Essays on trade policies and poverty in developing countries

Thèse

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Résumé

ommerciales et d'intégration sur la pauvreté dans les pays en développement. Elle analyse plus spécifiquement l'effet de l'adhésion au GATT et à l'OMC et des politiques tarifaires sur la pauvreté dans les pays en développement.

Dans le premier chapitre nous avons développé un modèle théorique basé sur le modèle Heckscher-Ohlin comportant une segmentation urbaine-rurale, avec des facteurs de production et des produits spécifiques à une région, pour expliquer le rôle de l'avantage comparatif dans la relation entre l'accession au GATT et à l'OMC et la pauvreté. Empiriquement, nous avons recouru aux méthodes économétriques d'appariement pour identifier les effets de l'adhésion au GATT et à l'OMC sur la pauvreté en utilisant un échantillon de 125 pays sur la période 1980-2012. Nos résultats montrent que l'adhésion au GATT et à l'OMC a réduit la pauvreté dans les pays membres qui sont des exportateurs nets de produits agricoles et plus spécifiquement d'exportations de produits agricoles à forte intensité de main-d'œuvre. A l'inverse, l'adhésion au GATT et à l'OMC a accru la pauvreté dans les pays en développement qui sont des importateurs nets de produits agricoles.

Dans le deuxième chapitre, nous examinons les effets hétérogènes de l'adhésion au GATT et à l'OMC sur la pauvreté. Nous utilisons un modèle Heckscher-Ohlin avec une dimension régionale et des différences de productivité entre pays pour montrer les effets de l'accession au GATT et à l'OMC sur la pauvreté peuvent varier considérablement d'un pays à l'autre en fonction de leur productivité et de leurs dotations factorielles et par conséquent de leur niveau initial de pauvreté. En conséquence, nous utilisons la régression quantile pour tester que l'adhésion a des répercussions différentes pour des pays regroupés dans différents quantiles de pauvreté. Nos résultats révèlent que l'adhésion au GATT et à l'OMC augmente considérablement la pauvreté dans tous les quantiles. L'augmentation de la pauvreté est plus élevée dans les pays les plus pauvres (quantiles supérieurs) que dans les pays les moins pauvres (quantiles inférieurs).

Enfin, dans le troisième chapitre, nous évaluons les effets des politiques tarifaires consistant à réduire la taxe sur le commerce international couplé de l'augmentation des taxes domestiques sur la pauvreté dans les pays en développement. Nous modélisons le lien entre les réformes

tarifaires et la pauvreté comme hétérogène entre les pays en utilisant un échantillon de 91 pays en développement sur la période 1980-2016. Nos résultats montrent que le passage des taxes sur le commerce international aux taxes nationales avec neutralité des recettes fiscales réduit la pauvreté dans les pays qui ont consolidé en moyenne leur avantage comparatif dans le secteur agricole ; par contre la pauvreté augmente dans les pays qui sont passés d'exportateurs nets à des importateurs nets de produits agricoles.

Abstract

This thesis investigates theoretically and empirically the effects of trade policies and trade integration on poverty in developing countries. More specifically, we are interested in the effects of GATT/WTO membership on poverty and the effects of trade tax reforms on poverty in developing countries.

In the first chapter, we develop a Heckscher-Ohlin framework featuring an urban-rural segmentation, with region-specific and product-specific factors and goods to explain the role of comparative advantage in how GATT/WTO accession impacts on poverty. We rely on matching econometrics to identify the effects of GATT/WTO membership on poverty using a sample of 125 countries over the 1980-2012 period. Our results show that the GATT/WTO membership decreased poverty in member countries that are net exporters of agricultural products and more specifically of labor-intensive agricultural exports. In contrast, GATT/WTO accession increased poverty in developing countries that are net importers of agricultural products.

In the second chapter, we we develop a Heckscher-Ohlin model with a regional segmentation and country-specific productivity shifters to show that the incidence of GATT/WTO adhesion generally depends on productivity and endowment differences and hence on the level of poverty prior to adhesion. This justifies an empirical model featuring a quantile regression approach. This approach allows us to test that the effects of GATT/WTO on poverty vary across countries belonging to different poverty quantiles. Our results reveal that GATT/WTO membership increases significantly poverty across the entire conditional poverty distribution. Countries with high initial poverty rates suffer higher poverty increases than countries with lower poverty rates.

Finally, in the third chapter, we assess trade-tax reforms induced by the reduction in trade taxes that typically accompany participation in multilateral and regional trade agreements in terms of their effects on poverty in developing countries. We model the trade tax reforms-poverty nexus as heterogeneous across countries with cross-sectionally dependent errors using a sample of 91 developing countries over 1980-2016 period. We find that a shift from taxes on international trade towards domestic taxes under revenue-neutrality reduces poverty in the countries that have consolidated on average over time their comparative advantage in

agriculture while it increases poverty in countries that moved from being net exporters to net importers of agricultural products.

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To my lovely mum Akouwa Afanou, this happened because of you. Thank you mum
To my sisters and brothers

An investment in knowledge pays the best interest.

Benjamin Franklin

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Avant-propos

Cette thèse est le fruit des études de doctorat à l'Université Laval. Il s'agit d'une thèse par articles comportant trois articles. Tous les trois articles sont co-écrits avec mes directeurs de thèse et je suis le principal auteur de chacun des trois articles. Les deux premiers articles ont été co-écrits avec mon directeur principal le Prof. Bruno Larue et ma co-directrice la Prof. Marilyne Huchet. Je suis l'unique auteur du troisième article.

Introduction

The roles of trade and trade policies in the development process and on poverty have received a considerable attention over the past decades. There is a consensus that open economies perform better than closed ones and in the long run, trade liberalization policies contribute significantly to economic growth and development (Dollar and Kraay, 2001; Krueger, 1985). However, there is no consensus about the effects of trade liberalization on poverty. This was first recognized by Winters et al. (2004) and more recently Harrison et al. (2010). Trade liberalization triggers sales reallocation between firms within a sector and reallocate resources between sectors and have distributional effects among poor people depending on what sectors are liberalized and how poor people earns their income. Furthermore, recent researches on trade, firms and labour markets conclude that trade liberalization increases wage inequality (Helpman et al., 2017, 2010). There is a regional dimension to poverty. In developing countries, poverty remains more acute in rural areas (Alkire et al., 2014; **?**; **?**). Unlike developed countries, developing countries have a large share of their population relying on agriculture for their livelihood and consumers spend a large share of their income on food. Hence, the way trade liberalization affects the agricultural sector is important for poverty reduction. If trade liberalization favours the agricultural sector by increasing the price of agricultural products and exports, poor people working in agriculture will benefit.

Over the last fifty years, many countries in the world have engaged in trade liberalization to speed up economic progress and this is why we have witnessed an explosion in the number of regional trade agreements (RTAs) in the world. One manifestation of this enthusiasm towards trade liberalization was the creation of the World Trade Organization (WTO) in 1995 whose role is to promote the world trade by reducing tariffs and non-tariff measures and facilitate the integration of developing countries into the world trading system. However, trade liberalization has had differential effects in terms of poverty reduction both within countries and between countries (e.g., Le Goff and Singh, 2014; Anderson et al., 2011; Goldberg and Pavcnik, 2004; Chen and Ravallion, 2004; Spilimbergo et al., 1999). Similarly, the effects of GATT/WTO accession on trade are very mixed and vary largely across countries (e.g., Eicher and Henn, 2011; Subramanian and Wei, 2007; Goldstein et al., 2007; Rose, 2005, 2004).

Dutt et al. (2013) analyzing the effect of GATT/WTO membership on extensive and intensive margins of trade find that GATT/WTO membership increases extensive margin (exports of new products) and reduces intensive margin of trade (export of existing products or old flows). Imai and Kim (2019) criticizes fixed-effect regressions to infer causal patterns and use a non-parametric matching technique to show that GATT/WTO adhesion induces a small, but positive trade effect. Tobin and Busch (2019) challenge the notion that GATT/WTO adhesion lowers tariffs. They argue that exporters in less developed countries involved in generalized system of preferences prior to joining GATT/WTO have a weaker incentive to fight protectionism once GATT/WTO accession is secured. All else equal, tariffs increase and trade falls.

Carter et al. (2009) analyze China's transition from a net exporter to a net importer of agricultural products after China's accession in the WTO. They find that WTO accession induced substantial changes in production patterns of agricultural products, favoring labor-intensive agricultural products at the expense of land-intensive ones.

Developed countries' agricultural subsidies are equivalent to 2/3 of Africa's total GDP and makes it difficult to some less developed countries to exploit fully their comparative advantage in agriculture. While agricultural subsidies are increasingly decoupled, there remains sensitive products supported by highly trade-distorting measures. The European sugar quota system was dismantled, but 179 million euros worth of coupled payments to sugar beet was spent in 2017 which made it sugar-producing countries to penetrate the European market. A tariff being equivalent to the combination of a production subsidy and a consumption tax, it follows that tariff reductions are far less effective when domestic subsidies are in place.[1]

The aim of this thesis is to investigate the effects of GATT/WTO membership on poverty in developing countries and to identify and measure the influence of key factors on this relationship.

In the first chapter we develop a Heckscher-Ohlin framework featuring an urban-rural segmentation, with region-specific goods and product-specific factors to explain the role of comparative advantage in how GATT/WTO accession impacts on poverty. Because rural and urban areas within a country have region-specific factors and produce different goods, their trade pattern differ and this support a persistent rural-urban wage gap. Stolper-Samuelson effects are region-specific and so are poverty effects. Generally, GATT/WTO-induced liberalization effects on poverty are ambiguous, but countries with a comparative advantage in agriculture are more likely to experience poverty alleviation after adhesion to GATT/WTO. We then test this assertion using a sample of 125 developing countries over 1980-2012 period. We use a matching econometrics approach to deal with the self-selection into the GATT/WTO membership and estimate the average treatment effects on treated. The re-

[1] https://ec.europa.eu/agriculture/sugar/doc/factsheet-end-sugar-quota_en.pdf

sults show that the GATT/WTO membership decreased poverty in member countries that are net exporters of agricultural products and more specifically of labor-intensive agricultural exports. GATT/WTO accession increased poverty in developing countries that are net importers of agricultural products.

The second chapter investigates the heterogeneous effects of GATT/WTO membership on poverty using a quantile regression approach. Developing countries differ on many characteristics and the effects of GATT/WTO membership on poverty may not be monotonic, increasing or decreasing poverty depending on a country's initial poverty level. GATT/WTO membership requires that new members undertake some trade liberalization which, on one hand, induces foreign competition and on the other, provides the access to many foreign markets. Clearly, not all poor countries have the same factor endowments, income distributions and produce, export and import the same goods. It follows that the number of poors in poor countries is expected to respond differently to the WTO "treatment". For this purpose, we investigate the heterogeneity in the effect of GATT/WTO membership on poverty using unconditional quantile regression methods. We develop a Heckscher-Ohlin model with urban and rural regions and country-specific productivity shifters to analyze how trade liberalization impacts on poverty. Because countries have specific productivity shifters and rural and urban areas within a country have region-specific factors and produce different goods, Stolper-Samuelson effects are region-specific and poverty effects are country-specific (depending on productivity level). The results suggest that GATT/WTO membership increases significantly poverty across the entire conditional poverty distribution. Countries with a higher poverty rate lost more from trade liberalization than countries with lower poverty rates. However, splitting the sample of countries into groups that have and do not have a comparative advantage in agriculture, we find that less poor countries that are net exporters of agricultural products experience poverty reduction whereas poverty increases in net importing countries across poverty quantiles. These results are robust across different unconditional quantile regression methods and to the selection bias.

The final chapter examines the effects of trade tax reforms on poverty. Trade tax reforms consist in reducing trade taxes on goods imported from partners in regional trade agreements and raising other taxes or creating new ones. We model the trade tax reforms-poverty nexus as heterogeneous across countries with cross-sectionally dependent errors. Using a sample of 91 developing countries over 1980-2016 period, we find that a shift from taxes on international trade towards domestic taxes under revenue-neutrality reduces poverty in the countries that have consolidated on average over time their comparative advantage in agriculture while it increases poverty in countries that moved from nets exporters to net importers of agricultural products. Moreover, we show that public goods don't play a significant role in the relationship.

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Chapter 1

Is GATT/WTO membership increasing or decreasing poverty in developing countries?

1.1. Résumé

Ce chapitre s'intéresse à l'effet de l'adhésion au GATT et à l'OMC sur la pauvreté dans les pays en développement. Nous avons développé un modèle théorique basé sur le modèle Heckscher-Ohlin comportant une segmentation urbaine-rurale, avec des facteurs de production et des produits spécifiques à une région, pour expliquer le rôle de l'avantage comparatif dans la relation entre l'accession au GATT et à l'OMC et la pauvreté. Empiriquement, nous avons recouru aux méthodes économétriques d'appariement pour identifier les effets de l'adhésion au GATT et à l'OMC sur la pauvreté en utilisant un échantillon de 125 pays sur la période 1980-2012. Nos résultats montrent que l'adhésion au GATT et à l'OMC a réduit la pauvreté dans les pays membres qui sont des exportateurs nets de produits agricoles et plus spécifiquement d'exportations de produits agricoles à forte intensité de main-d'œuvre. A l'inverse, l'adhésion au GATT et à l'OMC a accru la pauvreté dans les pays en développement qui sont des importateurs nets de produits agricoles.

1.2. Abstract

This paper investigates how GATT/WTO membership impacts on poverty. We develop a Heckscher-Ohlin framework featuring an urban-rural segmentation, with region-specific and product-specific factors and goods to explain the role of comparative advantage in how

GATT/WTO accession impacted on poverty. Using a sample of 125 developing countries over the 1980-2012 period, we estimate the average treatment effect on the treated to characterize the causal effect of GATT/WTO membership on poverty rates, while controlling for the self-selection problem. Our results, robust across different matching methods, show that the GATT/WTO membership decreased poverty in member countries that are net exporters of agricultural products and more specifically of labor-intensive agricultural exports. GATT/WTO accession increased poverty in developing countries that are net importers of agricultural products.

Keywords: GATT/WTO, Trade liberalization, Poverty, Treatment effects, Matching econometrics.

JEL classification: F10; F13; F15

1.3. Introduction

Poverty alleviation and income inequalities issues have been a global concern for decades. The Millenium Development Goals (MDG) had as a primary purpose the eradication of extreme poverty and hunger. The aim was to reduce by half the proportions of people living in extreme poverty (with revenue below $1.25 a day) and of people suffering from hunger between 1990 and 2015. Sala-i Martin (2006) argues that both global income inequality and poverty have decreased during the 1980s and 1990s. Recent FAO estimates show that the proportion of people living under $1.25 per day decreased from 47% in 1990 to 14% in 2015. However, according to FAO et al. (2017), there were still 815 million people living in extreme poverty in the world in 2016, or roughly one-eighth of the world's population. At a historic UN meeting held in September of 2015, world leaders adopted the 2030 Agenda for Sustainable Development. This program builds on the success of the MDG and it is structured around 17 sustainable development goals. Some of these goals pertain to the acceleration of economic growth, industrial development and innovation. Trade liberalization is generally regarded as a mean to achieve these goals through static and dynamic selection effects that increase productivity and growth (e.g., Sampson, 2016; World Bank Group and World Trade Organization, 2015). However, economic theory is more ambiguous when it comes to the effect of trade on other goals like ending poverty and reducing inequalities.

Trade liberalization affects poverty through its effects on output and input prices (Stolper-Samuelson theorem). When a country liberalizes trade, consumers pay lower prices for imported goods while producers obtain higher prices for their exported goods. The higher prices on exported goods tend to increase the prices of inputs used intensively in the production of exported goods. Trade liberalization also affects poverty and growth through its incidence on investment, innovation and sources of government revenue (Bannister, 2001). Other channels through which trade liberalization affects poverty are technology diffusion, information flows and the quality of institutions (Nissanke and Thorbecke, 2006, 2010).

There is a long established consensus that open economies perform better than closed ones due to the exploitation of comparative advantage (Krueger, 1985). Dollar and Kraay (2001) analyzed the relationships between trade, growth and poverty and conclude that developing countries that have significantly opened up to international trade have experienced rapid economic growth and poverty reduction. Various international institutions, like the International Monetary Fund (IMF) and the World Bank, have encouraged developing countries to liberalize their economies in their fight against poverty. Harrison (2006) notes that developing countries have increasingly integrated the world trading system and that trade liberalization can help alleviate poverty especially when complementary policies promoting macroeconomic stability and the development of human capital are implemented. However, other authors argue that trade liberalization has increased the dependency of developing countries on world markets

and made their consumers and farmers more vulnerable to external shocks (Díaz-Bonilla and Ron, 2010; Dawe et al., 2015; Ceballos et al., 2016). This is more likely in countries where a large share of consumers' income is spent on food and a significant fraction of the population works in agriculture (World Bank, 2007).

Though the Doha Round of multilateral negotiations was called the Development Round, little is known about the incidence of GATT/WTO membership on poverty. The WTO was established in 1994. It began overseeing the implementation of agreements on trade in services and on intellectual property in 1995 and continued implementing the General Agreement on Tariffs and Trade (GATT) which was created in 1947 by 23 founding signatories. Among those founding signatories, about half were developing countries. However, China, Lebanon, Syria and Liberia withdrew in the early 1950s, tipping the membership toward high-income countries. GATT administers agreements, provides a forum for negotiations, provides a trade dispute settlement mechanism, monitors national trade policies and gives technical assistance and training to developing countries.

Developing countries (GATT/WTO members) are given "more time to adjust, greater flexibility and special privileges" in WTO agreements. However, the GATT/WTO had limited success in leading ou encouraging developed countries to reduce domestic support and import tariffs on many agricultural goods exported by developing countries.[1] There is no doubt that GATT/WTO membership provides many benefits to developing countries, but does it reduce poverty?

There has been much more interest about GATT/WTO membership on trade than on poverty. Surprisingly, empirical results about the GATT/WTO's trade promoting effect are mixed. Rose (2004) concludes that GATT/WTO accession does not boost trade. Subramanian and Wei (2007) found that GATT/WTO membership promotes trade for industrialized countries, but not for developing countries. Goldstein et al. (2007) show that GATT/WTO increases trade and so does Rose (2005). Eicher and Henn (2011) find that GATT/WTO membership increases trade prior to the implementation of regional trade agreements and between developing countries that are not too distant from one another.

The existing literature on the incidence of GATT/WTO accession on poverty is generally country-specific. We are not aware of studies that have attempted to evaluate the GATT/WTO effect on poverty using a large sample of GATT/WTO members and non-members. For instance, Chen and Ravallion (2004) using a computable general equilibrium (CGE) model show that China's accession to the WTO had a negligible impact on households' average income and on poverty. Carter et al. (2009) contend that farm income has risen in China after its accession to the WTO, but that not all Chinese farmers have benefitted from

[1] After several GATT Rounds, industrialized countries tend to have low tariffs on most of their agricultural imports, but have high peaks. For example, 85% of Canada's agricultural tariffs are between 0 and 10%, but 5% of Canada's agricultural tariffs are in excess of 100%.

it. Cling et al. (2009) also using CGE model show that Vietnam's WTO accession boosted employment, caused growth in real wages especially for unskilled workers and reduced poverty. Likewise, Rutherford and Tarr (2008) using a computable general equilibrium model assessed the impact of Russia's WTO accession on its income distribution and found that households had gained.

