1000 US dollars from 1961 to 2010, however, given inflation the unit values need to be converted to constant US dollars for appropriate time-series comparison. There are a variety of ways to deflate currencies using different price indexes. For this work, since FAO already gives the export values in US dollars, the US dollar deflator used by the World Bank to convert US GDP from nominal to constant 2005 US dollars was used. The data to do so is available upon request or can be found through the data source of the World Bank located at: http://data.worldbank.org

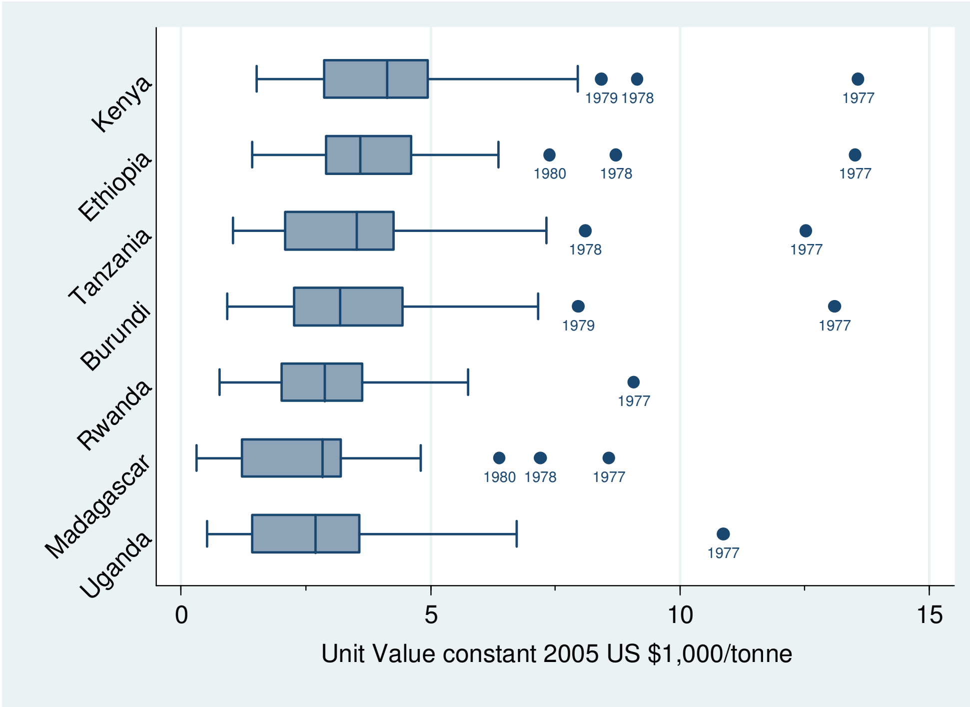


Figure 114: Box plot of export green coffee unit value (constant 2005 $1,000 US / tonne) for East African countries (1961-2010) (FAOSTAT, 2014)

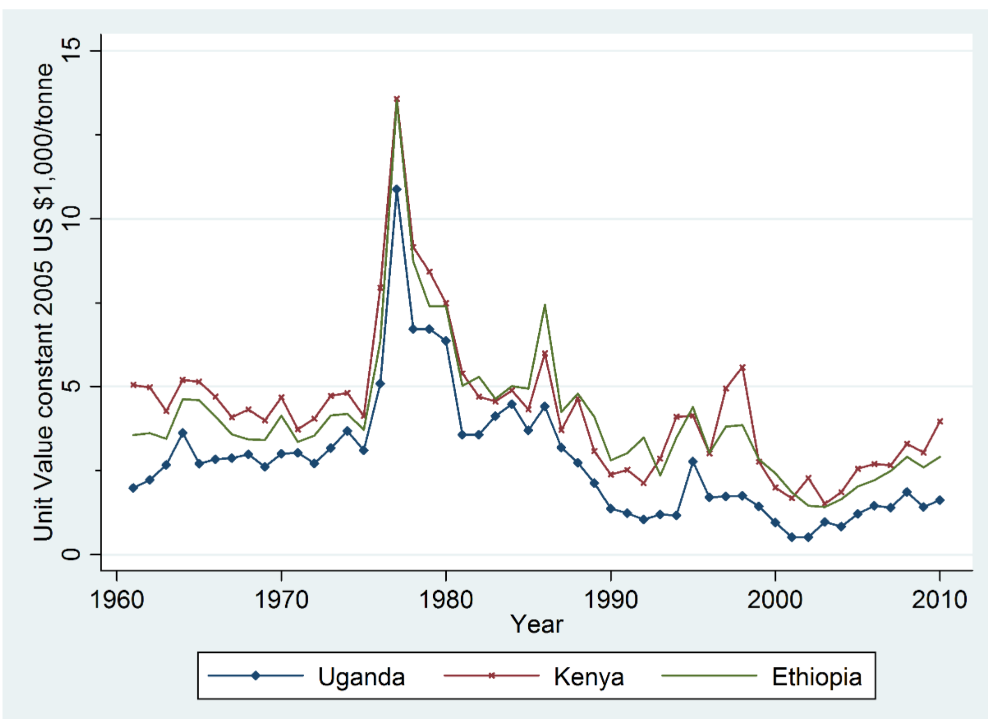


Figure 115: Unit value over time (1961-2010) for top 3 East African coffee exporters by volume (FAOSTAT, 2014)

A.25.5. Competition among Ugandan exporters

Data from the UCDA's monthly reports was extracted manually from the data tables in their monthly reports given as pdf documents available to the public via their website.[232] This monthly export data was used in order to analyse the export at the firm level from Ugandan UCDA registered exporting firms.