Countries that have joined the WTO may have characteristics that would have induced reductions or increases in poverty whether they had joined or not the WTO. Evidence about a WTO effect from member countries may suffer from a selection bias. The latter can be corrected through several methods such as instrumental variables (e.g., Chen and Ravallion, 2004; Baier and Bergstrand, 2002; Magee, 2003), matching (e.g., Smeets and Warzynski, 2013; Baier and Bergstrand, 2009) and difference-in-difference matching (Egger et al., 2008). The difference-in-difference could be used to assess the impact of WTO accession treatment by comparing poverty before and after accession for members and non-members. The underlying assumption is that poverty trends were the same in all non-member countries until some joined the GATT/WTO. However, because it is likely that there were differences in poverty trends between non-members that remained non-members and non-members that eventually joined GATT/WTO, we implement matching methods. We test the impact on poverty for developing countries belonging to the GATT/WTO relative to those which are not members of the WTO.

The contribution of this article is twofold. First, we provide a theoretical foundation drawing on a new Heckscher-Ohlin framework with countries made up of urban and rural regions endowed with common and specific factors to link poverty to comparative advantage and GATT/WTO-induced terms of trade changes. Second, we estimate the average treatment effect of belonging to GATT/WTO on poverty by using a large sample of developing countries (125 countries) over a relatively long period (1980-2012). We estimate the treatment effect of GATT/WTO accession on poverty by comparing the poverty effect of GATT/WTO membership between all members and non-members after controlling for observables that also impact on poverty. Our first set of results is based on the pooling of all the countries, irrespective of their comparative advantage. Then, as per our theory, we allow GATT/WTO membership to differ for developing countries that are net exporters of agricultural products and developing countries that are net importers.[2]

Our Heckscher-Ohlin framework explains the resilience of the urban-rural wage gap and the urbanization growth observed in developing countries. The Stolper-Samuelson theorem operates differently in rural and urban areas because these regions produce different goods using different combinations of factors. Developing countries tend to export more labor-intensive

[2]Divisions between the two groups regarding trade liberalization issues are cited as a contributing factor for the failure to conclude the Doha Round (Financial Times, Dec.21, 2015 https://www.ft.com/content/9cb1ab9e-a7e2-11e5-955c-1e1d6de94879)

agricultural goods like fruits and vegetables and meats while developed countries tend to specialize in land-intensive agricultural goods like cereals and oilseeds with the exception of Brazil, a top soya exporter. Given that poverty is concentrated in rural areas, our theoretical framework predicts that countries with a comparative advantage in labor-intensive agricultural products are more likely to experience poverty reduction after GATT/WTO accession than developing countries that net importers of agricultural products. Our empirical results indicate that GATT/WTO accession increased poverty when all developing countries are pooled together. However, when the analysis is conducted on truncated samples, it is shown that GATT/WTO membership contributed to reduce poverty in member countries that are net exporters of agricultural products while having the opposite effect for developing countries that are net importers of agricultural products. These results are robust across different matching methods (propensity score matching methods and nonparametric matching methods). Rosenbaum tests show that the influence of unobservable variables would need to be much larger to undermine the causal inference from our matching estimates.

The paper is organized as follows. After presenting a succinct review of the literature on the relationship between trade liberalization and poverty in Section 1.4, we present a novel Heckscher-Ohlin theoretical framework in Section 1.5 to provide new insights showing that trade liberalization may reduce poverty while increasing inequality. Section 1.6 describes the data and methodology used to estimate the causal effect of GATT/WTO membership on poverty. Section 1.7 presents results while Section 1.8 explores Stolper-Samuelson linkages on GATT/WTO poverty effects. Finally, Section 1.9 concludes.

1.4. Trade and poverty linkages: a review

The purpose of this section is to briefly review some of the mechanisms by which trade liberalization may reduce or exacerbate income inequality and/or poverty. In some cases, authors use the two terms interchangeably, but many are careful about distinctions between income inequality, pay inequality, wealth inequality and poverty. Poverty is typically defined in terms of the fraction of a population with an income below a specific threshold. Inferences about income inequality pertains to the uneveness of the distribution of national income across individuals. Many income inequality measures have been proposed, the Gini, Theil and Hoover indices being a popular metrics. In theoretical trade models, income inequality often boils down to the wage spread between low and high skilled workers (e.g., Helpman et al., 2010). Studies can be classified as either static or dynamic (Bhagwati and Srinivasan, 2002). Static studies focus mainly on the wage gap between low-skilled and high-skilled workers. Dynamic studies concentrate on the effects of trade on economic growth and the incidence of growth on income distribution.

The Stolper-Samuelson theorem predicts that when a country opens up to trade, the remuneration of its relatively abundant factors tend to improve while the remuneration of its scarce factors tends to worsen. In countries relatively abundant in low-skilled workers and agricultural land, trade liberalization is likely to induce increases in the rewards for low-skilled workers and land owners. Accordingly, some unskilled rural workers and small plot owners in rural areas might experience welfare gains large enough to pull them out of poverty. In a study covering 34 developed and developing countries, Spilimbergo et al. (1999) show that trade openness increases income inequality in skilled-labour abundant countries, but not so much in land and capital abundant countries. However, when the sample is limited to developing countries, Spilimbergo et al. (1999) find no significant relationship between trade openness and inequality. Leamer et al. (1999) argue that income inequality in Latin America is due to abundance in natural resources which pulls capital away from manufacturing.

Goldberg and Pavcnik (2004) review the poverty and inequality impacts of trade in developing countries and find that many developing countries paradoxically protect unskilled labor-intensive sectors. As a result, trade liberalization hurts unskilled workers in the short run in these countries. Rodrik (2017) argues that the relative strength of distributional Stolper-Samuelson effects increases vis-à-vis efficiency or growth effects as trade liberalization progresses. He concludes that additional trade liberalization is more likely to induce a populist opposition in countries with low tariffs than in countries with high tariffs. Grossman et al. (2017) extend the Heckscher-Ohlin model with two industries and two factors by introducing heterogeneous workers and managers as factors of production. Changes in terms of trade induce sorting and matching that increase inequalities in wages and salaries paid within manufacturing industries. Using a monopolistic model, Helpman et al. (2012) also argue that between-firm wage dispersion within a sector is an important determinant of wage inequality. The opening up of trade increases wage dispersion between firms within the same sector. On average, exporting firms are larger and pay higher wages than other firms.

A review of the literature reveals that some other factors influence the trade liberalization-poverty relationship. North (1989, 1990) state that institutions play a central role in economic development and Rodrik (1998) contends that strong institutions can help developping countries secure more benefits from trade liberalization while limiting adverse effects, namely income inequality, by facilitating the setting up better safety nets. Le Goff and Singh (2014) find that trade liberalization reduces poverty in countries with deep financial sectors, high levels of education and strong institutions. Clearly, when trade liberalization is accompanied by complementary policies, it can be beneficial to the poor (Harrison and McMillan, 2007). Gozgor and Ranjan (2017) provide empirical evidence that trade openness leads to more income redistribution and that the relationship is stronger for richer countries. Trade liberalization forces countries that rely substantially on trade taxes to fund public expenditures to find alternative revenue sources and/or cut expenditures. Anderson et al. (2011) find

that trade policy reforms reduce poverty especially when the fall in trade taxes is offset by an increase in the income tax levied on high-income earners.

Globalization facilitates the movement of capital and foreign direct investment inflows tend to increase the productivity of high skilled labour, causing a widening of the wage gap (Feenstra and Hanson, 1996). Zhu and Trefler (2005) argue that the technological catch-up by developing countries leads to a higher demand for skilled labour in both developed and developing countries and therefore an increase in wage inequality in both regions.

The incidence of trade on poverty and inequality also depends on country characteristics, especially the ones pertaining to their labor market (Banerjee and Newman, 2003; Foellmi and Oechslin, 2010). Labour market rigidities can create trade-induced unemployment and prevent Stolper-Samuelson effects. Helpman and Itskhoki (2010) use a two country, two-sector model of international trade to study the role of rigidities in the labour market. Firms in both sectors face frictions in the labour market. These labour market frictions provide a source of comparative advantage and determine trade flows. Trade liberalization increases unemployment rate when labour market frictions in sector producing differentiated products are stronger than in the constant return sector.

Country-specific studies show that trade liberalization effects on households not only differ across household income, but also across locations (Nicita, 2009, for instance). In the case of Mexico, tariff reduction pass-throughs were much smaller in regions far from the US border. Controlling for location, richer households have gained more from lower tariffs than poor households. Nicita et al. (2014) analyze the trade policies of Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, Gambia, and Madagascar and find a pro-poor bias involving redistribution from rich to poor households in all countries except Ethiopia. However, trade barriers used by these countries' trade partners tend to penalize poor households in rural areas through lower prices on agricultural goods and strong Stolper-Samuelson effects.

The relationship between trade liberalization and income inequalities may not be monotone. Agénor (2004) argues that globalization is detrimental for the poor under a certain level of poverty but pro-poor beyond this threshold, suggesting an inverted U-shaped relationship between trade and poverty. Beyond a certain threshold, trade liberalization strenghten domestic institutions and legal infrastructure. Meschi and Vivarelli (2009) and Brambilla et al. (2014) argue that developing countries trading more with rich countries experience technological changes biased toward high skilled labour that widen the wage gap.

From a dynamic perspective, trade liberalization affects poverty through its effects on economic growth (Bannister, 2001; Winters, 2002; Winters et al., 2004). Winters et al. (2004) highlight that high economic growth increases income levels which in turn increase government tax revenues that can be redistributed to reduce poverty. Several empirical studies

provide evidence supporting this point. Roemer and Gugerty (1997) [3] show that there is a one-for-one relationship between GDP growth and income growth for the poorest 40% using a sample of 26 developing countries. Similarly, a 1% increase in GDP induces an increase of 0.92% for the poorest 20%. Gallup et al. (1998) in a study including both developed and developing countries also find a one-for-one relationship between economic growth and real income growth for the poor, but they also show that most of the variables influencing economic growth also influence income distribution.[4] Similarly, Dollar and Kraay (2001) find that the average income of the poorest quintiles moves in a one-for-one relationship with the average income of the population as a whole. Thus, rapid economic growth correlates with significant poverty decline (Fields, 1989). However, Ravallion (2012) argues that the initial level of poverty matters when analyzing the relationship between economic growth and poverty in developing countries. Countries starting with a higher initial incidence of poverty tend to experience a lower rate of growth and therefore have a lower rate of poverty reduction. The next section provides a new way by which the Stolper-Samuelson theorem can affect poverty, income inequality and the urban-rural wage gap in developing countries.

1.5. Heckscher-Ohlin and rural-urban trade-poverty linkages

1.5.1. A Heckscher-Ohlin model with rural and urban regions

"The Heckscher-Ohlin (HO) model posits that trade can be motivated by differences in factor endowments. Accordingly, one would expect that the HO model should be particularly useful to explain trade in resource-intensive goods like forest, mining and agricultural products. The HO model and its higher dimensional extension, the Heckscher-Ohlin-Vanek (HOV), have fallen in disfavour when empirical studies conducted in the 1980s and 1990s found little support for the HOV equation linking the factor content of trade to factor endowments (e.g., Bowen et al., 1987). Trefler (1995) called the discrepancy between the predicted and actual trade in factors the missing trade paradox and showed how the empirical performance of the model could be improved by relaxing some assumptions like identical technology across countries. Despite their shortcomings, the HO-HOV models provide useful insights. Romalis (2004) developed monopolistic competition and transports costs and found support for factor abundance as a determinant of trade patterns. Recently, Jäkel and Smolka (2017) developed a higher-dimensional version of the Stolper-Samuelson theorem linking factor prices to the factor content of trade under free trade, and hence to factor abundance, to explain cross-country and within-country differences in attitudes toward free trade.

[3] They use the poorest 20% and 40% of the population as the measure of poverty.

[4] The only variables that do not influence economic growth and income distribution are political instability, lax government budget policies and location in the tropics.

Standard HO-HOV models assume that all factors are mobile in order for free trade to replicate an integrated economy (with free factor movement). However some factors, such as agricultural land, are immobile within countries. This suggests that factors and goods are generally tied to regions within a country. Accordingly, it seems natural to break down developing countries into rural and urban areas, especially since poverty appears to be worse in rural areas of developing countries and given that the fraction of the population living in rural areas is very high in some countries.[5] Another motivation for a rural-urban break down is the persistence of an urban-rural wage gap in developing countries. Our model provides an explanation for an urban-rural wage gap based on external factors which contrasts with internal causes as in the Harris-Todaro tradition (Harris and Todaro, 1970) or by appealing to ethnic network effects as in (Munshi and Rosenzweig, 2016).

Agricultural goods differ in terms of their factor intensities. Advances in mechanized inputs in the last century have made agricultural production intensive in capital and land in developed and middle-income countries. Developing countries rely mostly on labor and land to produce agricultural goods. Many agricultural goods like milk, livestock, grains and oilseeds are produced in every country of the world, but with different factor intensities and in many cases with different technologies. Some goods like vanilla, cocoa and coffee are produced only in a few countries. Import protection and domestic support also varies tremendously between countries for a given agricultural good and between agricultural goods within a country (OCDE, 2019). Accordingly, cross-country differences in factor prices are likely to remain with or without trade liberalization. Under these conditions, the factor price equalization theorem is bound to fail. This applies between countries and regions within a country. This allows the regional Heckscher-Ohlin model developed below to generate new insights about trade liberalization and poverty.

We develop a 4-good (goods 1, 2, 3 and 4) 3-factor (land, unskilled and skilled labor) Heckscher-Ohlin model with a rural-urban segmentation within countries and region-specific factors and goods to investigate the linkages between trade liberalization, poverty and inequality in developing countries. We are not the first to develop a Heckscher-Ohlin framework featuring regions with different factor endowments within countries. Melvin (1985a,b) stand out in this regard. However, his model differs in important ways from ours with east-west regions using the same two factors to produce the same two goods. Internal trade costs and different capital-labor endowment ratios implies that the country import and export both goods as regions export different goods. We assume that rural areas are endowed with agricultural land and unskilled workers. Agricultural land is specific to rural areas and it is essential in the production of two rural goods. Similarly, it is assumed that urban workers are endowed with one unit of unskilled labor and that some workers have different levels of skills or human

[5] 80% of Ethiopia's population was living in rural areas in 2016 according to the World Bank's Economic Indicators.

capital and that unskilled labor and skills are required in the production of two urban goods. Skills in the urban region plays the same role as land in rural areas. More specifically, the rural area is endowed with $\bar{L}_k^R$ unskilled workers and $\bar{D}_k^R$ units of agricultural land. Goods 1 and 2 are produced in the rural area using land and unskilled labor and goods 3 and 4 in the urban area using skilled and unskilled labor. Good 1 is assumed to be land-intensive and good 2 is labor intensive. With $\bar{d}_k^R \equiv \dfrac{\bar{D}_k^R}{\bar{L}_k^R}$ denoting the relative land endowment in the rural region of country k, then incomplete specialisation entails $d_1 > \bar{d}_k^R > d_2$ for all admissible relative wages $\bar{\omega}_k^R = \dfrac{w_k^R}{r_k^D}$ where $d_i \equiv \dfrac{D_i}{L_i}, i = 1, 2$, r_k^D is the price of land and w_k^R is the wage of unskilled workers in the rural area. The urban area's endowments in unskilled workers is $\bar{L}_k^U$. Human capital or skill endowment is denoted by $\bar{H}_k^U$. $\bar{h}_k^U \equiv \dfrac{\bar{H}_k^U}{\bar{L}_k^U}$ is defined as the relative abundance of skills. The quantities of manufactured goods are denoted by Q_{3k}^U and Q_{4k}^U. It is assumed that $h_3 > \bar{h}_k^U > h_4$ for all admissible $\omega_k^U = \dfrac{w_k^U}{r_k^H}$ where w_k^U is the wage rate of unskilled workers in the urban area and r_k^H is the rental rate on human capital or skills. Goods can be internationally traded and inter-regionaly traded. Regional and international prices, respectively p_{ik}^j and p_i^w, where i, j, k respectively denote the good, the region, and the country, are linked as follows: $p_{ik}^j = p_i^w$ when good i in region j is exported and $p_{ik}^j = p_i^w \tau_{ik}$ with $\tau_{ik} \geq 1$ accounting for tariff protection and other trade costs for good i imported in region j of country k.[6] If goods are traded between rural and urban areas, say from region $-j$ to region j, then: $p_{ik}^j = p_{ik}^{-j} \tau_{ik}^d \leq p_i^w \tau_{ik}$. It will be assumed that if one of the rural (urban) goods is imported in the rural (urban) area, then it is also imported in the urban (rural) area. Also, country k's trade is balanced, but regions can have a trade surplus or a trade deficit.

Linearly homogenous technologies imply that the cost function of good i produced in region k can be specified as $C_{ik}^j = Q_{ik}^j \phi_{ik}^j(s)$, where s is a vector of factor prices. Shepherd's lemma links factor demands to derivatives of the average cost: $\phi_{ikm}^j \equiv \frac{\partial \phi_{ik}^j}{\partial s_m} = \frac{V_{ikm}^j}{Q_{ik}^j}$, where s_m is the price of factor m and V_{ikm}^j is the quantity demanded of factor m to produce good i. Thus, ϕ_{ikm}^j can be interpreted as the requirement of factor m per unit of output i. Perfect competition entails average cost pricing: $p_{ik}^R = \phi_{ik}^R(w_k^R, r_k^D)$, $i = 1, 2$ in the rural area and $p_{ik}^U = \phi_{ik}^U(w_k^U, r_{ik}^H)$, $i = 3, 4$ in urban areas. If goods are internationally traded and produced in one region, the Stolper-Samuelson applies, tying domestic factor prices to international output prices.

[6] As in Melvin (1985a,b), we assume that the rest of the world is large and integrated so that both regions face the same world prices

1.5.2. Poverty in rural and urban areas

Workers in the rural area of country k are endowed with one unit of unskilled labor and with land $D_{nk} \in [0, D_{max,k}]$. Worker n's income is given by: $Y_{nk}^R \equiv w_k^R + r_k^D D_{nk}$.[7] This income line is linear with respect to land endowment D_{nk}. Land is distributed according to density $f_k(D)$. We assume that there is a large mass of workers endowed with little or no land and that very few workers have a lot of land. The richest rural worker owns $D_{max,k}$ units of land. Empirical evidence reported in Deininger and Olinto (2000) confirms that land distribution is more uneven and more variable across countries than income distribution. Accordingly, we assume that $f_k' < 0 < f_k''$. It is also assumed that landless workers are poor, $w_k^R < P_{line}$,[8] and that there is a critical level of land owned $D_{ck} \equiv \frac{P_{line} - w_k^R}{r_k^D}$ below which workers are poor. Accordingly, the number of poor in the rural area is defined by:

$$Poor_k^R = \bar{L}_k^R \int_0^{D_{ck}} f_k(D) dD \tag{1.1}$$

where $\bar{L}_k^R$ is the number of rural workers. The above expression tells us that all else equal, the number of poor increases with the rural population and the poverty line. The land rental rate and the rural wage, in different ways, lower the land threshold D_{ck} and hence the number of poor. A higher rural wage reduces the amount of land needed to escape poverty by shifting up the rural income line $w_k^R + r_k^D D_{nk}$. A higher land rental rate increases the slope of the income line and it too lowers the land threshold D_{ck}.

$$\frac{\partial Poor_k^R}{\partial w_k^R} = \bar{L}_k^R f_k(D_{ck}) \left(\frac{-1}{r_k^D} \right) < 0 \tag{1.2}$$

$$\frac{\partial Poor_k^R}{\partial r_k^D} = \bar{L}_k^R f_k(D_{ck}) \left(\frac{-D_{ck}}{r_k^D} \right) < 0 \tag{1.3}$$

The above expressions show that poverty reduction in the rural region is conditioned by land distribution (i.e., the density of rural poor $f(D_{ck})$) and by the price of land r_k^D. All else equal, poverty reductions are larger when many workers' land endowment just fall short of the land threshold below which people are poor. The land rental rate has poverty alleviating direct effects in Eqs. (1.2) and (1.3). Both the wage and land rental rate have indirect alleviating effects through the level of the critical land threshold $D_{ck}(w_k^R, r_k^D)$.

Workers in the urban area of country k are endowed with one unit of unskilled labor and with skills $H_{nk} \in [0, H_{max,k}]$. Urban worker n has income $Y_{nk}^U \equiv w_k^U + r_k^H H_{nk}$. Skills are distributed

[7] Transfers, such as tariff revenue redistributions, can differ across workers and be positive or negative, but they must add up to $T = \int_0^{D_{max,k}} f(D_n) T_n^R dD_n + \int_0^{H_{max,k}} g(H_j) T_j^U dH_n$. Since our argument revolves around factor price changes, we simplify the exposition by ignoring transfers in this section.

[8] P_{line} is the income below which one is classified as poor.

according to density $g_k(H)$. The proportion of workers who have not had the opportunity to acquire any education and hence are unskilled has fallen rapidly in the last decades in most countries, but this proportion remains high in some less developed countries according to the Barro and Lee (2013) dataset on educational attainment. The proportions of workers with some or completed primary and secondary education vary substantially across countries and within countries over time. In the case of Bangladesh, the 2010 data indicate that 33.1% of 15-64 years old population had no education, 21.7% (20.8%) had some (completed) primary schooling, 42% (35%) had some years of (completed) high school, and 3% (2%) had some (completed) tertiary schooling. The density about years of schooling in Bangladesh has an important mass at zero. From zero, it drops before rising again up to the end of primary schooling, drop over the first few years of high school and rise at the end of high school and then drops over higher years of education. This example shows that the distribution of years of schooling can be multimodal. Some countries like Egypt have a density with a major hump over high school years (51% of working population with some high school) while others like Cameroon have a density with a major hump over primary schooling years (49.3% of working population with some primary schooling). Accordingly g'_k and g''_k may have different signs depending on at which level of skills they are evaluated.

It is assumed that urban unskilled workers are poor, $w_k^U < P_{line}$, and that there is a critical level of skills $H_{ck} \equiv \frac{P_{line} - w_k^U}{r_k^H}$ below which workers are poor. Accordingly, the number of poor in the urban area is defined by:

$$Poor_k^U = \bar{L}_k^U \int_0^{H_{ck}} g_k(H) dH \tag{1.4}$$

Urban poverty falls when the skill threshold falls. This occurs when the urban wage for unskilled workers increases, all else constant, or when the returns for skills increases, all else constant. The total number of poor is simply the sum of Eqs. (1.1) and (1.4),

$$Poor_k = Poor_k^R + Poor_k^U = \bar{L}_k^R \int_0^{D_{ck}} f_k(D) dD + \bar{L}_k^U \int_0^{H_{ck}} g_k(H) dH \tag{1.5}$$

It follows that the change in the number of poor in country k hinges on the number of poor in rural and urban areas as well as on changes in factor prices:

$$dPoor_k = \bar{L}_k^R f_k(D_{ck}) \left(\frac{-1}{r_k^D} \right) dw_k^R + \bar{L}_k^R f_k(D_{ck}) \left(\frac{-D_{ck}}{r_k^D} \right) dr_k^R + \bar{L}_k^U g_k(H_{ck}) \left(\frac{-1}{r_k^H} \right) dw_k^U + \bar{L}_k^U g_k(H_{ck}) \left(\frac{-H_{ck}}{r_k^H} \right) dr_k^H \tag{1.6}$$

1.5.3. The rural-urban wage gap

The rural (urban) region of country k produces goods 1 and 2 (3 and 4) and all four goods are consumed in both regions. There are many possible equilibria involving different international and inter-regional trade patterns. Let us assume that the two rural goods and the two urban goods are always produced and internationally traded, either imported or exported, by at least one region. For goods that are imported into a region, that region's prices are equal to the world prices augmented by tariffs and other trade costs, whether it also buys or not from the other region. The other region's price is then tied to the world price directly if it exports or indirectly through the arbitrage condition for inter-regional sales.[9] Regional prices will change in response to changes in world prices and/or changes in tariffs and trade costs.

Stolper-Samuelson (SS) equations for the rural and urban areas are described below:

$$w_k^R = \frac{-L_2 d_2 p_{1k}^R Q_{1k}^R + L_1 d_1 p_{2k}^R Q_{2k}^R}{L_1 L_2 (d_1 - d_2)} \tag{1.7}$$

$$r_k^D = \frac{L_2 p_{1k}^R Q_{1k}^R - L_1 p_{2k}^R Q_{2k}^R}{L_1 L_2 (d_1 - d_2)} \tag{1.8}$$

$$w_k^U = \frac{-L_4 h_4 p_{3k}^U Q_{3k}^U + L_3 h_3 p_{4k}^U Q_4^U}{L_3 L_4 (h_3 - h_4)} \tag{1.9}$$

$$r_k^H = \frac{-L_4 p_{3k}^U Q_{3k}^U - L_3 p_{4k}^U Q_4^U}{L_3 L_4 (h_3 - h_4)} \tag{1.10}$$

The above equations show that rural and urban being determined by different prices. There is a rural-urban wage gap when the rural wage falls short of its urban counterpart. Unless indicated otherwise, we will assume that the poorest of the poor in country k live in the rural area.

Proposition 1. *The rural-urban wage gap for unskilled workers ($w_k^U - w_k^R$) that arises when all factors of production are immobile is unaffected by allowing unskilled workers with no or little land endowments to migrate from the rural area to the urban area as long as both regions remain incompletely specialized in the trading equilibrium.*

Proof: SS equations link rural (urban) factor prices to world output prices, trade costs and quantities produced of goods 1 and 2 (3 and 4). Accordingly, w_k^U and w_k^R will generally

[9] For example, if good 1 is imported in the urban region, $p_{1k}^U = p_1^w \tau_{1k}$ and $p_{1k}^R = p_1^w$ if good 1 is exported from the rural region, and $p_{1k}^R = p_1^w \frac{\tau_{1k}}{\tau_{ik}^d}$ if good 1 transits from the rural to the urban area, but not exported. If the rural area exports good 1, its price in the urban area is $p_1^w \tau_{1k}^d$ if it is not imported.

differ and respond to different triggers as long as conditions supporting SS equations are met: each region must be incompletely specialized and regional prices ($r^D \times D$) must be linked to international ones. Rural workers whose land endowment is such that $w_k^R + r_k^D \times D_{nk} < w_k^U$ have an incentive to move to the urban region.

The urban-rural wage gap for unskilled workers is resilient to factor movements for the same reason that the Rybcynski theorem is often called the factor-price insensitivity theorem (e.g., Feenstra, 2014, p.8). As long as production patterns and international prices remain the same, migration from the rural to the urban area will not reduce the wage gap.[10]

Corollary. *The presence of a structural urban-rural wage gap induces a movement of unskilled workers from the rural area to the urban area. Applying the Rybcynski theorem, this urbanisation process causes production shifts favoring the labor-intensive sector in the urban area and the land-intensive sector in the rural area.*

Rural workers with an incentive to move to the urban area are the ones with no or little land. The threshold amount of land is computed from the identity $D_m \equiv \frac{w_k^U - w_k^R}{r_k^D}$. A larger wage gap, all else equal, induces a higher land threshold. The labor endowment in the rural (urban) area is reduced (augmented) by the amount $\bar{L}^R \int_0^{D_m} f(D)dD$ workers. Changes in world output prices can trigger changes in factor prices that can exacerbate the rural exodus or induce a migration reversal if departed rural workers had rented their land instead of selling it.

1.5.4. Stolper-Samuelson effects, inequality and poverty

Trade liberalization following entry in GATT/WTO typically reduce prices of imported goods and increases prices of exported goods, improving the new member's terms of trade. The SS equations show that variation in any price will bring about variations in opposite directions for factor prices. Using "hat" to indicate a percentage change in a variable, magnification effects for the rural area imply either $\hat{w}_k^R > \hat{p}_{2k}^R > \hat{p}_{1k}^R > \hat{r}_k^D$ or $\hat{r}_k^D > \hat{p}_{1k}^R > \hat{p}_{2k}^R > \hat{w}_k^R$. Similarly for the urban area we have either $\hat{w}_k^U > \hat{p}_{4k}^U > \hat{p}_{3k}^U > \hat{r}_k^H$ or $\hat{r}_k^H > \hat{p}_{3k}^U > \hat{p}_{4k}^U > \hat{w}_k^U$. Therefore, it is not possible to consider a single input price change in isolation in Eq. (1.6) even if we allow only one output price to change.

[10]The literature offers alternative explanations for the persistence of the rural-urban wage gap. In the original Harris-Todaro model (Harris and Todaro, 1970), the urban-rural wage gap is caused by a domestic policy, namely a minimum urban wage. Rural workers have an incentive to migrate as long as the rural wage falls short of the minimum urban wage multiplied by the probability of finding a job in the urban region. Munshi and Rosenzweig (2016) motivates persistence of spatial wage differences in India by appealing to a consumption-like insurance supplied by local cast-based networks that neutralizes wage gains incentives to migrate. Our explanation rests on urban and rural regions having different factor endowments and producing different goods.

We define inequality in region $j = U, R$ as the ratio of incomes for the richest and poorest workers. For the rural area, $I^R = \frac{w^R + r^D_{max}}{w^R}$ and in urban area inequality is given by, $I^U = \frac{w^U + r^H_{max}}{w^U}$.

Proposition 2. *In the rural (urban) area, income inequality increases if the rental rate on land (skills) increases faster than the wage rate in response to country k's entry into GATT/WTO.*

Proof: Differentiating inequality in the rural area with respect to factor prices yields: $dI^R = (\frac{D_{max}}{w^R})(\hat{r}^D - \hat{w}^R)$. Similarly for the urban area we have $dI^U = (\frac{H_{max}}{w^U})(\hat{r}^H - \hat{w}^U)$. Magnifying Stolper-Samuelson effects cause the rental rate on land to increase faster than the wage rate in rural areas if the price of good 1 increases faster than that of good 2.

In their analysis of China's accession in the WTO, Carter et al. (2009) analyze China's transition from a net exporter to a net importer of agricultural products. Exports of labor intensive agricultural products such as meats, fruits and vegetables grew rapidly after China's accession in 2001, but not as fast as imports of land intensive products such as wheat, corn and soybeans. China's exports of labor-intensive agricultural products benefitted from significant reductions in tariffs and non-tariff barriers from WTO trade partners which translated into higher Chinese domestic prices for these commodities. This suggests that rural Chinese workers benefitted from China's accession into the WTO at the end of 2001. According to the World Bank, the poverty headcount ratio in China has been reduced by 94% from 1980 to 2015 in rural area. The relatively equal distribution of land means that most farmers farm very small plots. Accordingly, not-so-poor and poor are affected similarly by changes in land values and government subsidies.[11] Land in China belongs to rural collectives, not to individuals. Livestock on the other hand is privately owned and this and changes in trade and agricultural policies have contributed to the emergence of larger livestock farms in China.

Increasing inequality is a major concern especially when the income of the poorest people decreases or stagnates. However, higher inequality may be the price to pay for reduced poverty. By the same token, reducing inequality by improving the welfare of the poorest, but not to the point of moving them out of poverty, might cause an increase in poverty. To see this, we will assume that each region import and export a good it produces so that the wage of unskilled workers in both regions either fall or increase.

Proposition 3. *If* $\hat{r}^D_k > \hat{p}^R_{1k} > 0 > \hat{p}^R_{2k} > \hat{w}^R_k$ *and* $\hat{r}^H_k > \hat{p}^U_{3k} > 0 > \hat{p}^U_{4k} > \hat{w}^U_k$, *inequality increases in both rural and urban areas, but poverty in country k falls if:*

$$\bar{L}^R f(D_c)\left(-\hat{w}^R_k - \hat{r}^D_k \frac{r^D_k D_c}{w^R_k}\right) + \bar{L}^U g(H)\left(-\hat{w}^U_k - \hat{r}^H_k \frac{r^H_k H_c}{w^U_k}\right) < 0 \tag{1.11}$$

[11] For more details, see https://blogs.worldbank.org/eastasiapacific/ending-poverty-in-china-what-explains-great-poverty-reduction-and-a-simultaneous-increase-in-inequality-in-rural-areas

If $\hat{w}_k^R > \hat{p}_{2k}^R > 0 > \hat{p}_{1k}^R > \hat{r}_k^D$ *and* $\hat{w}_k^U > \hat{p}_{4k}^U > 0 > \hat{p}_{3k}^U > \hat{r}_k^H$*, inequality decreases in both rural and urban areas, but poverty in country* k *increases if:*

$$\bar{L}^R f(D_c)\left(-\hat{w}_k^R - \hat{r}_k^D \frac{r_k^D D_c}{w_k^R}\right) + \bar{L}^U g(H_c)\left(-\hat{w}_k^U - \hat{r}_k^H \frac{r_k^H H_c}{w_k^U}\right) > 0 \tag{1.12}$$

Proof: Inequality increases (decreases) when the wage rate in both regions falls (increases) and the returns on land and skills increase (decrease). The conditions follow from inserting Eqs. (1.2) and (1.3) into (1.6) .

From (1.11), if $\bar{L}^R f(D_c) > \bar{L}^U g(H_c)$ which can be interpreted as the mass of rural poor close to being out of poverty is large relative to its urban counterpart, then the number of poor in country k may still fall even if the number of urban poor increases as long as

$$\left(\underbrace{w_k^R}_{(-)} + \underbrace{\hat{r}_k^D \frac{r_k^D D_{ck}}{w_k^R}}_{(+)}\right) > \left(\underbrace{-\hat{w}_k^U}_{(+)} - \underbrace{\hat{r}_k^H \frac{r_k^H H_{ck}}{w_k^U}}_{(-)}\right) > 0$$

. In this instance, poverty is alleviated because the land threshold separating poor and non-poor, $D_{ck} \equiv \frac{P_{line} - w_k^R}{r_k^D}$, is relatively high so that the increase in the land rental rate move a mass of land owners out of poverty. Figure 1.1 illustrates the case with the two rural income lines (Y_i^0, Y_i^1) crossing at a level of income below the poverty line P_{line}. This leads to a sizeable reduction in poverty given by the area below the density between poverty land thresholds D_{ck}^0 and D_{ck}^1.

The shape of the densities describing the allocation of land and skills across rural and urban workers has interesting implications for poverty alleviation.

Proposition 4. *A) Given the assumption that the density characterizing the distribution of land is monotone decreasing (i.e.,* $f, f' < 0$*), then if two countries with the same density* $f(D)$ *experience a similar reduction in the land threshold parameter* D_{ck}^R *after joining GATT/WTO, then the country with fewer rural poor prior to joining GATT/WTO sees its number of rural poor diminish the most; B) If two countries* c *and* m *have different density functions for land distribution, say* $f(D)$*, with* $f' < 0 < f''$ *and* $z(D)$ *with* $z' < 0 < z''$*, but have identical land threshold parameters,* $D_{ck} = D_{cm}$*, and face the same factor prices before and after joining GATT/WTO, then rural poverty decreases the most in country* k *(*m*) if* $f(D_{ck}) > (<) Z(D_{cm})$ *over the range spanned by the change in* D_c*; C) If two countries face the same non-monotone density for skills and GATT/WTO reduces their land threshold parameter by the same amount, then the country with fewer urban poor may or may not experience the largest decline in poverty.*

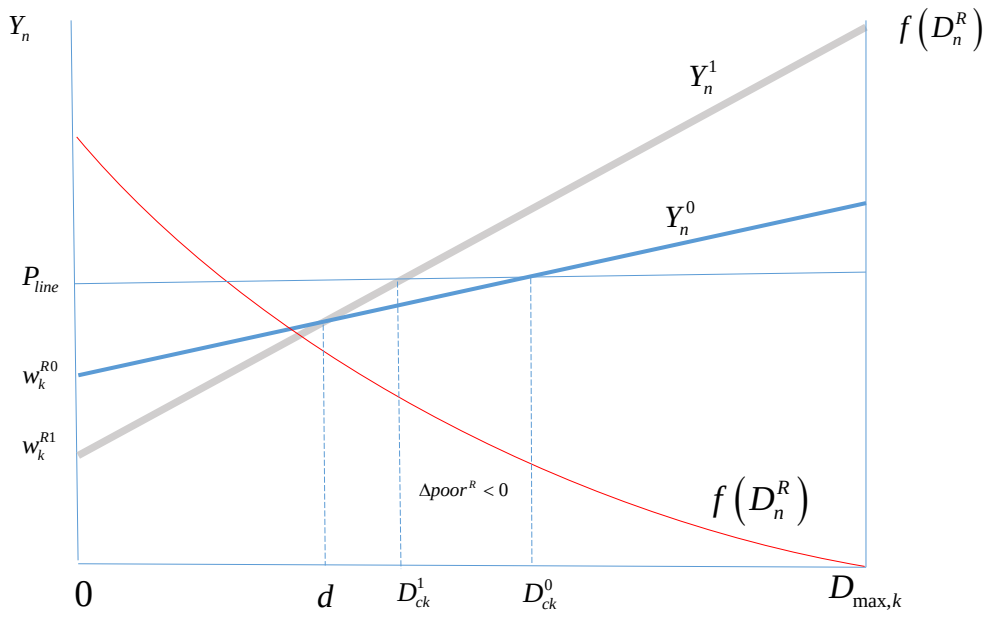
Proof: Part A) simply follows from and Eqs. (1.2) and (1.3). Let the richer country with higher factor prices be m. Then ($D_{cm} < D_{ck}$) which implies $f(D_{cm}) > f(D_{ck})$) because $f' < 0$. Figure 1.2 illustrates the result. The top set of income lines for country m generate the same difference between the land threshold parameters. The poorest workers in country m are not as poor as the poorest in country k and because the density is falling with D, poverty alleviation in the richer country covers workers with less land and as such it covers more workers. For part B), the densities are monotone decreasing in D and may cross once or twice. This implies that $z(D) > f(D)$ and $z(D) < f(D)$ can be observed over different values of D. Since the change in poverty is the integral of the density between the new and the old land poverty thresholds, then for $D^0_{ck} = D^0_{cm} > D^1_{ck} = D^1_{cm}$ and it follows that $f[D^0_{ck}] > z[D^0_{ck}]$ and $f[D^1_{ck}] > z[D^1_{ck}]$ is a sufficient, but not necessary, condition for $F[D^0_{ck}] - F[D^1_{ck}] > Z[D^0_{cm}] - Z[D^1_{cm}]$. Because the density functions f and z cross, it is possible to observe $f[D^0_{ck}] > z[D^0_{ck}]$ and $f[D^1_{ck}] < z[D^1_{ck}]$ or the reverse. In such cases, which country benefits from the largest poverty reduction is generally ambiguous. For part C), consider a multimodal distribution for skills in both countries. If skills are distributed such that there are modes at no education, primary school completion and high school completion and the largest mass is around primary school completion, then if the skill threshold parameters before and after joining GATT/WTO spans the primary school completion mode, poverty would be greatly reduced. If the area spanned by the skill threshold parameters is between two modes, then the reduction in poverty may be much smaller. This contrasts with part A).