The total number of firms has increased drastically in the past 6 years and the mean export by firm has decreased as well as shown in Figure 116. Similarly, for importers, the number of firms has increased and the mean monthly import decreased (see Figure 117). However, many of the exporters are quite small players in the market. The top five Ugandan exporters of coffee based on monthly export data acquired from the UCDA is given in Figure 118. The top five importers of Ugandan coffee based on the monthly data from the UCDA is presented in Figure 121. The exporters interviewed as part of the fieldwork come from this list of the top five exporters of Ugandan coffee (see 5.3.2). Despite several interviewees (#10 and #14) discussing the concentration of power in the top exporters that has happened since liberalisation, the emerging story seems to be one of many smaller players entering the export market based on Figure 116.

As shown in Figure 120 (page 428), the top five exporters within the sample extracted account for a decreasing percentage of the total annual export from Uganda each year. While they accounted for 70% of the total export in 2006, they make up only 40% for the first two months of 2013. The decrease in buyer concentration has not been as drastic, but still the top five importing firms buy a decreasing percentage of the total import (see Figure 121, page 428). While the impact on the supply chain from this movement in exporter concentration is an interesting research question, it will not be explored further in this chapter. However, the views from interviewees from two firms in this top five cohort will inform much of the work in the following sections. Similar movement with more firms importing Ugandan coffee can be seen in Figure 117. The cyclical trend in the mean import data would suggest that some of the bigger importers only by Ugandan coffee in certain months or place larger orders in those months. Questions arising from these figures are left for future research.

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[232] http://www.ugandacoffee.org/

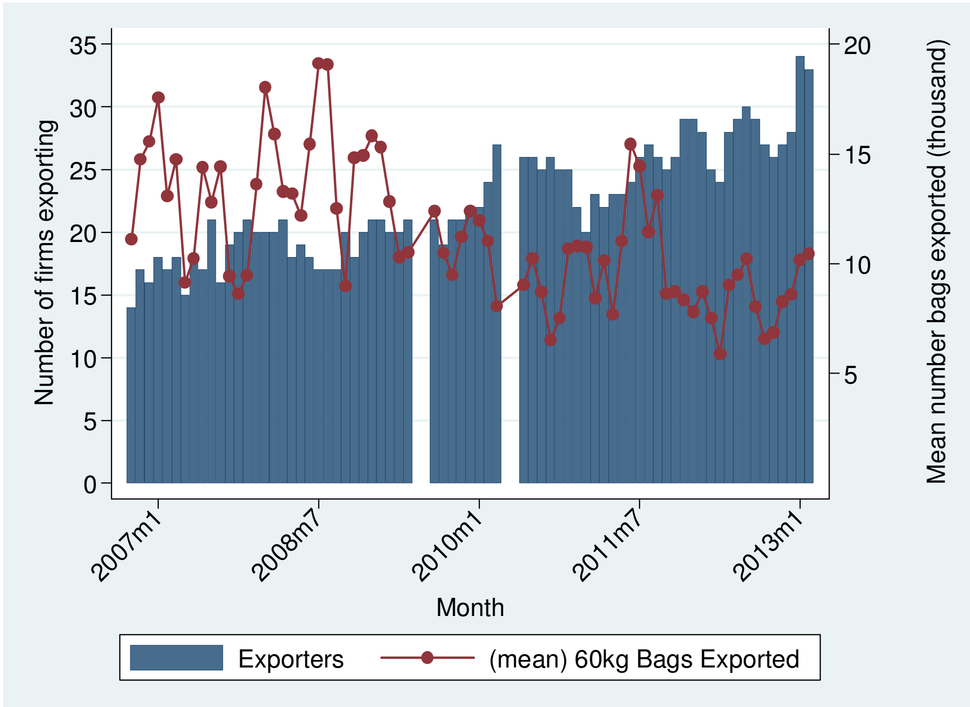
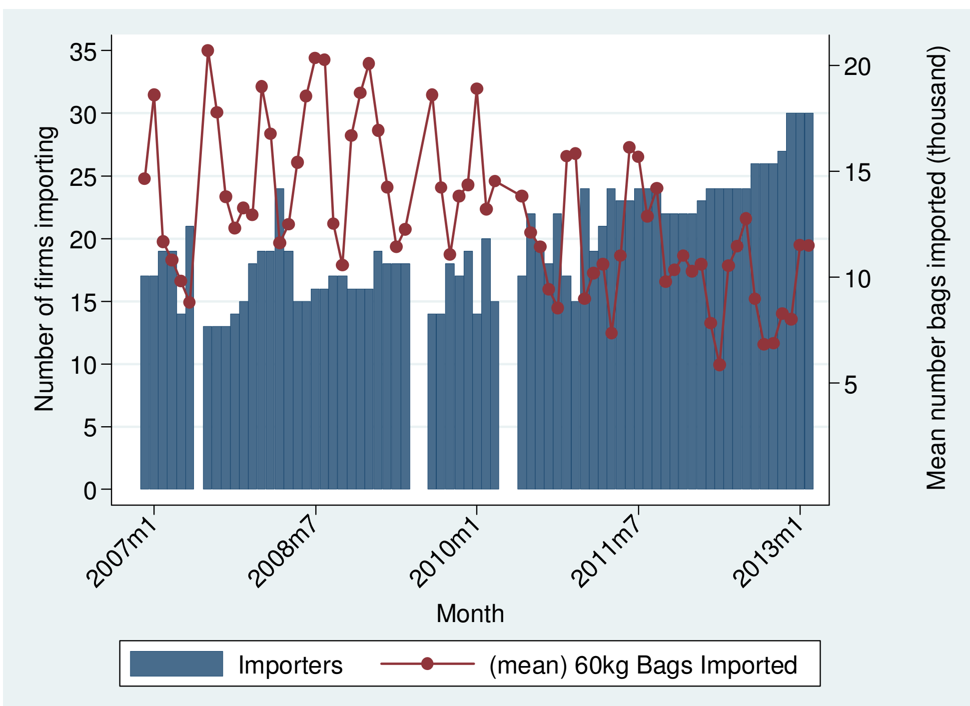
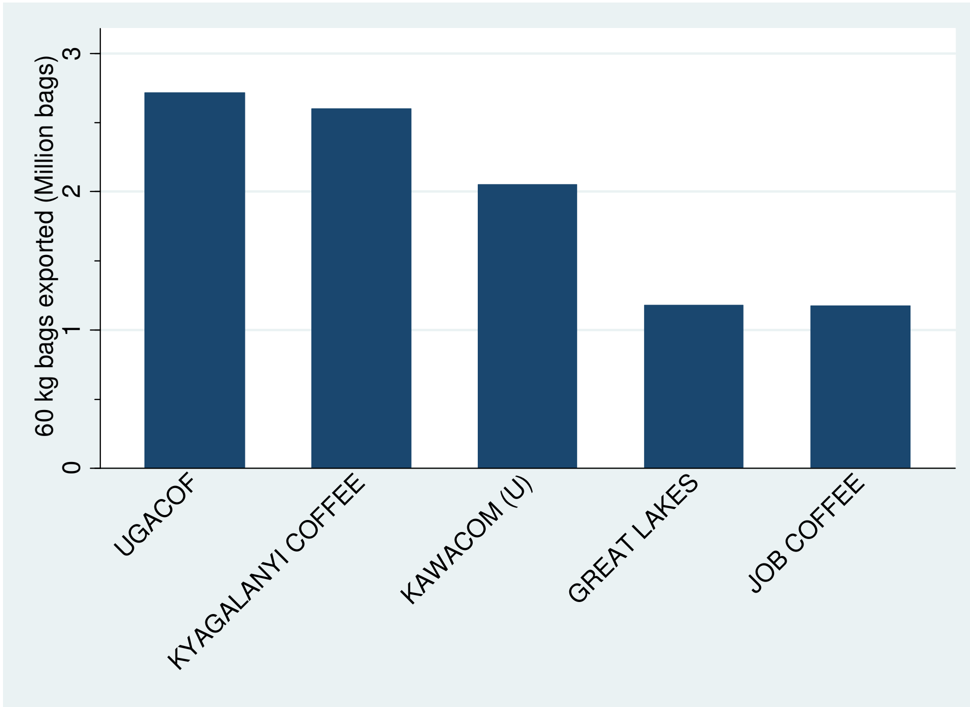


Figure 116: Trend of exporting firms and mean monthly mean export from 2006 to 2013



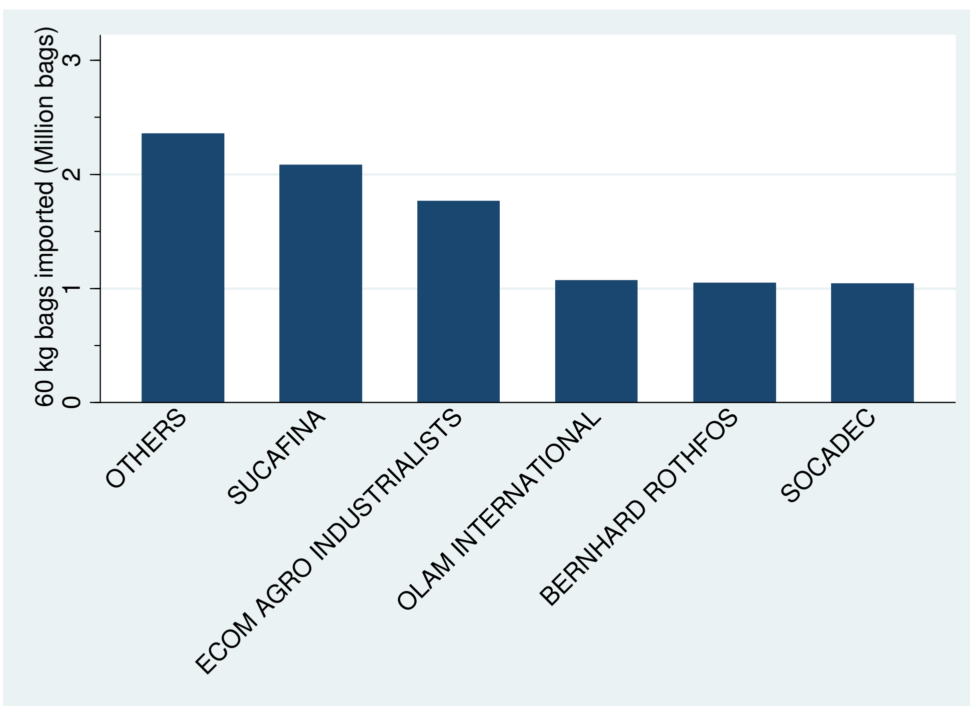
Note: Others category is assigned by UCDA so this total number of importers still reflects growth, but hides the nature of the smaller importers grouped in “others”.