A change in the output price of a single good i leads to an increase in the price of one factor and a decrease in the price of the other factor used in the production process of good i. As a result, the incidence of a price change on poverty is generally ambiguous. However, poverty in a given region unambiguously falls if the wage of unskilled workers and the rental rate on the other factor increase. For this to happen, both goods produced in the region must see their price increase and hence must be exported. If both regions export their two goods, the country's poverty unambiguously fall. Production of good i in region j must equal the sum of regional quantity demanded, inter-regional and export quantities: $Q^j_{ik} = X^j_{ik} + GE^j_{ik} + E^j_{ik}$. It should be noted that Q^j_{ik} are either positive or zero, that quantities demanded X^j_{ik} are strictly positive and that inter-regional quantity sold GE^j_{ik} and exports E^j_{ik} can be positive, zero or negative. If tariff revenue collected in a region is given back to consumers in that region, then the consumer budget constraint in region j entails that $\sum p^w_i E_i + \sum p^j_{ik} GE^j_{ik} = 0$ with $p^j_{ik} = p^w_i$ if $GE_{ik} > 0$ and $p^j_{ik} = p^w_i(1 + t^d_{ik})$ if $GE_{ik} < 0$. It follows from the latter that a region with an international trade surplus has an inter-regional trade deficit and vice versa. If internal trade costs prohibits inter-regional trade, then each region must have a zero international trade balance, unless the government allows one region to get more trade taxes than it collected. Naturally, such transfers can be progressive, neutral or regressive. A region need not export both goods to have an international trade surplus, but if it exports both goods and has a larger international trade surplus after joining GATT/WTO, the induced

increases in factor prices are likely to be substantial, and so would be the induced poverty alleviation in that region. It is also important to point out that even if the rural region has an international trade surplus, the country may still be a net importer of agricultural products. This would be the case of a country with a very large urban population and a small rural population. Therefore a country with a large rural population with a net international trade surplus in agricultural products is likely to experience the kind of terms of trade changes after its GATT/WTO adhesion that would induce poverty alleviation. Because this condition is neither necessary nor sufficient for poverty to fall, it can be the object of a hypothesis that will be tested in the following empirical section. "[12]

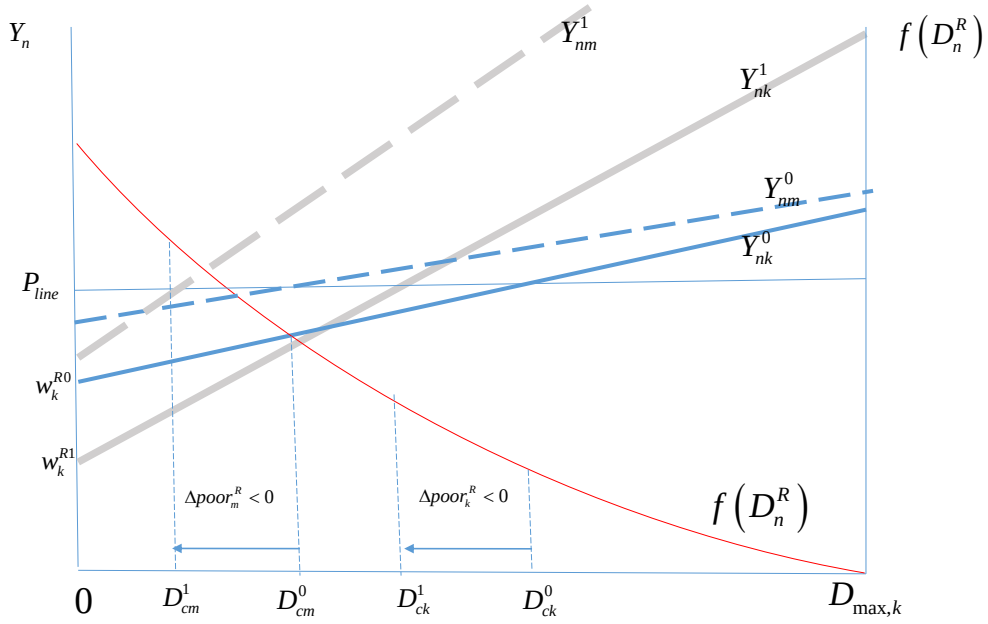
Hypothesis 1. *Countries with an international trade surplus in agricultural goods are more likely to experience a poverty reduction after joining GATT/WTO than countries with an international trade deficit in agricultural products.*

Figure 1.1 – Stolper-Samuelson effects and poverty variations



[12] Section 1.5 is reproduced in full with the permission of Bruno Larue, who is the author of this part of the thesis.

Figure 1.2 – Stolper-Samuelson effects and poverty variations across the distribution of land and skills



1.6. Empirical evidence

1.6.1. Data

Our empirical strategy uses panel data covering a sample of 125 developing countries over the 1980-2012 period to measure the impact of GATT/WTO membership on poverty. The list of countries and the description of variables are reported in Appendices A.1 and A.2. Summary statistics are reported in Table 1.1.

Table 1.1 – Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Headcount	4125	26.9	27.13	0	99.36
Povgap	4125	11.4	14.06	0	80.95
GATT/WTO	4125	.65	.48	0	1
GDP per capita	4121	7.14	1.19	4.17	10.22
Popgrowth	4112	1.76	1.33	-6.34	11.18
Tradebalance	4125	-9.42	19.67	-184.68	44.37
Investment	4109	25.36	3.27	17.5	35.47
Creditpriv	4104	39.56	29.72	.2	160.12
Inflation	4113	35.47	462.86	-18.11	23773.13
School	4125	57.67	28.12	3.14	123.98
Termstrade	4105	113.15	40.07	21.4	357.58
Disaster	4125	.42	.49	0	1
RTA	4125	.25	.43	0	1
Democracy	4125	1.17	16.64	-88	10
Durable	4125	14.97	16.58	0	105
Decentralization	4125	-70.93	257.6	0	2
Gov1rlc	4125	-167.62	374.93	0	3
Checks	4125	2.49	1.66	1	18
Frac	4125	.48	.29	0	1
Yrsoffc	4125	-61.02	253.75	1	46

1.6.2. Methodology

Our objective is to estimate the average treatment effect on the treated (ATT) to find out whether GATT/WTO membership has increased or decreased the proportion of poor people in member countries.[13] To do this, we use matching methods which correct for self-selection and are more robust than difference-in-differences (DID) when used on panel data (Imbens and Wooldridge, 2009).

Let $D_i \in \{0, 1\}$ be a treatment dummy variable that takes on the value of one if country i is a GATT/WTO member and zero otherwise and Y_{it} denote the outcome variable, the poverty of country i in period t. Y_{it} is determined by GATT/WTO status and a vector of additional covariates X_{it} described in a subsequent section.

Matching methods identify a control or untreated group (GATT/WTO non-members) that is similar to the treated group (GATT/WTO members) in terms of their covariates. The treated group includes countries that joined both GATT and WTO by the end of 1994 ($D_i = 1$) while the control group is composed of countries that joined WTO late or not ($D_i = 0$). The idea is to compare outcomes Y_{1i} (poverty headcount ratio for GATT/WTO members, $D_i = 1$)

[13] Developing countries are defined according to the World Bank definition and include low- and middle-income countries from the beginning of our sample.

and Y_{0i} (poverty headcount ratio GATT/WTO for non members, $D_i = 0$). Clearly, the two potential outcomes cannot be simultaneously observed: for a WTO member, only Y_{1i} is observed while for a non-member, only Y_{0i} is observed.

The causal effect of the treatment for a unit is measured by:

$$\Delta Y \equiv Y_{1i} - Y_{0i} \tag{1.13}$$

The average treatment effect on the treated (ATT) is the average difference between treated and untreated outcomes conditional on treatment. As in Hirano et al. (2003), it is defined as:

$$ATT = E[Y_{1i} - Y_{0i}|D = 1] = E[Y_{1i}|D = 1] - E[Y_{0i}|D = 1], \tag{1.14}$$

where $Y_{1i}|D = 1$ is the observed poverty indicator for GATT/WTO members while $Y_{0i}|D = 1$ is the poverty indicator for GATT/WTO members that would have been observed if the same country had not joined the GATT/WTO. The fact that $Y_{0i}|D = 1$ is not observed, leads to an identification problem.

A simple comparison of the mean poverty headcount ratios between the treated group and the control group would be misleading because GATT/WTO membership is not randomly assigned. Self-selection could bias comparisons because new GATT/WTO members might have had more or less poverty even if they had not joined the GATT/WTO.[14] We use propensity score matching (PSM) to deal with the self-selection bias.

The propensity score is the probability of joining the GATT/WTO, conditionally on X, the vector of observable covariates. These covariates control for the fact that poverty in member and non-member countries is likely to be conditioned by other factors besides GATT/WTO membership.

$$P(X_i) = Pr(D_i = 1|X) = E[D_i|X_i] \tag{1.15}$$

The logic of the propensity score matching approach is to compare groups that are similar in terms of observable characteristics affecting the treatment. In our case, we retain as control group all countries similar to GATT/WTO members in terms of observable characteristics which affect simultaneously the decision to join the GATT/WTO and the poverty headcount ratio. Thus, the difference in poverty between GATT/WTO members and the control group can be attributed to the treatment. The reliability of propensity score matching (PSM) rests on two assumptions: the conditional independence and common support assumptions.

[14] To be more precised, the simple comparison of the two groups, $E[Y_{1i}|D = 1] - E[Y_{0i}|D = 1]$ can be decomposed into $E[Y_{1i}|D = 1] - E[Y_{0i}|D = 1] + E[Y_{0i}|D = 1] - E[Y_{0i}|D = 0]$ where the first component is the average treatment effect on the treated (ATT) while the second is the selection bias that arises from using $E[Y_{0i}|D = 0]$ as a proxy for $E[Y_{0i}|D = 1]$

Defining WTO as GATT/WTO membership, the conditional independence assumption (CIA), i.e, Y_{0i}, $Y_{1i} \perp WTO|X$, requires that the outcomes Y_{1i} and Y_{0i} be independent of the treatment, conditional on covariates. Under this assumption, the ATT equation becomes:

$$ATT = E[Y_{1i}|D = 1, X_i] - E[Y_{0i}|D = 0, X_i] \tag{1.16}$$

As the number of covariates increases, the matching implementation becomes difficult. The use of propensity scores instead of covariates allows to overcome this high-dimensional problem (Rosenbaum and Rubin, 1983). This is why the independence of Y_{0i} to the treatment, conditional on observable variables, also implies its independence from the propensity score :

$Y_{0i} \perp WTO|X \Rightarrow Y_{0i} \perp WTO|P(X)$

This property enables us to match countries based on their propensity score instead of on observable covariates. This reduces the observables into one dimension.

Under the common support assumption ($0 < Pr(D_i = 1|X) < 1$), for each treated country, there is at least one comparable country in the control group . The ATT equation becomes:

$$ATT = E[Y_{1i}|D = 1, p(X_i)] - E[Y_{0i}|D = 0, p(X_i)] \tag{1.17}$$

Following Rosenbaum and Rubin (1985), we first use three different methods of propensity score matching: (i) the nearest neighbour (NN) matching which matches each treated unit i with a non-treated whose score is closest to that of the treated unit i, (ii) kernel and local linear regression (LLR) matching are implemented. These are non-parametric estimators that match any given treated unit with all untreated units weighted by their closeness in proportion to the propensity score with the treated unit. PSM provides a good estimate controlling for the self-selection on observables when the ATT is estimated only for the subsamples with good overlap (i.e., when the common support assumption holds) (Crump et al., 2009). When the overlap is lacking, the matching does not perfectly control for X and the PSM estimator is biased (Rubin, 1978). For this reason, the PSM is implemented on common support, which entails dropping treatment and control units outside the common support. Thus, treated countries with a propensity score higher than the maximum or less than the minimum propensity score of untreated countries are dropped.

The misspecification of the propensity score model can induce biases in treatment estimates. To address biases from model misspecification or lack of overlap, we also draw on Rubin (1978), Kreif et al. (2013) and Jordà and Taylor (2016) in implementing three nonparametric matching methods. The first is the inverse probability weighted matching (IPW), which relies on the inverse of the propensity score to weight control and treatment groups. The IPW estimator of ATT is efficient (Hirano et al., 2003). The second nonparametric method is the regression adjustment (RA) method which allows to control for other poverty determinants

besides GATT/WTO membership. The third method is the inverse probability weighted regression adjustment matching (IPWRA) which combines IPW with regression adjustment and allows the estimator to achieve semi-parametric efficiency. Accordingly, it is said to be doubly robust (Lunceford and Davidian, 2004; Imbens, 2004; Glynn and Quinn, 2010). The IPWRA estimator controls for a list of factors impacting poverty other than GATT/WTO membership while controlling also for the determinants of GATT/WTO accession and is consistent if only one of the two models (treatment and outcome models) is correctly specified.

To alleviate any suspicion that there might be a selection bias due to unobservable factors, we use Rosenbaum (2002) bounds test, to determine how strongly unobservable factors must affect selection into the treatment to undermine the significance of treatment estimates. We also account for unobserved heterogeneity by including time fixed effects in all probit models.

Poverty measures and GATT/WTO membership treatments

We retain two poverty indicators from the World Bank based on Foster–Greer–Thorbecke (FGT) indices: the poverty headcount ratio and the poverty gap at $1.25 a day line. These poverty measures are the dependent variables in our models. The **poverty headcount ratio** measures the proportion of the population whose income or consumption is below the poverty line at $1.25 a day. This is the share of the population that is not able to pay for a minimum basket of basic goods. Suppose that n denotes the size of the population and q the number of poor in the population, then the poverty headcount ratio H (in %) is defined as:

$$H = \frac{q}{n} \times 100 \tag{1.18}$$

The **poverty gap** measures the relative average gap between the poverty line at $1.25 a day and the average expenditure of poor households in the whole population. This indicator captures the distance between households' income and the poverty line and it reflects the magnitude and frequency of poverty. It is obtained by summing the income gap of all the poor (considering that the income deficits [15] of non-poor are nil) divided by the whole population. Therefore, it also measures the shortfall of the poor' income relative to the poverty line. The poverty gap (PG) is computed as follows:

$$PG = \frac{1}{n} \sum_{i=1}^{q} \left[\frac{z - y_i}{z} \right], \tag{1.19}$$

[15] "Poverty deficit refers to the resources that would be needed to lift all the poor out the poverty through perfectly targeted cash transfers" (The World Bank)

where y_i is the income of individual i, z is the poverty line and q is the number of poor, as defined above.

One obvious manner to define treatment is to use the date at which a country officially became a member of GATT or of the WTO. GATT's membership has expanded from the 23 initial members (of which 10 were developing countries) to 128 by 1994. In 2012, at the end of our sample, there were 157 WTO members. The number of developing countries which joined GATT/WTO largely increased over time especially through succession or sponsorship under GATT Article XXVI (see Figure A.1 for the evolution of the number of countries in our sample that have joined GATT/WTO over the 1980-2012 period). Many of the developing countries that gained their independence from colonial powers after World War II joined GATT under succession. Specifically, 64 of 128 GATT members acceded through succession (VanGrasstek, 2013). However, countries that were not eligible under Article XXVI, found the accession process more demanding after 1980 than in previous years (VanGrasstek, 2013). Furthermore, some developing countries found the transition following GATT accession difficult and requested more favourable treatment (called special and differential treatment or SDT). The 1979 decision on differential and more favorable treatment, reciprocity and fuller participation of developing countries, the so-called Enabling Clause, provided a new framework to define the rights and obligations of developing countries in GATT (Keck and Low, 2005). At the end of 1991, there were 102 members, of which 79 were developing countries (Hudec, 1992). However, despite the fact that the Uruguay Round reduced the number of SDT provisions (Laird, 2000), developing countries' membership continued to increase after the creation of the WTO. Nonetheless, developing countries continue benefiting from preferential treatment in the WTO.

The Enabling Clause is the foundation for the Generalized System of Preferences (GSP), which allows developed countries to offer non-reciprocal preferential treatment to products exported by developing countries, and for the the Global System of Trade Preferences (GSTP), under which a number of developing countries exchange trade concessions amongst themselves. Developing countries also have longer time periods for implementing agreements and commitments. They benefit from measures to increase trading opportunities and safeguard their trade interests. The WTO offers technical support to help developing countries gain the legal capacity to take full advantage of their membership. From 1995 to 2012, 30 countries joined the WTO.

Even though our sample includes only developing countries, the number of non-members has shrunk quickly since 1980, the beginning of our sample, and this is problematic because there are fewer control countries that can potentially be matched with treated ones. Another issue is that the timing of the membership could matter in ascertaining the incidence of GATT/WTO membership on poverty. First, older members made successive tariff concessions to the benefits of newer members, but have had more time to derive benefits and make

adjustments than newer members. Secondly, the scope of the liberalization process widened over time, with more issues being addressed and more countries playing by the same rules. This implies that newer members' exporting firms have more markets opening up, but it also means that market access concessions made during the accession negotiations apply to many more foreign firms. Thirdly, the dynamics of accession negotiations might have changed over time. The amount of adjustments put in motion before accession may have varied. Therefore, we use different definitions of GATT/WTO membership treatment and different comparisons to insure that our results are robust.

Aichele and Felbermayr (2013) faced similar issues in using matching techniques to analyze the incidence of Kyoto ratification on trade flows. They conducted various robustness checks, starting with the period within which countries can be considered as treated. Kyoto ratification began in 2001 and they first restricted the treated group to countries that had ratified between 2001 and 2003. Subsequently, they extended the window of treatment. They assessed the implications of using 2005, the coming into force of the protocol, as the beginning of the treatment and made various sample adjustments. For our first set of results, we limit our benchmark period to 1980-1997 and the treated group corresponds to countries that were GATT members by the end of 1994. Thus, the treated group can be likened to "GATT countries". The control group is then made up of countries that were not GATT members and encompass countries that joined WTO after 1995 [16], just like countries that had not joined WTO by the end of our sample. In defining the non-treated group in such a way, we follow Aichele and Felbermayr (2013), Minea and Tapsoba (2014) and Lin and Ye (2009, 2007). Minea and Tapsoba (2014) and Lin and Ye (2009) evaluate the treatment effect of inflation targeting (IT). They include in the non-treated group countries that adopted IT one or two years before the end of their sample. For example, the sample in Minea and Tapsoba (2014) covers 1985-2007, but the non-IT group encompasses countries that are non-IT adopters throughout and countries that adopted IT after 2005. Like us, they also have countries that are treated throughout. We subsequently consider changes in the definitions of the treated and control groups to address the timing of the accession over the 1980-2012 period. Some countries referred to as "GATT_old" were GATT members in 1980, the first year of our sample. Countries that joined in 1981 or after are part of a group called GATT_late. To ascertain whether the WTO treatment differs from the post-1980 GATT treatment, we define a sub-group made up of countries that joined GATT between 1981 and 1995, referred to as GATT_1981, and a second sub-group of countries, WTO_1995, that joined the WTO without having been a member of GATT. Finally, the remaining countries that never joined GATT nor the WTO throughout our sample are part of a group called GATT_never.