Figure 117: Trend of importing firms and mean monthly mean import from 2006 to 2013



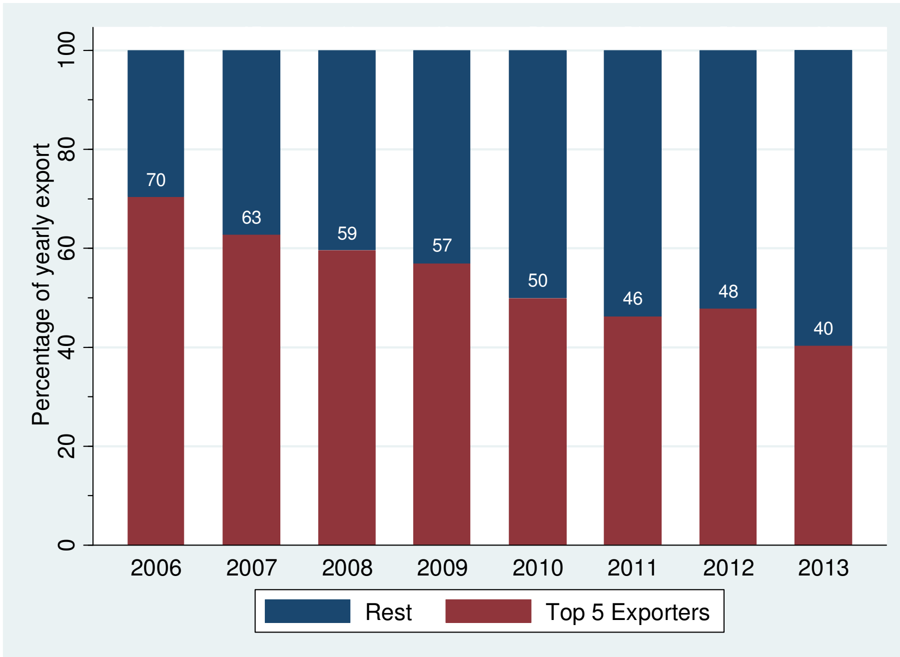
Note: Total from monthly export data from October 2006 to February 2013 with some month gaps where data was not available for any firm.

Figure 118: Top five firms exporting Ugandan coffee based on total export from 2006 to 2013



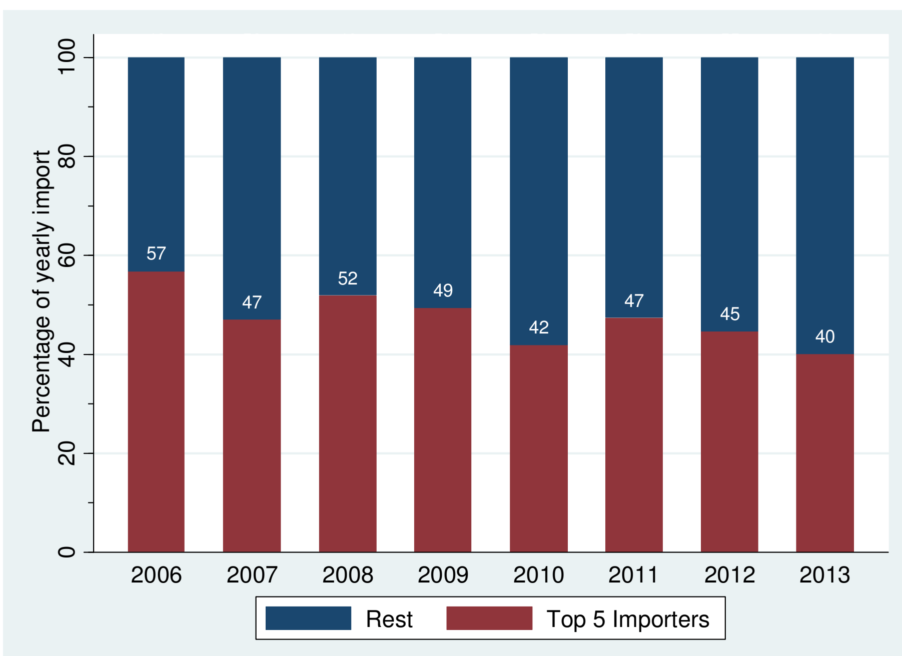
Note: Total from monthly export data from October 2006 to February 2013 with some month gaps where data was not available for any firm. Others is a category for all the miscellaneous smaller importing firms.

Figure 119: Others and top five firms importing Ugandan coffee based on total import from 2006 to 2013



Note: Top five exporters based on total export from 2006 to 2013 in the dataset

Figure 120: Top five exporters historically account for decreasing percentage of total export in later years



Note: top five importers based on total import from 2006 to 2013 in the dataset

Figure 121: Top five importers historically account for decreasing percentage of total import in later years

A.25.6. Implications for Ugandan production

Uganda has struggled to increase its market share with robust growth in world demand for coffee. Despite its position as a leading supplier in the 1960s, it has only lost competitiveness to other East African players like Ethiopia. Not only did Uganda lose its portion of East African exports of coffee, unfortunately, East African's share of world production has been going down as well.

Given the growing world demand for coffee, the question remains whether Uganda has lost out due to a lack of demand for their source of coffee or whether it has been supply constraints within the country. The primary answer is likely supply constraints. Robusta is largely traded as a commodity coffee and if Uganda were to produce more coffee that met the standards, there would be a buyer for the coffee. Uganda has lost a huge amount of productive trees to CWD and the disorder caused by the Idi Amin regime did not help the country nor the coffee producing sector. However, the answer is not supply issues completely. As mentioned by many stakeholders that were interviewed, Ugandan coffee faces a real problem with marketing and quality consistency in the final export product (personal conversations, interviewees #14, #10, #1). There is a perception among world buyers that quality cannot be dependable year-to-year for Ugandan coffee (personal conversation, interviewee #10). As such, roasters may prefer other origins for a more consistent product.

In addition to a shrinking portion of world exports of coffee and questions about consistent standards in the commodity coffee coming from Uganda, the supply of coffee is more variable year-to-year than other East African countries. While the drivers of this will not be determined at the national level, this sets the background for the following research on the supply chain actors on the ground from production to export. The research questions will address some of the pest and disease issues that could be leading towards the erratic output at the national level for Ugandan coffee. Additionally, the survey will help to analyse the determinants of growers decision-making on their plots. Furthering understanding of this specific commodity chain could help illuminate policies that improve quality and volume of Ugandan coffee, as well as, highlight the myriad issues that arise from the establishment and spread of plant pests/diseases more generally.