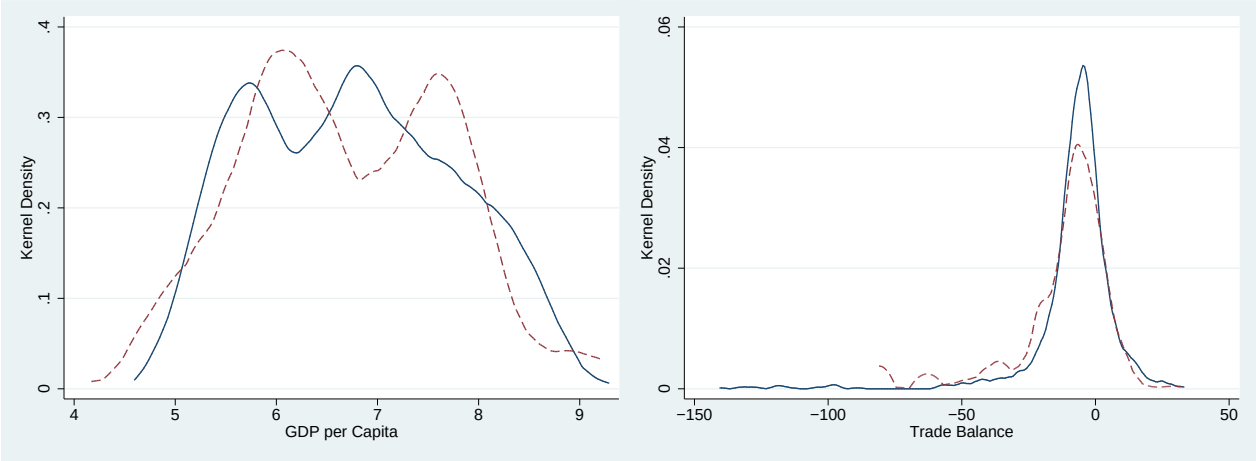
[16] In our 1980-1997 sample, the first GATT non-members joined WTO in 1996 and there are four countries that joined the WTO in 1996 and 1997. We treat them as non-GATT members (see Table A.2 in Appendix A.1).

Choice of matching variables

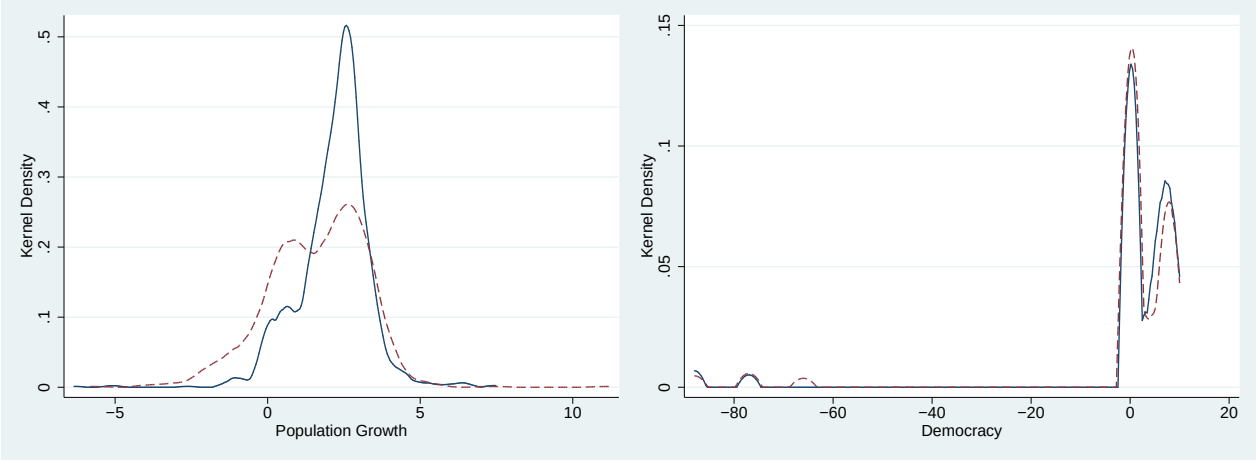
The choice of matching variables is based on theoretical and empirical models about GATT/WTO membership and poverty. The matching method stipulates that the appropriate covariates are those which affect both the GATT/WTO membership decision and the poverty indicator. It has been shown that poverty is conditioned by national production, trade, investment, the political system and institutional strength (see Roemer and Gugerty, 1997; Gallup et al., 1998; Tebaldi and Mohan, 2010; Ravallion, 2006). National production is measured by the product of gross domestic product per capita (GDP) and population, but we allow population growth and gross domestic product per capita to have different effects on poverty and on GATT/WTO membership (see Li and Wu, 2004; Tang and Wei, 2006). Trade is measured by trade balance which is the difference between exports and imports of goods and services. A country with balanced trade is more likely to join a free trade agreement (Grossman and Helpman, 1995) as there must be enough exporters in the country to lobby in support of the agreement. The political and institutional variables are measured by the democracy index (DEMOCRACY), the executive system (SYSTEM), regime durability (DURABLE), the government's orientation (GOV1RLC), the number of veto players (CHECKS), the country's fractionalization index (FRAC) and the number of years the government has been in office (YRSOFF). These variables also explain GATT/WTO membership according to Mitra et al. (2002). We also include participation in regional trade agreements (RTAs) which affect both poverty and GATT/WTO membership (Nina and Andersen, 2005).

Before the matching, we check for differences in covariates between treated and untreated groups. This can be performed using a t-test or kernel density function. Following Aichele and Felbermayr (2013), we rely on kernel density functions. Figure 1.3 illustrates the kernel density functions for our matching variables and shows that the treated group and the control group differ across matching variables. Panels (b), (c), (d) and (e) show that the distributions of the treated group differ substantively from the control group for trade balance, population growth, democracy and regional trade agreements. The kernel density functions of these four variables for the treated group (solid line) are rather to the right of the control group's kernel (dashed line). We can infer that the treated group respectively has a larger trade balance, higher population growth rate, is more democratic and is involved in more regional trade agreements. Panels (a) and (f) show that the difference in terms of GDP per capita and investment between the treated and control groups is small. The t-tests (results not reported) support similar conclusions.

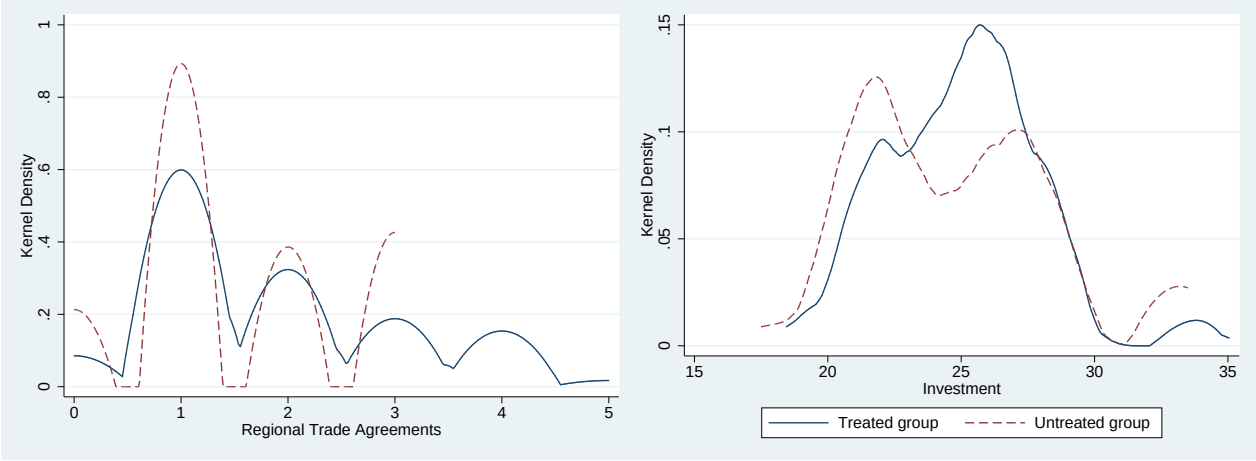
Figure 1.3 – Kernel densities before matching



(a) (b)



(c) (d)



(e) (f)

Poverty determinants

Our methodology allows us to control for other determinants of poverty beyond GATT/WTO membership. Inflation (INFLATION) is a measure of macroeconomic instability and can lead to an erosion of consumer purchasing power. Gross enrollment rate in secondary school (SCHOOL) serves as a proxy for human capital, terms of trade in agriculture (TERMSTRADE) proxies the well-being of rural residents, access to financial credit (financial depth) is measured as domestic credit provided by the financial sector to the private firms as a percentage of GDP (CREDITPRIV), and natural disaster occurrence (DISASTER) affects the wage of economic agents, especially in the agricultural sector. We also include the lagged value of poverty to take into account for the persistence of poverty over time.

1.7. Empirical results

1.7.1. Propensity scores pooling all countries

The propensity score is estimated by using a linear probit model of the GATT dummy indicator on matching variables. The PSM is based on the conditional independence assumption and requires that the matching variables be observed before the treatment. This is equivalent to using lagged value of the matching variables. However, some countries joined GATT/WTO through sponsorship or succession under the article XXVI 5(c) i.e., without pre-accession reforms (developing countries that were colonized for instance joined) while others joined with pre-accession extensive reforms (the case of most developed countries). Countries that have joined through sponsorship or succession are given time for implementing reforms later and this was the case of most developing countries that joined GATT/WTO before 1995.[17] This lead us to use matching variables at level instead of lagged values.

The results are reported in Table A.5 in Appendix A.3. We test several specifications including various institutional variables to assess the robustness of our results. Our results indicate that GDP per capita, trade balance surplus, population growth, investment and political decentralization increase the probability of joining the GATT/WTO. The coefficients of regional trade agreements and democracy are not statistically significant, suggesting that they are not a key determinants of GATT/WTO accession.

[17]The full text of the Article XXVI 5 (c) is as follow: "If any of the customs territories, in respect of which a contracting party has accepted this Agreement, possesses or acquires full autonomy in the conduct of its external commercial relations and of the other matters provided for in this Agreement, such territory shall, upon sponsorship through a declaration by the responsible contracting party establishing the above-mentioned fact, be deemed to be a contracting party". 64 of 128 countries that were members of GATT acceded through succession.

1.7.2. The Average Treatment Effect on the Treated (ATT)

Our baseline results performed on the common support are reported in Table 1.2.[18] We check the quality of the matching by carrying out the standardized differences and variance ratios diagnostic test of the balancing property of the matched sample (Austin, 2009; Rosenbaum and Rubin, 1985). Results in Appendix A.3 reveal that the standardized differences and covariance ratios values for the covariates are respectively all close to zero and that there are no significant differences between GATT/WTO members and non-members for the matched sample within the common support. Consequently, the covariates are balanced. Moreover, the kernel density and the box plots of the propensity score show that the propensity score balance the covariates for the matched and then the balancing property within the matched sample is satisfied (see Figures A.2 and A.3). Columns (1) to (3) of Table 1.2 report the results obtained from nearest-neighbour, kernel matching and local linear regression with propensity score matching by controlling for determinants of GATT/WTO accession and show that the coefficients of average treatment effect on the GATT members are positive (respectively 7.36, 8.00 and 8.03) and statistically significant at 1% level. This indicates that joining GATT has increased on average the poverty headcount ratio by 7.36-8.03%, when all developing countries are pooled together. The interpretation of the average treatment on the treated is that the countries that joined GATT would have had less poverty had they not joined. The results are robust to nonparametric matching methods. Columns (4) and (5) use respectively regression adjustment (RA) matching and inverse probability weighting (IPW) matching. They confirm our previous result by showing a positive ATT estimated coefficient of GATT membership on poverty. The coefficients are respectively 7.15% and 7.44% and are statistically significant at 1% level. Column (6) uses inverse probability weighted regression adjustment matching and allows to control both the selection model (GATT membership) and the outcome model (poverty headcount ratio). The latter shows that the ATT for the GATT membership on poverty is 5.44% and statistically significant at 1% level which confirms the results of the five previous regressions.[19]

Across all matching methods, the results indicate that GATT membership increased poverty from 5.44% to 8.03%. Country-specific studies by Anderson et al. (2004) and Chen and Ravallion (2004) suggest that wealthier citizens are better able than poorer citizens to seize economic opportunities arising from trade liberalization and get a disproportionate share of aggregate welfare gains. Even in developed countries, unskilled workers have problems adjusting to trade liberalization (Autor et al., 2016). Nicita (2009) argue that wealthier households have benefitted more from Mexico's tariff reductions than poorer households, but it was also shown that benefit transmissions were regionalized. Finally, GATT membership

[18] We also implemented stratification matching following the strategy of Caliendo and Kopeinig (2008) and radius matching. The results are nearly identical to ones in the Table 1.2.

[19] We also implemented a robustness check using a shorter 1980-1995 sample period and the results were nearly identical to the ones for 1980-1997 period.

might have caused a drop in government revenues and possibly on pro-poor government expenditures (Khattry, 2003).

Table 1.2 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: Baseline results

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	7.36***	8.00***	8.03***	7.15***	7.44***	5.44***
	(2.010)	(1.621)	(2.241)	(1.526)	(1.420)	(1.354)
Observations	2,224	2,224	2,224	1,819	2,224	2,222
Treatment group	1,440	1,440	1,440	1,190	1,440	1,440
Control group	784	784	784	629	784	782

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

1.7.3. GATT/WTO differential treatment effect over time

The incidence of the GATT/WTO membership on poverty may differ depending on when membership was obtained (see for instance Liu, 2009). To gauge whether the GATT/WTO treatment effect may vary depending on the definitions of GATT/WTO treatment and in samples, we compute additional ATTs for different groups of treated and non-treated. This exercise is relevant because GATT was created in the late 1940s and the creation of the WTO provided an opportunity to review GATT's accession protocol.[20] More importantly, GATT rules evolved and the WTO also oversees trade in services and intellectual property. The treatment is indicated by a treatment dummy variable D_i that takes a value of one for years for which country i is a member of GATT/WTO and zero otherwise. Several countries were GATT members many years before the beginning of our sample which covers a relatively long period, 1980-2012. Accordingly, countries can be partitionned in various groups. We define a group (GATT_old) of countries that were GATT members in 1980 or before. The group of countries that joined after 1980 is called GATT_late. It can be used as a group on its own or subdivided into two other groups: GATT_1981, which includes countries that joined

[20] see https://www.wto.org/english/thewto_e/acc_e/cbt_course_e/c4s1p1_e.htm

GATT between 1981 and 1995, and WTO_1995, which includes countries that joined after 1995. Finally, GATT_never is the group of countries that have not joined GATT nor the WTO during the sample period. We begin our robustness analysis by calculating ATTs of GATT/WTO membership for old members and late members using as control group countries that never joined GATT/WTO. The results (see Tables 1.3 and 1.4) are characterized by positive ATTs for GATT/WTO membership and indicate that GATT/WTO membership has increased poverty in member countries that joined between 1948 and 1980 and in member countries that joined after 1980. The ATTs obtained from different methods vary more, but the ATTs appear on average larger for countries that have been treated the longest. Perhaps late members have been more concerned about redistribution and implemented policies to mitigate adverse effects on poverty. Paul (2015) argues that China had begun implementing reforms before its accession and continued afterward.

To dig deeper into the timing of the membership, the ATTs for the group of very recent members (WTO_1995) are computed using GATT_never as control group. The results (see Table 1.5) are very similar to those already reported in sign and magnitude and this suggests that the poverty effects during the post-1980 GATT years and WTO years are roughly the same.

The GATT/WTO poverty effect can be measured by pitting countries that were in GATT in 1980 against countries that joined later, thus discarding countries that never joined. In this case, the sample needs to be truncated by at least a year as the ratio treated/untreated converges to one in 2012. The sample might be more homogenous, as all countries end up convinced that there are benefits to be had from joining GATT/WTO, but this need not translate into the adoption of similar economic policies. It turns out that all ATTs in Table 1.6 are positive and most are statistically different from zero. This suggests that countries that joined early adopted more regressive policies or that the GATT treatment has incremental effects on poverty over time. Developing countries that were in GATT by 1980 have 2.67% - 4.73% more poverty than developing countries that joined GATT/WTO after 1980. We also computed a GATT/WTO effect on a sample that excluded countries that are members throughout and hence included GATT_late members and WTO_1995. In this case too, all the ATTs turned out positive (see Table 1.7).

Table 1.3 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: GATT_old versus GATT_never

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	6.87***	7.54***	6.47***	2.96***	1.38	6.95***
	(1.341)	(1.598)	(2.019)	(1.007)	(2.189)	(1.269)
Observations	2,276	2,276	2,276	2,207	2,276	2,276
Treatment group	1,550	1,550	1,550	1,503	1,550	1,550
Control group	726	726	726	704	726	726

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

Table 1.4 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: GATT_late versus GATT_never

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	3.18**	3.17**	4.06**	4.15***	3.62***	4.60***
	(1.339)	(1.575)	(1.900)	(0.860)	(0.946)	(0.738)
Observations	2,438	2,438	2,438	2,444	2,438	2,434
Treatment group	1,457	1,457	1,457	1,462	1,457	1,453
Control group	981	981	981	982	981	981

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

Table 1.5 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: WTO_1995 versus GATT_never

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	7.41***	5.53**	5.28*	4.92***	2.22*	6.12***
	(1.679)	(2.339)	(2.751)	(1.180)	(1.232)	(1.008)
Observations	826	826	826	823	826	822
Treatment group	260	260	260	261	260	260
Control group	566	566	566	562	566	562

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

Table 1.6 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: GATT_old versus GATT_late

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	2.67***	1.12	2.71	4.73***	2.29*	3.84***
	(0.984)	(2.161)	(2.699)	(0.878)	(1.300)	(1.098)
Observations	3,246	3,246	3,246	3,142	3,246	3,242
Treatment group	2,463	2,463	2,463	2,416	2,463	2,463
Control group	783	783	783	726	783	779

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

Table 1.7 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: GATT_late versus WTO_1995

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	8.84***	7.07	7.09	4.83***	1.25	7.68***
	(1.175)	(5.237)	(9.497)	(1.087)	(1.293)	(1.108)
Observations	1,657	1,657	1,657	1,654	1,657	1653
Treatment group	927	927	927	928	927	927
Control group	730	730	730	726	730	726

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

1.7.4. Robustness Checks

To assess the robustness of our baseline results, we first use the lagged value of matching variables to estimate the propensity score. Second, we use the poverty gap as an alternative measure of poverty. Third, we test the sensitivity of our results from the deviations from the identifying assumption of selection on observables.

Use of lagged value of matching variables to estimate the propensity score

We use the lagged values of matching variables to estimate the propensity score and this doesn't affect our ATT relative to the results when using the matching variables at level (see Table A.7 in Appendix A.4 for the robustness for the baseline results).

The use of alternative poverty line of $1.90 a day

We test the sensitivity of our results to the poverty line using an alternative poverty line of $1.90 a day. The results reported in the Table A.8 in Appendix A.4 confirm our baseline results. However, the coefficients are higher. In fact, the share of poor people is higher with a $1.90 line a day than that of a $1.25 line a day and explain the higher coefficients when using a poverty line of $1.90 a day compared with the coefficients obtained with a poverty line of $1.25.

The use of poverty gap as an alternative measure of poverty

Results reported in Table A.9 in Appendix A.4 confirm our baseline results. GATT/WTO accession increases poverty by 4.27% to 5.72% among its members.

Henceforth, only the poverty headcount ratio is used as the poverty measure in the next sections.

Sensitivity to deviations from selection on observables

The identification of the ATT of GATT/WTO membership on poverty using propensity score matching is based on the assumption of selection on observables (CIA). It is possible that there are unobserved factors that affect jointly the decision to join GATT/WTO and a country's poverty level. The CIA would be violated if GATT/WTO members and non-members differed in terms of unobserved characteristics, and our ATT estimates would be biased. Since the CIA is not directly testable with non-experimental data, we conduct a sensitivity analysis about our baseline ATT estimates with respect to possible violations of CIA. We rely on the bounds approach proposed by Rosenbaum (2002). This approach determines how strongly the unobservable variables have to affect the selection into GATT/WTO membership to invalidate the inference made about the significance of the ATT (Rosenbaum, 2002; Becker and Caliendo, 2007). Since our outcome variable (poverty) is continuous, the sensitivity checks use the *rbounds* stata routine (Gangl, 2004). The *rbounds* procedure computes Hodges-Lehmann point estimates for different values of a parameter (Γ) that measures the odds of differential assignment due to unobserved factors. In our case, we wish to evaluate whether the finding of a significant ATT remains valid after the introduction of a hypothetical confounding variable whose confounding strength increases with Γ.[21] We implemented the procedure for Γ values up to 5 following the literature (e.g., Ferraro et al., 2007). We are interested in the upper bounds under the assumption that the ATT have been overestimated. Based on the result of the test with 1% bounds, our estimates may be questioned around an odds higher than 1.5. This means that our positive ATT is robust to unobserved heterogeneity provided that the unobserved factors do not change the odds ratio by more than a factor of 1.5 between treated and untreated countries (see Table A.10).

The next section focusses on subsamples of countries defined by comparative advantage in agriculture. WTO negotiations on agriculture have showcased contrasting views from coalitions of countries. For example, the developing countries in the CAIRNS group, a group of agricultural exporting countries, favor ambitious agricultural trade liberalization while the

[21] If $\Gamma = 1$ with p-value<0.05, it means that there is no hidden bias due to an unobserved confounder. More the value of Γ is close to one, less is the hiden bias due to an unobserved confounder. In the social sciences, a value of *Gamma* s between 1 and 2 could be good to test sensitivity due to unobserved confounder (**?**).

G-33 calls for limited market opening in agriculture. Many high-income GATT members made substantial adjustments to their agricultural policy in the late 1980s and early 1990s. This is why the Uruguay Round commitments on market access, domestic support and export subsidies used 1986-88 averages as base levels. High-income GATT members had on average much higher tariffs on agricultural goods than non-agricultural ones and as a result the Uruguay Round might have had an alleviating effect on poverty in developing countries that are net exporters of agricultural products as for the sub-Saharan countries investigated by Nicita et al. (2014).

1.8. Comparative advantage and heterogenous GATT/WTO effects on poverty

Most developing countries have a large share of their population working in agriculture and living in rural areas. As Carter et al. (2009) document for China, GATT/WTO accession triggered substantial changes in production patterns of agricultural products, favoring labor-intensive products like fruits and vegetables and meats at the expense of land-intensive products like cereals and oilseeds. Figure A.4 in Appendix A.5 shows the evolution of average trade balances of agricultural products in net exporting and net importing countries. Fruits and vegetables, meat and livestocks and oilseeds constitute the largest category of net exports for net exporters over the entire period. For net importing countries, fruits and vegetables are the main products in which they are net exporters with some fluctuations. For the meats and livestocks, cereals, oilseeds they are net importer over the entire period while for the cotton they are net importer except for the period 1985-1987 (for which they are net exporter). Amongst land-intensive exports, oilseeds rose sharply around 2005 for net exporting countries, due in large part to Brazil's soya exports.

Net exporters of agricultural products tend to be relatively more arable land abundant than net importers. For each country, an index of relative land abundance was computed as the difference between the country's share of the world endowment in arable land and the country's share of world GDP as in (Feenstra and Taylor, 2012, p.100-109). We then computed simple averages for countries that are net exporters of agricultural products and net importers of agricultural products. Relative abundance in arable land can be corrected for agricultural productivity differences across countries, but this does not change the fact that developing countries that are net exporters of agricultural products are more land-abundant than net importers of agricultural products (see Figure A.5).

Our theoretical framework predicts that developing countries with a strong comparative advantage in agriculture should experience poverty reduction following GATT/WTO accession. Accordingly, we split our sample and estimate GATT/WTO treatment effects for countries

that have a comparative advantage in agriculture and countries that do not; to test the Hypothesis 1 derived from our theoretical model. A country is defined as a *net exporter* if in period t, its agricultural trade balance (difference between export value and import value of agricultural products) is positive, and *net importer* if the difference is negative. Thus, we distinguish 95 net exporting countries and 88 net importing countries over 1980-1997 period, to investigate heterogeneous poverty effects across countries of our baseline results. Over the 1980-1997 period, which implies that 58 countries switch group at least once over the time period. According to Hypothesis 1, poverty is expected to decrease in net exporting countries and to increase in net importing countries.

1.8.1. Countries that are net exporters of agricultural products

The results for the sample of 95 net exporting countries are reported in the Table 1.8. The coefficients are negative and range between -5.80 and -8.30 and are statistically significant at 5% and validate Hypothesis 1.[22] This implies that when a country is a net exporter of agricultural products, joining GATT/WTO reduces poverty by 5.80% to 8.30%. GATT/WTO accession induces tariff reductions on products like cereals and improves relative prices of agricultural exports like fruits and vegetables and meats and livestock. The data show that net exporting countries have consolidated their comparative advantage as their agricultural trade balances have increased on average over time (see Figure A.6). Better terms of trade induce reallocation of resources towards export sectors. Dutt et al. (2013) analyzing the effect of GATT/WTO membership on extensive and intensive margins of trade find that GATT/WTO membership reduces the fixed cost of trade and therefore increases the number of products exported (extensive margins of trade). Hasan et al. (2012) also showed that trade liberalization in India increased employment in states with a high employment share in net export sectors. Jäkel and Smolka (2017) showed that trade liberalization change a country's income distribution in favor of the more abundant factors.

Figure A.7 shows that net exporting countries are more endowed in land than net importing countries. The size of farms is correlated with the productivity level and Adamopoulos and Restuccia (2014) show that labour productivity increases with farm size. Accordingly, net exporting countries farmers are more productive and then earn higher income resulting in a poverty alleviation.

This result brings to light the leading role of the agricultural sector in conditioning economic growth and poverty reduction in developing countries. Christiaensen et al. (2011) show that increases in agricultural GDP per capita are five times more potent in alleviating poverty

[22] We document the non significance of the PSM coefficients by testing the sensitivity to unobservables using. The Rosenbaum (2002) test shows that the PSM results is affected by some unobserved factors. However, the non-parametric matching results are more efficient.

than similar increases in "non-agricultural" GDP per capita.

Table 1.8 – GATT/WTO ATT for countries that are net exporters of agricultural products

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	−1.66	2.27	3.07	−6.41***	−5.80**	−8.30**
	(2.185)	(2.181)	(4.597)	(2.47)	(2.92)	(3.694)
Observations	1,232	1,232	1,232	881	1232	933
Treatment group	810	810	810	728	810	772
Control group	422	422	422	153	422	161

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

1.8.2. Countries that are net importers of agricultural products

Results about the net importing countries are reported in the Table 1.9. The coefficients are positive and statistically significant at 5% and validate Hypothesis 1. These results indicate that the GATT/WTO accession increases poverty by 4.06% to 7.71% in countries which are net importer of agricultural products. For these countries, GATT/WTO accession expose rural households to greater import competition by reducing tariffs and hence domestic prices on many more agricultural products than in countries that are net exporters of agricultural products. This is confirmed by our data (see Figure A.5). The change in the terms of trade may encourage an exodus from rural to urban areas and temporary unemployment as displaced farmers try to find alternative employment. Menezes-Filho and Muendler (2011) find that the absorption of trade-displaced workers by firms operating in comparative-advantage sectors can be incomplete and slow. Our results suggest that this problem tends to be worse in developing countries that do not have a comparative advantage in agriculture.

Table 1.9 – GATT/WTO ATT for countries that are net importers of agricultural products

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	7.71***	5.47**	3.49	4.06**	4.71**	5.17***
	(1.94)	(2.30)	(3.143)	(2.025))	(2.344)	(2.089)
Observations	992	992	992	944	992	992
Treatment group	630	630	630	597	630	630
Control group	362	362	362	347	362	362

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

1.9. Conclusion

Membership to GATT/WTO confers privileges and responsibilities, but it is generally accepted that it encourages trade liberalization which in turn is conducive to faster economic growth. However, there is more debate about the incidence of GATT/WTO membership and trade liberalization on poverty alleviation, as more attention is being paid to the distributional effects of trade liberalization. This paper analyzes the incidence of GATT/WTO membership on poverty in developing countries. New GATT/WTO members must lower tariffs on a wide range of goods, but face lower tariff and non-tariffs barriers for their exports. Since goods produced in rural and urban areas in developing countries are not the same and use different combinations of factors of production, with some factors being region-specific, then one can infer that rural and urban workers will be affected differently by GATT/WTO accession. We developed a Heckscher-Ohlin framework featuring countries with urban and rural areas producing different goods from different combinations of factors that explains the persistence of urban-rural wage gaps and the urbanisation trend in developing countries as well as how poverty responds to changes in the prices of labor-intensive and land-intensive agricultural products. Our model shows that trade liberalization generally has ambiguous effects on poverty which need not correlate with the effects on inequality. However, the model suggests that countries that are net exporters of agricultural products are more likely to benefit from poverty reductions after adhesion to GATT/WTO. We use various matching methods on a sample of 125 developing countries, accounting for the endogeneity of GATT/WTO accession,

to estimate the GATT/WTO causal effect on poverty.

When all developing countries are pooled together, the average treatment effect on treated (ATT) of the GATT/WTO membership on poverty is positive, ranging from 5.44 to 8.06 per cent, and robust across matching methods, poverty definitions, and in treatment and control assignments to account for the possibility that the treatment might have changed over time as the sample include countries that joined GATT before the start of our sample, or joined GATT between 1981 and 1994 or joined the WTO without having been GATT signatories. However, since our theoretical framework suggests a differential treatment effect, we split our sample into net exporters and net importers of agricultural products and find that GATT/WTO membership decreased poverty amongst countries with a comparative advantage in agriculture and has the opposite effect on net importers of agricultural products. The progressive effect of GATT/WTO membership in developing countries with a comparative advantage in agriculture is consistent with recent evidence regarding trade policy preference and factor abundance (Jäkel and Smolka, 2017).

Our results do not question the pertinence for developing countries to join GATT/WTO to achieve faster economic growth and secure gains from trade. However, our results suggest that complementary policies should be implemented to insure that poor people do not get poorer. Our theoretical and empirical results suggest that rural households in developing countries that do not have a comparative advantage in agriculture are particularly vulnerable. Policies facilitating trade adjustments have been analyzed by Lapan (1976) who derived the optimal dynamic wage subsidy in the presence labour market distortions, and Brander and Spencer (1994) and Feenstra and Lewis (1994) among others. As for the recent empirical papers about trade adjustments problems that brought back distributional issues in trade policy analysis (e.g., Autor et al., 2016), the bulk of the research pertains to developed countries. More research is needed to help developing countries implement pro-poor trade adjustment policies.

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Chapter 2

GATT/WTO membership-poverty nexus: A quantile regression approach

2.1. Résumé

Cet article développe un modèle de Heckscher-Ohlin avec des régions urbaines et rurales et des niveaux de productivité spécifiques à chaque pays pour analyser l'impact de la libéralisation du commerce sur la pauvreté dans les pays en développement. Nous montrons que les pays confrontés à différents niveaux initiaux de pauvreté subissent des impacts différents. Ceci justifie l'utilisation des régressions quantiles inconditionnelles pour évaluer l'incidence de l'adhésion au GATT/OMC sur la pauvreté dans les pays pauvres, les plus pauvres et les moins pauvres. Nos résultats suggèrent que l'adhésion au GATT/OMC augmente considérablement la pauvreté dans l'ensemble de la distribution inconditionnelle de la pauvreté. Les pays où les taux de pauvreté sont les plus élevés (pays les plus pauvres) enregistrent une plus forte augmentation de leur pauvreté après leur adhésion au GATT/OMC que les pays où les taux de pauvreté sont les plus faibles. Toutefois, en séparant l'échantillon de pays sur la base de l'avantage comparatif dans l'agriculture, nous constatons que les pays les moins pauvres exportateurs nets de produits agricoles connaissent une réduction de la pauvreté, tandis que la pauvreté augmente dans les pays importateurs nets indépendamment niveau de pauvreté. Ces résultats sont robustes à l'utilisation de différentes méthodes de régression quantile inconditionnelle et pour le biais de sélection.

2.2. Abstract

This paper develops a Heckscher-Ohlin model with urban and rural regions and country-specific productivity shifters to analyze how trade liberalization impacts on poverty in less developed countries. We show that countries facing different initial levels of poverty are impacted differently. This rationalizes the use of unconditional quantile regressions to evaluate the incidence of GATT/WTO membership on poverty in poor, poorer and the poorest countries. Our results suggest that GATT/WTO membership increases significantly poverty across the entire unconditional distribution of poverty. Countries with higher poverty rates (poorest countries) incur larger poverty increases after joining GATT/WTO than countries with lower poverty rates. However, splitting the sample of countries into groups that have and do not have a comparative advantage in agriculture, we find that less poor countries that are net exporters of agricultural products experience poverty reduction whereas poverty increases in net importing countries across poverty quantiles. These results are robust across different unconditional quantile regression methods and to the selection bias.

Keywords: GATT/WTO, Poverty, Treatment effects models, Quantile regression, Developing countries.

JEL classification: C21, F10; F13; F15

2.3. Introduction

There is a widespread acceptance that open economies perform better than closed ones in the long run due to the exploitation of comparative advantage in classical trade models (Krueger, 1985) or gains from variety and firm selection in new trade models (Feenstra, 2018). Unfortunately, the incidence of trade liberalization on poverty is more ambiguous, theoretically and empirically (Harrison and McMillan, 2007). Topalova (2007) shows that trade liberalization increases poverty in Indian districts. Goldberg and Pavcnik (2007) find no evidence of a link between trade liberalization and poverty in urban areas of Colombia. Conversely, Hasan et al. (2007) find that the reductions of tariff rates and non-tariff barriers led to reductions of poverty in India. Krishna et al. (2010) find that trade liberalization is associated with reduced poverty in Bangladesh, India, Nepal, Pakistan and Sri Lanka, but that poverty alleviation is more muted in poorer countries because of a weaker transmission of international prices into domestic prices. Bergh and Nilsson (2014) also find that globalization is associated with a poverty reduction using a panel data covering 114 countries over the 1983-2007 period.

The trade-poverty relation is complex, being affected by country characteristics (e.g., geography and factor endowments, quality of institutions) and domestic complementary policies (Le Goff and Singh, 2014; Winters et al., 2004). Complementary policies include policies that promote human capital accumulation, investment, access to credit, governance and macroeconomic stability. Chang et al. (2009) show that trade openness is good for growth under certain complementary policies such as investment in education, financial depth, inflation stabilization and public infrastructure promotion. Similarly, Le Goff and Singh (2014) find that trade openness reduces poverty in the countries with deeper financial sectors and high educational level. Institutions also play a key role in the link between trade liberalization and poverty (Bergh et al., 2016; Nissanke and Thorbecke, 2010). Sindzingre (2005) points out that institutions determine whether the benefits of globalization are spread to the poor or are seized by the well-off. Then, the effect of globalization may be heterogeneous across countries depending on the quality of their institutions.

Trade liberalization affects poverty via several channels that could be categorized into macroeconomic and microeconomic effects. The macroeconomic effects allude to the effects of trade on economic growth and technology diffusion (productivity) while the microeconomic channels are about price linkages between output and factor markets and collection and distribution of government revenues from taxes on trade (Winters et al., 2004; Winters, 2002). Trade liberalization causes productivity growth by facilitating access to inputs, technology adoption and learning by doing. There is empirical evidence that trade increases productivity (De Loecker, 2011; Alcalá and Ciccone, 2004; Ferreira and Rossi, 2003; Krishna and Mitra, 1998). Using Indonesian manufacturing data over 1991-2001 period, Amiti and Konings (2007) show that a 10 percentage point fall in input tariffs leads to a productivity gain of 12 percent for firms

that import their inputs, at least twice as high as any gains from reducing output tariffs. Goldberg et al. (2010) show that tariff reductions on inputs, make for a greater variety of inputs available and stimulate the production of new products and employment.

Trade reforms cause changes in domestic output prices which in turn cause changes in factor prices affecting households' real income and welfare. Trade liberalization impacts on the purchasing power of households by changing consumer prices and factor rewards. When a majority of poor households live in rural areas and are engaged in agriculture, increases in the prices of agricultural commodities may have a potent alleviating effect on poverty. Santos-Paulino (2017) highlights that in developing countries, manufacturing and agricultural exports contribute to poverty reduction, agricultural exports effects being larger. Trade liberalization does not affect the prices of all agricultural products in the same way as exports for most commodities are typically dominated by a small set of countries, with the countries in the sets changing across commodities.[1] Porto (2006) analyzes the distributional effects of the Mercosur on Argentinean households by examining both consumption and labour market outcomes. He estimates output prices and wage responses to tariff changes implied by the creation of Mercosur on Argentinean households. Mercosur was beneficial to the poor because it lowered tariffs on skilled-labor intensive goods, left some protection for sectors intensive in unskilled labor and increased the protection on agricultural goods. Similarly, Nicita (2009) studies the distributive effects of tariff liberalization in Mexico. His results reveal that Mexican tariff reductions induced reductions in the prices of agricultural and manufacturing products and that rural households were adversely impacted by the resulting lower prices on agricultural products. Urban households benefitted and the wage gap between skilled and unskilled workers increased. Marchand (2012) finds similar results for India. Estimating the distributional effects of trade liberalization both on rural and urban households, she finds that the average effect is pro-poor even though urban households benefit more than rural ones.

Part of the literature on wage inequality and the skill premium attempts to measure the influence of trade liberalization against that of technological change, but a more recent part has focused on outsourcing (e.g., Harrison et al., 2011; Attanasio et al., 2004; Feliciano, 2001; Hanson and Harrison, 1999; Wood, 1998; Revenga, 1997). Firms involved in global value chains specialized in different tasks in the production of final goods based on factor prices in their respective countries. The marginal tasks change locations and this reallocation favors skilled labour even in countries mainly endowed with unskilled labour because marginal tasks performed in these countries are relative more skilled intensive than the average task performed. Similarly for countries relatively more endowed with skilled labour, the foregone marginal tasks are more intensive in unskilled labour than the average task performed in these countries. This finding goes against the standard Stolper-Samuelson predictions for

[1]For example, Côte d'Ivoire and Ghana are the main exporters of cocoa. Madagascar and Indonesia are the main exporters of vanilla and for beef Brazil and India are major exporters

developing countries abundant in unskilled labour and scarce in skilled workers. Nicita (2006) shows that the export-led growth in the textile and apparel sector in Madagascar had only a small effect on overall poverty because the poverty reduction effects were restricted to the urban areas. The majority of poor, who live in rural areas, were unable to benefit from the new employments opportunities. They had little incentive to migrate to the urban areas because they just did not have the skills. Trade liberalization can also induce growth in informal employment (Goldberg and Pavcnik, 2003; Attanasio et al., 2004) and impact on wage inequality and poverty through that channel.