A.26. PERSPECTIVES ON LIBERALISATION OF THE COFFEE INDUSTRY IN UGANDA IN THE 1990S

Coffee has been a large part of agricultural production and foreign exchange earnings in Uganda for over 50 years. It is an income source for at least half a million families (Cheyns, Mrema & Sallée, 2006). The sector has seen many challenges and changes through the decades. The supply chain observed and discussed throughout this chapter largely reflects the changes that occurred during a period of liberalisation that happened in the early 1990s. The stakeholders interviewed had differing views on the benefits of this major shift to the supply chain for coffee in Uganda.

The Research Fellows at EPRC (interviewees #11 and #12) explained that one of the most significant and lasting shifts due to liberalisation has been the concentration of exporters. This shift towards larger export firms has been driven by the need to link to roasters and processors without a coffee marketing board aiding the industry (personal conversations, interviewees #11 and #12). On the demand side, some exporters have been more successful at locking down the import market (the roasters) than others. Also on the supply side, the larger merchant traders who link processors to exporters develop favourable relationships with certain firms. While the recent trend in the export markets seems to suggest an emergence of smaller exporters again (see section A.25.5), neither interviewees were aware of this shift in the data from the UCDA.

Another shift after liberalisation was the liberalisation of seedling production. The private sector became a major player in the supply of seedlings via the nursery sector between 1999 and 2005 (personal conversation, interviewee #11). Also from 1999-2005 there was a large intervention by the government to encourage the planting of seedlings, with a follow-on intervention from 2008-2011. These seedling campaigns boosted production some according to the interviewee, but there is still a lot of old standing stock (40+ year-old trees) causing supply constraints (personal conversation, interviewee #11). With many farmers surveyed not planting seedlings within the last five years, these supply constraints will not be ameliorated (see section 7.2.1).

The NGO view on the recent history of Ugandan coffee supply chain changes from liberalisation were more mixed. The Director of NGO B (interviewee #6) was most concerned about how liberalisation effectively eliminated many cooperatives that were encouraged by the Coffee Marketing Board. The NGO director credited the government's implementation of liberalisation alone with "squashing" the coops that existed before. Only recently through action from exporters and NGOs are cooperatives returning with strength and helping to improve the quality of Ugandan coffee (see section 5.5.2). NGO B's Director also felt that the price support mechanism that the government via the Coffee Marketing Board put into place was hugely beneficial to farmers. The price floor ensured a steady income which allowed coffee growers to feel secure with investments in inputs and farming effort. The director felt that it was the low and inconsistent prices that discouraged farmers leading them to not invest in coffee production. This opinion was largely confirmed by the survey results on the impact of the divergence between a farmers' view of a fair price compared to the current price (see sections 5.5.7 and 7.2.1). There was limited evidence from the coffee game at the workshop in Nkokonjeru to suggest farmers do indeed prefer a consistent, but possibly lower income (see section 6.4.1). The other NGO director (interviewee #1) thought the biggest issue after liberalisation was that farmers were no longer inspected and forced to maintain quality and plant other food crops. Although the survey found that many farmers were growing alternative crops and many food crops (see section 7.2.1), the interviewee thought it was better before.

Exporter B's Quality Manager (interviewee #3) felt that quality went way down after liberalisation for the dried coffee beans that they receive from traders with lots of defects entering the system. They also had more failures of the ochratoxin test, which was monitored in order to meet SPS requirements before export for the presence of mycotoxins. The increase in the failures indicated poorer handling of coffee during the drying process such that mould was likely growing on the drying cherries and leaving behind mycotoxins on the bean, even if the physical presence of the mould was removed when the bean was hulled. A typical example of this poor handling was observed in the survey of traders (see next section, Figure 87).

Some of the benefits of liberalisation have been massive investments in processing technology by exporter firms. The Managing Director of Exporter B (interviewee #10) thought liberalisation was great for the coffee industry. It generated much-needed investment in primary and secondary processing to get Uganda back from behind the curve on processing infrastructure post-Amin.[233] Exporter B had recently put $9M USD into a processing plant in Mbale and that level of investment never happened pre-liberalisation (personal conversation, interviewee #10).

Explored more in the next section, the Head of Programs from NGO B (interviewee #5) argued that it was the traders (or middlemen) that are killing the quality of coffee by mixing good and bad beans. This became easier to do after liberalisation as (1) exporters were more competitive and needed to compete for buying coffee volumes, and (2) the government was less strict in the regulation of growers. Interviewee #5 felt the government needed to intervene again and was nostalgic for the Coffee Marketing Board that would prohibit traders from mixing coffees. While cooperatives have worked to eliminate this issue, traders were still responsible for much of the quality issues in the supply chain.

A.26.1. The difficulty of quality coffee

Roasters have become more discerning about the choice between quality and price. The Quality Manager at Exporter A (interviewee #3) confirmed that buyers specify the quality, some asking for super clean and quality coffee, others happy for the exporter to send them whatever quality at a lower price. As a result, the key for an exporter to maximize profits is to be able to precisely sort coffee. Overall, though, interviewee #3 felt that quality requirements in markets were beginning to rise faster than they were accustomed to dealing with and they needed to focus more on marketing strategy and competiveness to keep their markets (personal conversation). The trend was that buyers would ask for lower prices rather than higher quality as the set point for quality was becoming quite high. There was a lot of good quality coffee on the market, which has pushed up buyers standards (personal conversation, interviewee #14). The margins for better coffee were also small. Screen 15 is paid at par to the London exchange price. FAQ is usually at around 80% of London price. Screen 18 is about +100-120 USh/kg above the Screen 15, par price (personal conversation, interviewee #14).