Trade openness has increased for most countries between 1960 and 2018 according to the World Bank. Multilateral organizations like the GATT/WTO[2] have contributed to this trend. The number of GATT/WTO developing countries members increased from 10 to 101 between 1947 and 2012. Because there is evidence that income inequality has increased over time (e.g., Dorn et al., 2018; Gozgor and Ranjan, 2017; Ezcurra and Rodríguez-Pose, 2013; Bergh and Nilsson, 2010; Dreher and Gaston, 2008), multilateral organizations have been accused of exacerbating inequality and poverty (Joseph, 2013, 2009; Stiglitz, 2002; Easterly, 2002). While it is recognized that developing countries are not all integrated to the same extent into the world trading system and that some face major geographical obstacles (being landlocked and/or far from large open markets), it is often pointed out that developing WTO members specialized in primary commodities face high tariffs when trading with developed WTO members (Haveman and Shatz, 2004; Henson and Loader, 2001). Against that one must weigh the GATT/WTO's special and differential treatment provisions introduced to accommodate developing and least developed members.[3]

In this paper, we shed some light on the trade liberalization effort required of developing countries joining GATT/WTO and its effect on poverty. We begin by developing a theoretical model that assumes that rural and urban areas have different factors of production, produce different goods and are generally impacted differently by trade liberalization. Unskilled workers are mobile and can move from the rural area to the urban area or vice versa. Agricultural land is rural-specific and is used with unskilled labor to produce rural goods. In the urban area, each worker is endowed with one unit of unskilled labor and some workers have skills. Skills and unskilled labor combine to produce two urban goods. Factor prices and individual factor endowments determine individual income. There are critical individual land and skill endowments below which rural and urban workers' income fall below the poverty line. Trade liberalization affect factor prices in rural and urban areas through Stolper-Samuelson effects

[2]The General Agreement on Tariffs and Trade (GATT) was created in 1947 to facilitate merchandise trade. The World Trade Organization (WTO) was created in 1995 to administer agreements on merchandise trade, trade in services and intellectual property, operate a dispute settlement body, conduct trade policy reviews and oversee multilateral negotiations.

[3]The WTO's special and differential treatment provisions include longer time periods for implementing agreements and commitments and; measures to increase trading opportunities for developing countries among others.

and countries with different patterns of specialization and endowment distributions will be impacted differently. Countries with similar endowments and endowment distributions, but with different country-specific productivities, as in Trefler (1995), have different levels of poverty and will generally see their poverty level respond differently to trade liberalization. This rationalizes our empirical analysis which relies on recent advances in unconditional quantile regression analysis to investigate how trade liberalization stemming from GATT/WTO membership impacts on poverty. The data covers 125 countries over the 1980-2012 period. The hypothesis that GATT/WTO membership exerts a differential effect on poverty for poor, poorer and the poorest countries is supported by strong empirical evidence. When all 125 countries in our sample are pooled, our results indicate that GATT/WTO membership increases poverty across quantiles with the largest poverty increases in the poorest countries. When the sample is split according to (revealed) comparative advantage in agriculture, GATT/WTO membership decreases poverty in countries that are net exporters of agricultural products, but poor countries that are net importers of agricultural products see poverty increase after joining GATT/WTO. These results are robust across different quantile regression methods.

The rest of the paper is organized as follows. Section 2.4 provides a theoretical framework to explain the effects of GATT/WTO membership on poverty that vary across quantiles. Section 2.5 presents the data and the empirical framework. Section 2.7 provides the robustness tests while Section 2.8 explores Stolper-Samuelson linkages on GATT/WTO poverty effects. Conclusion is presented in Section 2.9.

2.4. A Heckscher-Ohlin model of urban and rural poverties

"The Heckscher-Ohlin (HO) theorem relates the pattern of trade to cross-country differences in factor endowments. Intuitively, the HO model appears particularly well suited to explain the pattern of trade in resource-intensive primary commodities (e.g., mining and agricultural products). The HO model and its higher dimensional extension Heckscher-Ohlin-Vanek (HOV) have fallen in disfavour when empirical studies conducted in the 1980s and 1990s found little support for the HOV equation linking the factor content of trade to factor endowments (e.g., Bowen et al., 1987). Trefler (1995) called the discrepancy between the predicted and actual trade in factors the missing trade paradox and showed how the empirical performance of the model could be improved by relaxing some assumptions like identical technology across countries. Despite its shortcomings, the HO-HOV models provide useful insights. Romalis (2004) introduced monopolistic competition and transports costs into the HO model and found support for factor abundance as a determinant of trade patterns. Recently, Jäkel and Smolka (2017) developed a higher-dimensional version of the Stolper-Samuelson theorem linking factor prices to the factor content of trade under free trade, and hence to factor abundance, to explain cross-country and within-country differences in attitudes toward free

trade.

Textbook presentation of the HO model usually assume that all factors are mobile across sectors to show that free trade in goods between two countries is equivalent to free factor movement in a world without political borders. The first "2" in the 2x2x2 HO model refers the labor and capital inputs which are indeed mobile. In higher dimensional versions of the HO model, some factors such as agricultural land are immobile within countries. Clearly, some factors and goods are tied to regions within a country. In our model, developing countries are made up of two regions, a rural one endowed with agricultural land and unskilled workers and an urban one in which each worker has one unit of unskilled labor and some workers have skills. This regional breakdown is motivated by the stylized facts that there are poor in rural and urban areas, but that poverty is worse in rural areas. The fraction of the population living in rural areas and involved in agriculture is very high in some countries.[4] Another stylized fact motivating a regional dimension into a HO model about developing countries is the existence of an urban-rural wage gap.

Advances in mechanized inputs in the last century have given land-abundant developed and middle-income countries a comparative advantage in the production and export of land-intensive goods. These goods are also produced in developing countries with different technologies. Land quality and climate variables also influence productivity. Generally, agricultural technologies vary across countries. To keep the model as simple as possible, we will assume that production functions have a country-specific productivity shifter as in Trefler (1995). Goods 1 and 2 are produced in the rural region while goods 3 and 4 are produced in the urban region. Accordingly, our model differs from the regional HO model in Melvin (1985a,b) in which eastern and western regions used capital and labor to produce the same two goods. The production function of country k for good i is linearly homogenous and specified as:

$$y_{ik}^R = A_k \Phi_i(D_{ik}, L_{ik}^R), i = 1, 2 \quad , \quad y_{ik}^U = A_k \Phi_i(H_{ik}, L_{ik}^U), i = 3, 4 \tag{2.1}$$

where A_k is country k's productivity shifter, D_{ik} stands for agricultural land used in the production of good i, L_{ik}^R designates unskilled labour used in the production of good i in the rural region, H_{ik} and L_{ik}^R respectively denote skills and unskilled labour used to produce good i in the urban region. The corresponding cost functions, with r_k^D the rental rate on land, r_k^H the rental rate on skills and w_k^R and w_k^U the wage rates in the rural and urban areas of country k, embodied in input price vector W_k, are specified as:

[4] 80% of Ethiopia's population was living in rural areas in 2016 according to the World Bank's Economic Indicators.

$$C_{ik}^{R}(W_k^R, y_{ik}, A_k) = (\frac{y_{ik}}{A_k})\phi_i(r_k^D, w_k^R), i = 1, 2 \quad , \quad C_{ik}^{U}(W_k^U, y_{ik}, A_k) = (\frac{y_{ik}}{A_k})\phi_i(r_k^H, w_k^U), i = 3, 4 \tag{2.2}$$

Perfect competition implies average cost pricing: $p_{ik} = \frac{C_{ik}(.)}{y_{ik}^j} = A_k^{-1}\phi_i(.)$ with $j = R, U$. We assume that all consumers have the same homothetic preferences regardless of where they live and that all goods are consumed, produced and traded (either exported or imported). Regional output prices p_{ik} are equal to international prices under free trade and are inflated by tariffs when imports are taxed. Because the cost function is linearly homogenous in factor prices, $p_i = A_k^{-1}\phi_{iw}(W_k)w_k^R + A_k^{-1}\phi_{irD}(W_k)r_k^D$ for $i = 1, 2$ and $p_i = A_k^{-1}\phi_{iw}(W_k)w_k^U + A_k^{-1}\phi_{irH}(W_k)r_k^H$ for $i = 3, 4$. From Shepherd's lemma, $\phi_{iW}(W_k) = \frac{\partial\phi_i(W_k)}{\partial W}$ is the input requirement per unit good i produced. The output-input price relationship can be inverted to solve for input prices. The Stolper-Samuelson theorem posits that input prices are directly linked to output prices as long as the rural and urban regions in country k remain incompletely specialized. Urban and rural wages for unskilled workers generally and persistently differ as long as both regions remain incompletely specialized and involved in international trade. Because of the Stolper-Samuelson amplification effects, factor prices are more volatile than output prices. Each factor has an "output friend" and an "output enemy, the friend being the good that makes an intensive use of the factor. Workers who owns land in the rural area and workers with skills in the urban area lose income from one factor, but gain on the other. There is no buffer for landless unskilled rural workers and urban workers with no skills when the prices of goods intensive in unskilled labor drop. The country-specific productivity shifter A_k plays a key role. This productivity shifter can be construed as an index embodying the quality of the country's institutions and policies.

Lemma 1. *Being Hicks-neutral, the country-specific productivity parameter has a multiplicative effect on factor prices, holding fixed international output prices constant.*

Proof. In each region we have two input prices determined by two output prices. Let us focus on a single input price, say the land rental which is used in the production of rural goods 1 and 2. We can write its solution as: $r_k^D = \frac{\phi_{2w}p_1 - \phi_{1w}p_2}{\phi_{1rD}\phi_{2w} - \phi_{2rD}\phi_{1w}}$. Let country-specific productivity parameter for country k be $A_k = 1$ and that for country K be $A_K > 1$. Then dividing all unit input requirements by A_K to compute r_K^D, it is easy to verify that $r_K^D = A_K r_k^D$. The structure of the equations for the rural wage and for urban input prices are similar and it follows that the multiplicative effect of the productivity parameter applies to them as well. *something*

We analyze the incidence of the productivity parameter on poverty and inequality in the next sections.

2.4.1. Poverty in rural and urban areas

Each workers is endowed with one unit of unskilled labour whether the worker is located in the rural area or in the urban area of country k. Some rural workers are endowed with land $D_{ik} \in [0, D_{max,k}]$. Worker i's income is given by: $Y_{ik}^R \equiv w_k^R + r_k^D D_{ik}$.[5] This rural income line is linear with respect to land endowment D_{ik}. Land is distributed according to density $f_k(D_{ik})$. We assume that there is a large mass of workers endowed with little or no land and that very few workers have a lot of land. The richest rural worker owns $D_{max,k}$ units of land. Empirical evidence reported in Deininger and Olinto (2000) indicates that land distribution is more uneven and more variable across countries than income distribution. We assume that $f_k' < 0 < f_k''$ and that landless workers are poor, $w_k^R < P_{line}$. There is a critical level of land owned $D_{ck} \equiv \frac{P_{line} - w_k^R}{r_k^D}$ below which rural workers are poor. Denoting $\bar{L}_k^R$ as the number of rural workers in country k, the number of poor in the rural area is defined by:

$$Poor_k^R = \bar{L}_k^R \int_0^{D_{ck}} f_k(D_{ik}) dD_{ik} \tag{2.3}$$

For rural poverty to fall after trade liberalization, the land threshold must fall which implies: $dw_k^R + dr_k^D D_{ck} > 0$. A sufficient condition is for both factor prices to increase. If only the rural wage increases, then the increase must be sufficiently large to make up for the drop in land rental and vice versa if the land rental increases. In the case of two identical countries except for the country-specific productivity parameter, a more productive country K with $A_K > 1$, it is easy to see that its land threshold is lower than that of country k with $A_k = 1$ since $D_{ck} - D_{cK} = \frac{P_{line}(A_K - 1)}{A_K r_k^D} > 0$. This difference is increasing in the productivity parameter. This is important because initial poverty rates condition poverty changes induced by trade liberalization.

Workers in the urban area of country k are endowed with one unit of unskilled labor and with skills $H_{ik} \in [0, H_{max,k}]$. Urban worker i has income $Y_{ik}^U \equiv w_k^U + r_k^H H_{ik}$. Skills are distributed according to density $g_k(H)$. The proportion workers with no education or skills is downward trending in most countries but this proportion varies a lot across developing countries according to Barro and Lee (2013)'s dataset on educational attainment. The distribution of educational attainment varies a lot across countries. Some distributions are multimodal, with a mass at zero and modes at the completion of primary education and at the completion of secondary education. This implies that g_k' and g_k'' may change sign depending on the level of skills they are evaluated. This reiterates the importance of the initial skill poverty threshold.

It is assumed that urban unskilled workers are poor, $w_k^U < P_{line}$. There is a critical level of

[5] We ignore tariff revenue redistributions in our discussion of workers' income to simplify the exposition. Historically, developing countries' transfers have favored urban areas at the expense of rural areas (Zhang and Zhang, 2003; Yang, 1999).

skills $H_{ck} \equiv \frac{P_{line} - w_k^U}{r_k^H}$ below which urban workers are poor. The number of poor in the urban area is defined by:

$$Poor_k^U = \bar{L}_k^U \int_0^{H_{ck}} g_k(H) dH \tag{2.4}$$

The total number of poor is simply the sum of Eqs. (2.3) and (2.4),

$$Poor_k = Poor_k^R + Poor_k^U = \bar{L}_k^R \int_0^{D_{ck}} f_k(D) dD + \bar{L}_k^U \int_0^{H_{ck}} g_k(H) dH \tag{2.5}$$

The change in the number of poor in country k depends on changes in the number of poor in rural and urban areas which depend on changes in factor prices and land and skills distributions. The relationship below suggests that poverty changes are likely to be larger in countries with high tariffs prior to joining GATT/WTO. The initial rural and urban poverty levels have an impact on the change in poverty through the densities. Countries with different comparative advantages will face different factor price variations and will contend with different variations in their poverty rate.

$$dPoor_k = \bar{L}_k^R f_k(D_{ck}) \left(\frac{-1}{r_k^D} \right) dw_k^R + \bar{L}_k^R f_k(D_{ck}) \left(\frac{-D_{ck}}{r_k^D} \right) dr_k^R + \bar{L}_k^U g_k(H_{ck}) \left(\frac{-1}{r_k^H} \right) dw_k^U + \bar{L}_k^U g_k(H_{ck}) \left(\frac{-H_{ck}}{r_k^H} \right) dr_k^H \tag{2.6}$$

2.4.2. Productivity, inequality and poverty

Let us assume that countries K and k are identical in all respects (factor endowments, distributions of factor endowments, consumer preferences) except for the country specific productivity parameter. Let $A_K > A_k$ or that country K is more productive than country k. Let us define regional inequality as the income difference between the richest worker and the poorest worker in a given region. Rural inequality is defined as $I_k^R = r_k^D D_{max,k}$ and its urban counterpart is $I_k^U = r_k^H H_{max,k}$.

Proposition 1. *With two countries with different country-specific productivity parameters but otherwise identical, the more productive country K has fewer poor, more inequality, and more volatile input prices than the less productive country k. The poverty spread between countries K and k decreases (increases) when trade liberalization induces increases (decreases) in the rental rates for land and skills. Increase in the prices of goods intensive in unskilled labor have ambiguous effects on poverty, but they reduce more/increase less poverty in the more productive country K.*

Proof. From Eq. (2.5), the number of poor decreases if the land and skill poverty thresholds decrease. Given $A_K > 1 = A_k$, $w_K^R = A_K w_k^R$, $r_K^D = A_k r_k^D$, $w_K^U = A_K w_k^U$, $r_K^H = A_k r_k^H$ (from Lemma 1) and $\omega_K^R = \frac{w_K^R}{r_K^D} = \frac{w_k^R}{r_k^D} = \omega_k^R$, $\omega_K^U = \frac{w_K^U}{r_K^H} = \frac{w_k^U}{r_k^H} = \omega_k^U$ then the land and skills poverty thresholds in the rural and urban areas of the more and less productive countries satisfy: $D_{cK} = \frac{P_{line}}{A_K r_k^D} - \omega_k^R < D_{ck} = \frac{P_{line}}{r_k^D} - \omega_k^R$ and $H_{cK} = \frac{P_{line}}{A_K r_k^H} - \omega_k^U < H_{ck} = \frac{P_{line}}{r_k^H} - \omega_k^U$. Regional inequality is defined by the income difference between the poorest and richest workers in the area : $I_K^R = A_K r_k^D D_{max,k} > r_k^D D_{max,k} = I_k^R$, and $I_K^U = A_K r_k^H H_{max,k} > r_k^H H_{max,k} = I_k^U$. For country inequality, $I_K = A_K(r_k^H D_{max,k} + w_k^U - w_k^R) = A_K I_k$.

The change in rural poverty caused by changes in factor prices is given by: $d(D_{cK}) = -D_{cK}\hat{r}_k^D - \omega_k^R \hat{w}_k^R$ where "hat" denotes a percentage change. It follows that $d(D_{ck} - D_{cK}) = -(D_{ck} - D_{cK})\hat{r}_k^D = \frac{-P_{line}\hat{r}_k^D}{r_k^D}\left(\frac{A_K - 1}{A_K}\right)$. If changes in factor prices decrease rural and urban poverties in the more productive country K, then poverty reduction in the poorer country k will be larger (smaller) when the rental rates for land and skills increase (decrease). An increase in the land rental rate induces rural poverty convergence between countries K and k while a decrease in the land rental rate increases the poverty spread. As for urban poverty between identical countries except for their country-specific productivity parameter, $d(H_{ck} - H_{cK}) = \frac{-P_{line}\hat{r}_k^H}{r_k^H}\left(\frac{A_K - 1}{A_K}\right)$.