When asked about the possibility of a single origin Robusta market for Ugandan exporters, the industry expert felt it was next to impossible (personal conversation, interviewee #14). The

[233] Idi Amin was the infamous dictator of Uganda in the 1970s whose regime devastated the economy of the country and killed hundreds of thousands of citizens

markets are poor with little interest in Ugandan Robusta on its own since it is usually sold into a mass market. Additionally, the image of Robusta as a "bad" coffee constrains the ability to sell a single origin, quality coffee to consumers. Another constraint is the setup of the Ugandan coffee supply. It is difficult to bulk smallholder coffee and get a consistent specialty coffee; one needs big estates like those that they have in Kenya with a central processing place on-site (personal conversation, interviewee #14). Given the nature of the Ugandan supply chain, the best way to improve coffee quality is to work on aggregation and help with bulking the supply. The industry expert (interviewee #14) believes the best way to do so is to cut out the intermediaries with viable farmer groups that can bulk the coffee instead and incentivize them to keep coffee separated into different qualities. The farmers in the workshops had either heard this message or largely agreed on their own accord (see section 5.5.7).

Other stakeholders still keep a part of their operation geared towards quality Robusta production. The Managing Director of Exporter B said that although they were doing washed Robusta, it was prone to quality issues. The operation was sensitive to loading of the cherries: if too few come in, then both water and time are wasted; and if too many come in, some may over-ripen and contaminate the whole lot of cherries. As soon as a batch begins to ferment too much, the coffee is ruined and has to be discarded. As such, it is very difficult to make the operation financially viable.

A local entrepreneur (interviewee #19) faced similar challenges when trying to start a cooperative in the Nkokonjeru area to make washed Robusta. The logistics of getting all the cherries from farms to a central processing facility in time were just too great, and so they could not maintain quality consistency to keep up the business. As well, farmers felt that they were being cheated when the company refused to pay for green, unripe cherries, or black, dried cherries. There was a tremendous amount of social inertia. Growers wanted to carry on the practices they were accustomed to; they demanded an inflated price to justify changing to a new system where quality was demanded, and where poor quality was refused.

While UCDA has a mandate to help farmers and improve quality, they are too understaffed (personal conversation, interviewee #2). For instance, there have one employee who is supposed to cover three districts. They also have not been identifying good export markets as they are mandated to do; the largest exporters (like Exporter A in the interviewee's opinion) have been doing that. The presence of multinationals having a stronger operation in Uganda has also made the market more competitive (see section A.25.5). Given the thin margins for quality coffee and the lack of government subsidy, it is also difficult for the UCDA to effectively incentive farmers to follow GAPs and conform to best practices.

The Managing Director of Exporter B (interviewee #10) focuses on incentives when talking about getting growers to improve quality and yields because the MD knows it works. A favourite anecdote the MD shared with the author highlighted the extent to which most small holders respond to cash incentives that are presented to them, even when it compromises the quality of the crop. In the early 1980s, Côte d'Ivoire had a government guaranteed price for every level of production from the farm gate through the product ready for export. However, the price to deliver on 1st November and 1st December were the same. As a result, at the beginning of November, farmers harvested everything and got the guaranteed price, but once the beans had been processed, it was clear that they had just produced a massive amount of black beans at a national-scale from a perverse policy incentive. Cash-strapped farmers harvested everything when it was green and unripe in order to book profits as soon as they could. Traders passed the poor quality beans along since the price was guaranteed regardless. The government's export board was stuck with the issue when no foreign importer would buy any of the entire national production.

A.27. SUMMARY STATISTICS FOR COFFEE EXIT MODELS

Table 83: Summary statistics for models in section 7.2.5 of Chapter 7

VARIABLE	UNITS	MEAN	SD	MIN	MAX	N
fair price factor	(scalar)	1.78	0.59	0.75	5	114
% plot in coffee	(proportion)	0.37	0.22	0.033	1	119
Num. other incomes	(count)	3.33	1.49	1	8	119
social	(count)	2.78	2.20	0	7	119
log(income)	log(Ush/year)	14.06	1.07	11.47	16.30	110
i.importance	(category)	2.16	0.71	1	4	119
volume decrease factor	(scalar)	0.77	0.69	0.10	5.60	112
coffee plot size	ha	1.34	1.69	0.10	14	119
total plot size	ha	4.52	6.26	0.13	50	119
NRC	(count)	4.90	2.11	0	8	119

A.28. RASFF AND RAPEX BORDER REJECTIONS REVEAL RISK AT EU BORDER

There are two research questions that could be addressed using EU border rejections of food and non-food products due to safety issues. RASFF notifications represent new cases of a reported health risk detected in a shipment of food or feed and rejected at any border post within the EU; border rejections are those consignments of products that were refused entry into the EU for violating regulations meant to protect human, animal, or environmental health. The RAPEX is a parallel system for non-food products (a closer parallel to the TBT agreement).

The first research subject is that issuing SPS/TBT measures on imports is meant to mitigate risks associated with the import pathway back down to an appropriate level of risk for the given country. Previous econometric studies have looked extensively at whether SPS and TBT measures are trade facilitating or trade reducing (see literature in section 2.4 of Chapter 2), but the question of evaluating ex-post whether risks have decreased to an acceptable level has not been extensively analysed.

Another possible research question is what factors make shipments more likely to fail inspections and be rejected? An interesting methodology to test the possibility of new invasive species coming into the UK was used by Mwebaze, Monaghan, Spence, et al. (2010) using interception data for fresh produce. The overarching logic behind the model is that products coming from new origins are more likely to contain pests previously unestablished in the importing country (assuming the origin country is a unique source of said pest). They test this for new non-indigenous insect pests in the imports of fresh produce to the UK, confirming the hypothesis with the interception data. Extending the scope from Mwebaze, Monaghan, Spence, et al. (2010), analysis could look at any food product covered in the RASFF database (as opposed to just fresh produce) and look at the entire EU (as opposed to just the UK). Unlike the data source used by Mwebaze, Monaghan, Spence, et al. (2010), RASFF only records interceptions and not the number of inspections. As a result, one could not consider the cost effectiveness of inspections.

The data needs signficiant processing to be useful for analysis. As an example, the reason for rejecting the product is recorded in a text box without clear indicators of the issue. The author began to use regular expressions in STATA to develop a way to code the results. Examples of the code are given below to pick specific terms out of the variable "Danger" which was the free text box describing the reason for rejection:

```
/// DECIPHERING PROBLEM IN THE PRODUCT
//aflatoxin dummy
gen aflatox = 1 if regexm(Danger, ".*aflatox*")
replace aflatox = 1 if regexm(Danger, ".*ochratox*") & aflatox==.

//gmo dummy
gen gmo = 1 if regexm(Danger, ".*genetically modified.*")

//residue dummy (prohibited substance)
gen residue = 1 if regexm(Danger, ".*prohibited substance*")

//salmonella E coli and Bacillus cereus
gen bact = 1 if regexm(Danger, ".*E.* coli .*")
replace bact = 1 if regexm(Danger, ".*Salmonella.*") & bact==.
replace bact = 1 if regexm(Danger, ".*Bacillus cereus.*") & bact==.
replace bact = 1 if regexm(Danger, ".*plate count.*") & bact==.

//insects or arachnids (mites)
gen insects = 1 if regexm(Danger, ".*insects.*")
replace insects = 1 if regexm(Danger, ".*mites.*") & insects==.

//mould or spoilage, temperature control, organoleptic
gen spoiled = 1 if regexm(Danger, ".*spoil.*")
replace spoiled = 1 if regexm(Danger, ".*organoleptic.*") & spoiled==.
replace spoiled = 1 if regexm(Danger, ".*temperature control.*") & spoiled==.
```

Once the issues are coded more effectively, seasonal trends can be plotted as demonstrated in Figure 122 or by year to see how hazards at the border have changed in Figure 123. It appears that aflatoxins are being better controlled, but there is a rise in the amount of food arriving spoiled at the border.

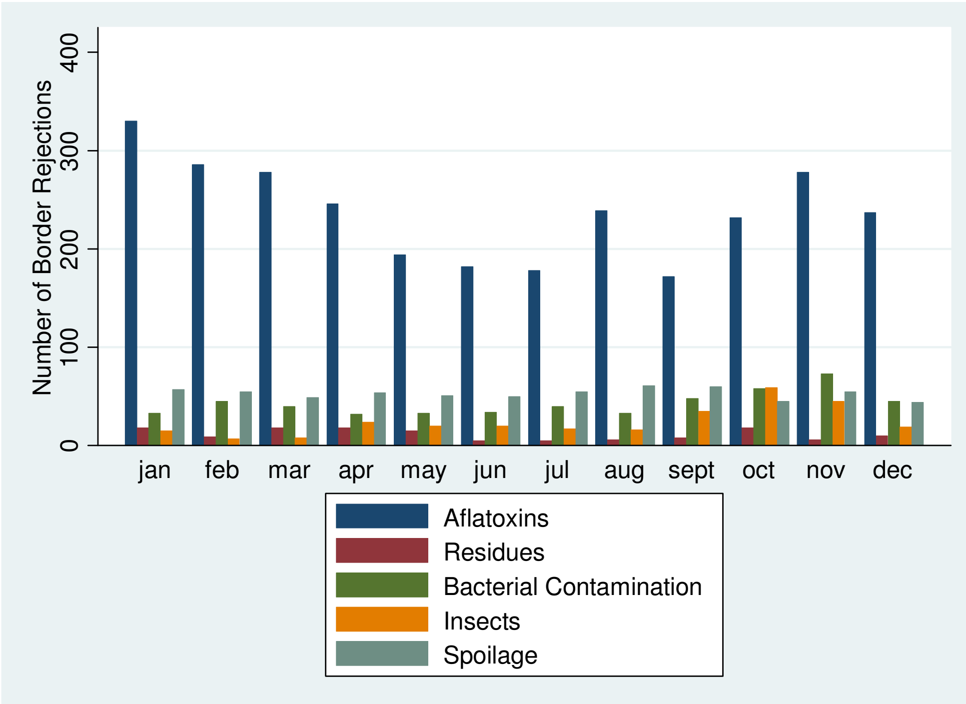


Figure 122: Seasonal trends on reasons for border rejections from RASFF

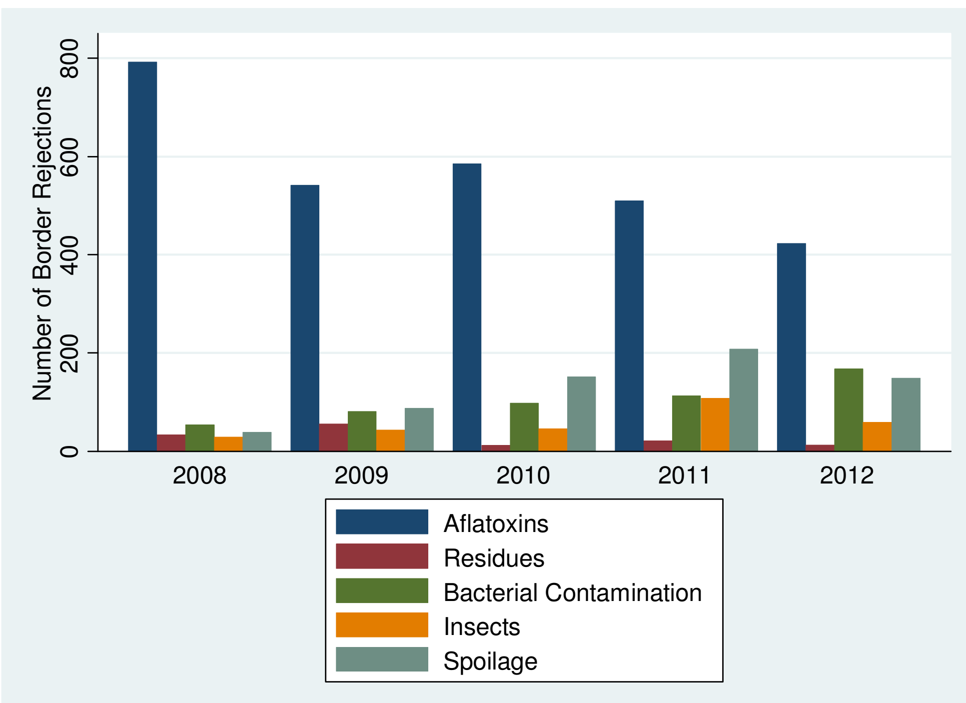


Figure 123: Hazards at the EU border by year

A.29. COPY OF RASFF AND RAPEX PERMISSION DOCUMENTS

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Copyright and Legal Issues Section

Luxembourg, 28 February 2013

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The public must be aware that the Commission is not in a position to release more information other than that published here. However, in exceptional circumstances where the protection of human health requires greater transparency, the Commission takes the appropriate action through its usual communication channels.

The Commission informs the authorities of third countries of notifications concerning products manufactured in, distributed to or dispatched from these countries. However, the fact that a country is mentioned as the origin of a product does not necessarily imply that the identified hazard(s) originated in the country concerned.

The Commission cannot and does not take any responsibility for the accuracy of the information in the RASFF portal online database. The information is published as it has been received from the official contact points in the Member States/EEA-EFTA countries. In the event that further information received from a contact point regarding an already published notification leads to modification or withdrawal of the notification, the Commission shall correct the information in its RASFF portal database at once or shall withdraw the notification concerned

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Yours sincerely,

Marcela Kubová

Publications Office

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The official contact points of the Member and EFTA-EEA States provide the information published in these weekly overviews. Under the terms of Annex II.10 to the General Product Safety Directive (2001/95/EC), responsibility for the information provided lies with the notifying party. The Commission does not take any responsibility for the accuracy of the information provided."

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Yours sincerely,

Marcela Kubová

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2, rue Mercier, 2985 Luxembourg – Tel. +352 29 29-42746 – Fax +352 29 29-44331

A.30. DIFFICULTY OF MERGING RASFF PRODUCTS WITH SPS NOTIFICATIONS AND TRADE DATA

The author first contacted the DG Sanco support office Feb 19th, 2013. A brief discussion revealed there was some work on developing a concordance system to merge RASFF notifications with trade data and SPS notifications, but it was still underdeveloped. The author saved the work of developing the concordance for future work.

---

product concordance with Harmonized System

4 messages

Lee Pearson <L.Pearson10@imperial.ac.uk> Tue, Feb 19, 2013 at 8:39 AM
To: sanco-rasff-portal-support@ec.europa.eu

Dear Support,

Is there a way to map theRASFF food categories of products smoothly onto standard HS codes from COMTRADE such that you can merge in trade data and SPS notifications to the WTO with notifications to the RASFF portal?

Thanks for your help.

Sincerely,
Lee

SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu <SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu> Thu, Feb 21, 2013 at 1:45 PM
To: "Pearson, Lee M" <l.pearson10@imperial.ac.uk>
Cc: "SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu" <SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu>, "Sanco-Rasff@ec.europa.eu" <Sanco-Rasff@ec.europa.eu>

Dear Lee,

Thank you for your email.

We had made a mapping several years ago, but this is no longer up to date. Because of the differences between the categories and RASFF and CN codes, it is a difficult and tricky affair.

Thanks,

Alecsandra Demetrescu
Application Services Center

DG SANCO
Rue Breydel 4, B-1040 Bruxelles

Lee Pearson <L.Pearson10@imperial.ac.uk> Thu, Feb 21, 2013 at 3:27 PM
To: "SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu" <SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu>
Cc: "Sanco-Rasff@ec.europa.eu" <Sanco-Rasff@ec.europa.eu>

Hi Alecsandra,

Thanks for the response! I appreciate the help. Is the old mapping publicly available? At least it would give me a point of departure and I can get trade data from COMTRADE in older classifications, or focus at a higher aggregation level to 4-digit or 2-digit HS code if need be.

Thanks for the help.

Lee

SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu <SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu> Fri, Feb 22, 2013 at 9:39 AM
To: "Pearson, Lee M" <l.pearson10@imperial.ac.uk>
Cc: "SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu" <SANCO-SUPPORT-RASFF-WINDOW@ec.europa.eu>

Dear Lee,

Here is the file with the mapping, done in 2006, so not up to date.

Best regards,

Alecsandra Demetrescu
Application Services Center

DG SANCO
Rue Breydel 4, B-1040 Bruxelles

From: Lee Pearson [mailto:L.Pearson10@imperial.ac.uk]
Sent: Thursday, February 21, 2013 4:28 PM
To: SANCO SUPPORT RASFF WINDOW
Cc: SANCO RASFF
Subject: Re: [IM0011826841] product concordance with Harmonized System

[Quoted text hidden]

mapping Rasff - CN.XLS
76K