A sufficient, but not necessary, condition for rural (urban) poverty to fall is for the wage of unskilled rural (urban) workers and the land (skills) rental to increase. However, the land and skills rental rates and the regional wages may move in opposite directions when output prices change. To see this , define the share of factors of production in the unit cost of production of goods $i = 1 - 4, j = R,\ f = D$ if $i = 1, 2$ and $j = U,\ f = H$ if $i = 3, 4$ as $\theta_{iL} \equiv \frac{\phi_{iw} w_k^j}{\phi_i}$ for labor and $\theta_{if} \equiv \frac{\phi_{ir} r_k^f}{\phi_i}$, for the land and skills, then : $\hat{w}_k^R = \hat{p}_1 - \frac{\theta_{1D}}{\theta_{1D} - \theta_{2D}}(\hat{p}_1 - \hat{p}_2)$, $\hat{r}_k^D = \frac{\theta_{2L}}{\theta_{2L} - \theta_{1L}}(\hat{p}_1 - \hat{p}_2) + \hat{p}_2$, $\hat{w}_k^U = \hat{p}_3 - \frac{\theta_{3H}}{\theta_{3H} - \theta_{4H}}(\hat{p}_3 - \hat{p}_4)$ and $\hat{r}_k^H = \frac{\theta_{4L}}{\theta_{4L} - \theta_{3L}}(\hat{p}_3 - \hat{p}_4) + \hat{p}_4$. Assuming goods 2 and 4 are intensive in unskilled labor imply $1 > \theta_{2L} > \theta_{2D} = (1 - \theta_{2L}) < 0.5$, $\theta_{2L} > \theta_{1L}$, $\theta_{4L} > \theta_{4D}$ and $\theta_{4L} > \theta_{3L}$. For the rural and urban wage rate to increase $\hat{p}_2 > \hat{p}_1\left(\frac{\theta_{2D}}{\theta_{1D}}\right)$ and $\hat{p}_4 > \hat{p}_3\left(\frac{\theta_{4H}}{\theta_{3H}}\right)$. By the same token, the land and skills rental rates increase if: $\hat{p}_2 < \hat{p}_1\left(\frac{\theta_{2L}}{\theta_{1L}}\right)$ and $\hat{p}_4 < \hat{p}_3\left(\frac{\theta_{4L}}{\theta_{3L}}\right)$. Then, all factor prices increase when $\hat{p}_1\left(\frac{\theta_{2D}}{\theta_{1D}}\right) < \hat{p}_2 < \hat{p}_1\left(\frac{\theta_{2L}}{\theta_{1L}}\right)$ and $\hat{p}_3\left(\frac{\theta_{4H}}{\theta_{3H}}\right) < \hat{p}_4 < \hat{p}_3\left(\frac{\theta_{4L}}{\theta_{3L}}\right)$. To see the poverty implications of output price variations not respecting the above bounds, first consider $\hat{p}_1 > 0 = \hat{p}_i$, $i = 2, 3, 4$. Urban poverty is not affected and the change in rural poverty in country k hinges on the change in the land poverty threshold $\frac{\partial D_{ck}}{\partial p_1} = -D_{ck}\hat{r}_k^D - \omega_k^R \hat{w}_k^R$, which, after some substitutions, reduces to the following expression $\left(\frac{\hat{p}_1 \theta_{2L}}{r_k^D(\theta_{2L} - \theta_{1L})}\right)\left(-P_{line} + \frac{w_k^R}{\theta_{2L}}\right) \lesseqgtr 0$. The term in the first set of parentheses is positive and the direction of the change in poverty hinges on sign of the expression in the second set of parentheses. An increase in the land-intensive good, that increases the land rental and reduces the rural wage, reduces poverty when the poverty line is sufficiently high relative to the rural wage. The wage rate being higher in the more

productive country and the labor share in the cost of production of good 2 being independent of the country specific productivity parameter, then it follows that an increase in the land intensive good is more likely to induce poverty alleviation in the poorer country than in the more productive one. Similarly, if only the price of the labor intensive rural good increases, then $\frac{\partial D_{ck}}{\partial P_2} = \left(\frac{\hat{p}_2\theta_{1L}}{r_k^D(\theta_{2L}-\theta_{1L})}\right)\left(P_{line} - \frac{w_k^R}{\theta_{1L}}\right) \lesseqgtr 0$. In this case, the ensuing increase in the rural wage and drop in the land rental price reduce poverty provided that the initial wage is not too low relative to the poverty line. This condition is more likely to be met in the more productive country. For a country with a low productivity and a low wage, the negative effect on poverty is compounded by the lower land rental rate which tends to inflate the first component of the above product. Similar conditions can be derived for changes in urban goods.

something

The above proposition shows that countries that are identical up to a Hicks-neutral technological change may experience different poverty changes even though they have identical relative factor prices in rural and urban areas. Increases in the prices of goods intensive in unskilled labor lower inequality but tend to increase (decrease) poverty in the poorer (more productive) countries. However, increases in the rental rates for land and skills are friendlier to the poorer countries. This suggests that poor countries with a relatively large land endowment are likely to experience reductions in poverty after trade liberalization. Trade policy and comparative advantage (relative factor abundance) vary across countries and as a result output price changes induced by GATT/WTO membership are likely to differ substantially across countries, adding another level of complexity in the analysis of the incidence of GATT/WTO membership on the level of poverty of less developed countries. Our theoretical results define a prior that poverty levels in poor, poorer and the poorest countries should be impacted differently by GATT/WTO membership. The levels of factor prices playing key roles in terms of predicting the magnitude and direction of poverty changes. A second prior is that poverty is likely to increase in some countries and decrease in others even in countries that are identical except for a country-specific productivity parameter. Regional poverty decreases when both factor prices increase in the given region. With poverty concentrated mainly in rural areas, then declines in rural poverty are likely to bring down national poverty and this is more likely to happen when rural terms of trade improve. Thus, if agricultural goods produced in rural areas fetch higher prices, national poverty is more likely to fall after a poor country enters GATT/WTO. However, increases in the prices of land-intensive and labor-intensive rural goods, if asymmetric “enough", will prompt factor prices to move in opposite directions, decreasing poverty in some cases and increasing it in others. These hypotheses motivate the next section, an empirical one featuring unconditional quantile regressions.”[6]

[6] Section 2.4 is reproduced in full with the permission of Bruno Larue, who is the author of this part of the thesis.

2.5. Empirical strategy and data

2.5.1. The empirical framework: the quantile regression principle

Several studies on poverty impacts of trade liberalization (e.g., Desai and Rudra, 2018; Kis-Katos and Sparrow, 2015; Topalova, 2007) have relied on ordinary least squares (OLS) and instrumental variables (IV) to estimate an average effects. These studies do not allow countries facing widely different levels of poverty to be affected differently. Because our theoretical framework indicates that GATT/WTO membership is likely to have a different impact on countries with varying levels of poverty, it seems most appropriate to rely on quantile regressions to ascertain the sign and magnitude of the GATT/WTO treatment on poverty.

Consider the following model:

$$Y_{it} = \delta d_{it} + X\beta + \varepsilon_{it} \tag{2.7}$$

where Y_{it} denotes the outcome variable. It is the poverty headcount ratio of country i in period t. X the set of control variables and ε the error term. Y_{it} is determined by GATT/WTO status and a vector of additional covariates X_{it}.

Let $d_{it} \in \{0, 1\}$ be the treatment dummy variable that takes on the value of one if country i joins GATT or WTO in time t and zero otherwise. Doing so, we allow the treatment to vary over time.

The OLS estimated coefficients of Eq. (2.7) measure the effect of the explanatory variables on a conditional mean of the dependent variable. However, GATT/WTO membership may affect differently countries due to differences in factor endowments, country-specific productivity, trade and domestic policies and regulations. Heterogeneous treatment effects are to be expected and cannot be handled by OLS regressions.

Quantile regression was introduced by Koenker and Bassett (1978) and provides the quantile of the dependent variable given some values of independent variables. Quantile regressions have been used recently to investigate various international trade issues (e.g., Foster, 2008; Dufrénot et al., 2010; Imai et al., 2013; Chetverikov et al., 2016).

The quantile regression solves the following optimization problem:

$$min \sum_{i=1}^{N} \sigma_\tau(y_i - x'\beta) \tag{2.8}$$

where y_i is the vector of the dependent variable, x_i is the vector of independent variables, β

is the estimated vector of parameters and σ_τ is the absolute value function that yields the τ^{th} sample quantile as its solution.

"The main advantage of quantile regressions is that potentially different solutions at distinct quantiles may be interpreted as differences in the response of the dependent variable to changes in the regressors at various points on the conditional distribution of the dependent variable" (Foster, 2008, page 548). Until the late of the 2000s, the common quantile regression used in the literature was based on the conditional quantile regression (henceforth, CQR) method as developed by Koenker and Bassett (1978).

The CQR provides the marginal effect of the independent variables in τth quantile of the conditional distribution of the dependent variable. Since the one unit change in the independent variable is infinitesimal, then it is assumed that the individual remains in the same quantile (Cameron and Trivedi, 2009). However, the marginal effect depends on the set of covariates and this complicates the interpretation of CQR coefficients as they may not embody the sort of information needed for policy analysis in some circumstances (Borah and Basu, 2013).[7] Hence, in this paper, we use unconditional quantile regression providing a more interpretable parameter that does not vary with the set of control variables.

The unconditional quantile regression (UQR) introduced by Firpo et al. (2009) generates the marginal effect over the distribution of the covariates i.e., at the marginal distribution of the dependant variable (Y_{it}). The UQR has the advantage of not changing with the set of covariates or the set of explanatory variables in the model (Borah and Basu, 2013; Powell, 2016).[8] Its effect is more interpretable and generalizable. To implement the UQR, we first use the quantile estimator in Firpo et al. (2009) which relies on the recentered influence function. We test the robustness of the benchmark results using Powell (2016)'s Generalized Quantile Regression (GQR) estimator, the unconditional exogenous quantile treatment effect estimator (Firpo, 2007), and the unconditional endogenous quantile treatment effect estimator developed by Frölich and Melly (2013) which endogenizes the GATT/WTO membership treatment. The latter two estimators are matching quantile estimators. We consider three groups of poor (25%), poorer (50%) and poorest (75%) countries.

The choice of the control variables in the estimation is based on the standard determinants of poverty in the literature: market size (imports and exports), human capital (education level), physical capital (investment), institutional quality (democracy) and natural disasters. The choice of selection variables (that determine the accession in the GATT/WTO) is also based in the literature on GATT/WTO accession. These variables are GDP per capita, trade, economic system (socialism), democracy and te durability of a regime. More detailed

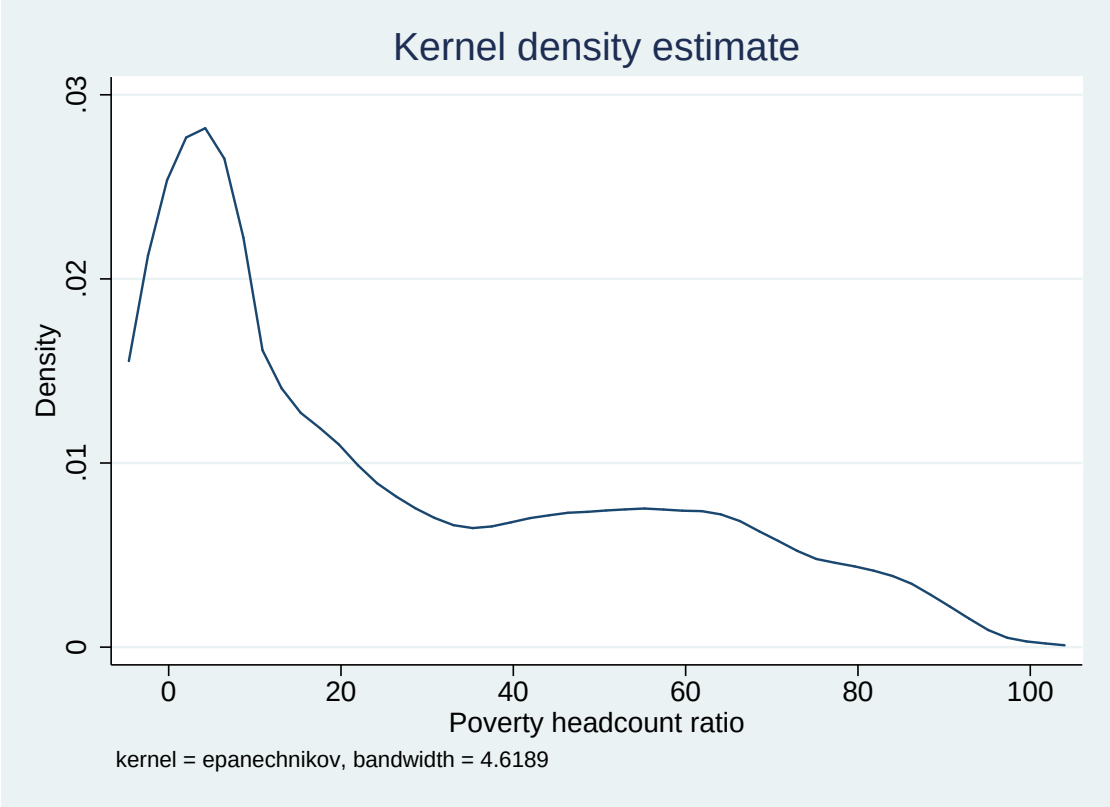
[7] In the absence of any other covariates in the model, "the conditional and unconditional treatment effects with a binary X are also identical for all quantile of Y" (Borah and Basu, 2013).

[8] "Even in the presence of a vector of covariates W, the effect on the unconditional quantile is always evaluated marginally over the distribution of W" (Borah and Basu, 2013, page 1056).

motivations on the choice of the variables are provided in the empirical estimation section of each model.

The unconditional distribution of the poverty headcount is skewed to the right with a spike at 0.1 (see Figure 2.1). Since we are using the poverty headcount ratio as poverty indicator, the lower quartile (0-25) group is considered as the most well-off amongst poor countries, while countries in the upper quartile groups are poorer countries, with the poorest in the 75th quartile. The first quartile include countries with a poverty rate ranging from 0 to 2.37 (25 % less poor). The third quartile includes countries with poverty rates ranging from 48.87 to 99.36.[9]

Figure 2.1 – Unconditional distribution of poverty headcount



In this paper, we first use unconditional quantile regression based on the recentered influence function (RIF) by Firpo et al. (2009).

[9]Liberia and Madagascar have a poverty rate higher than 95%. This higher poverty rates occurs in Liberia consecutively from 1993 to 1997 and in Madagascar in 1980, 1985, 1987 and 1990.

Unconditional quantile regression based on the recentered influence function (RIF): the benchmark results

Firpo et al. (2009) introduced the unconditional quantile regression (UQR) to estimate the impact of changes in the distribution of explanatory variables, X, "on the marginal quantiles of the outcome variable", Y, "or other functional of the marginal distribution of Y". They build their UQR on influence function. The recentered influence function (RIF) regression is a robust estimation method. The influence function is defined by Firpo et al. (2009) as the influence of an individual observation on a specific distributional statistic (mean, quantile, gini, etc).

The poverty gap between GATT/WTO members and non-members for a specific quantile τ is given by:

$$\Delta_\tau = q_{1\tau} - q_{0\tau} \tag{2.9}$$

Firpo et al. (2009) show that we can estimate the τth unconditional quantile of the distribution of Y by running a regression where Y is replaced by the recentered influence function (RIF). Let F_y be the cumulative function of Y. The RIF equation estimated for the quantile q_τ is:

$$RIF(Y : q_\tau, F_y) = q_\tau + \frac{\tau - \mathbb{1}\{Y_i \leq q_\tau\}}{f_y(q_\tau)} \tag{2.10}$$

where $f_y(q_\tau)$ is the density function of Y at point q_τ and $\mathbb{1}(\cdot)$ an indicator function.

We estimate Eq. (2.9) with RIF-OLS [10] which assumes that the outcome quantiles are a linear function of the covariates (the determinants of poverty). We include as control variables GDP per capita as an economic development indicator, exports and imports of goods and services to control for country's openness to trade, the investment, democracy as an institutional quality indicator, education measuring human capital level following the literature (e.g., Bergh and Nilsson, 2014; Le Goff and Singh, 2014). We expect that GDP per capita, investment and education reduce poverty; exports, imports and democracy may have ambiguous effects. In fact, the effect of exports and imports depends on the type of goods produced by countries (requiring skilled or unskilled labour).

[10] Time-invariant fixed effects are used in all the regressions to consider the unobservables factors that may affects our estimations. The standard errors are calculated using 200 bootstrap replications.

2.5.2. Data

Our dataset consists of observations about 125 developing countries examined over the 1980-2012 period. We use the poverty headcount as poverty indicator. The **poverty headcount ratio** measures the proportion of the population whose income or consumption is below the poverty line. This is the share of the population that is not able to pay for the minimum basket of basic goods. In this paper, we use a poverty line of \$1.25 a day. Suppose that n denotes the size of the population and q the number of poor in the population, then the poverty headcount ratio H (in %) is defined as:

$$H = \frac{q}{n} \times 100 \tag{2.11}$$

The list of variables and countries are reported in the Appendix B.1 (Tables B.1 and B.2). Descriptive statistics of our variables are reported in the Table 2.1.

We report the first, second and third quartiles of the variables. The means of poverty headcount ratio for the first, second and third quartiles are respectively 0.61, 4.47 and 67.2.

Table 2.1 – Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	P25	P50	P75
headcount	4125	26.9	27.13	0	99.36	2.37	16.5	48.87
omc	4125	.62	.48	0	1	0	1	1
gdppercapita	4121	7.14	1.19	4.17	10.22	6.16	7.1	8.03
trade	3580	76.45	41.17	.02	375.38	46.86	67.44	98.78
export	3580	34.02	20.56	.01	166.36	18.74	29.09	45.67
import	3580	42.43	24.44	0	246.81	25.82	37.65	53.68
rta	4125	.25	.43	0	1	0	0	0
numbers	4125	.73	.44	0	1	0	1	1
socialism	4125	.23	.42	0	1	0	0	0
investment	4109	25.36	3.27	17.5	35.47	22.74	25.36	27.45
secenroll	4125	57.67	28.12	3.14	123.98	32.74	58.61	82.3
inflation	4113	35.47	462.86	-18.11	23773.13	3.56	7.11	12.67
disaster	4125	.42	.49	0	1	0	0	1
democ	4125	1.17	16.64	-88	10	0	5	8
durable	4125	14.97	16.58	0	105	3	10	21

Notes: P25=25th percentile or first quartile; P50=50th percentile or second quartile; P75=75th percentile or third quartile

2.6. Empirical results

Our baseline results use Firpo et al. (2009) unconditional quantile regression based on the recentered influence function (RIF). The regressions with GATT/WTO membership dummy

are estimated for 25th, 50th and 75th quantiles (see columns (1) to (3) in Table 2.2). These coefficients measure the effect of GATT/WTO membership on poverty keeping the full distribution of all other covariates unchanged. The results indicate that GDP per capita, investment, imports and education reduce poverty while exports increase poverty. Democracy has an ambiguous effect depending on the quantile. The GATT/WTO membership effect on poverty is positive and statistically significant at 1% for all quantiles τ and increases with the quantile. GATT/WTO membership increases poverty by 2.61% in the less poor countries, by 4.95% in the 50th quantile and by 13.89% in the poorest countries. The effect is greater in the poorest countries (upper quartile) than in the less poor countries (lower quartile). The results validate our theoretical prior about heterogeneous effects.

The domestic agricultural support measures used by developed countries the export potential of developing countries with a comparative advantage in agriculture. However consumers in developing countries that import a lot of agricultural and food products see their purchasing power increase from the agricultural support measures of developed countries. For example, the European Commission has spent 2.7 billion euro per year in 2000s, making sugar profitable for European farmers and crowding out low-cost imports of tropical sugar (IMF, 2001). While agricultural subsidies are increasingly decoupled, there remains sensitive products supported by highly trade-distorting measures. The European sugar quota system was dismantled, but 179 million euros worth of coupled payments to sugar beet was spent in 2017.[11] In addition, developed countries maintain restrictive non-tariff measures that curb market access for products from developing countries. The same time, several developing countries have reduced considerably their tariffs. Leibovici and Crews (2018) highlight that average foreign import tariffs declined more in low-income countries than in middle and upper-income countries. In countries where the poorest workers are concentrated in import-competing sectors, reallocation of resources to more competitive sectors have proven difficult when export growth is hindered by high tariffs in developed countries. Developing countries depend heavily on agriculture and natural resources. Second, the loss of tariff revenue may be difficult to replace through other means of taxation and governments may be forced to cut it pro-poor public expenditures (Khattry and Rao, 2002; Baunsgaard and Keen, 2010). Even in the United States, increased imports from China have adversely affected production in specific regions to the point of eroding the local tax base and the provisions of services (Feler and Senses, 2017).

Furthermore, the difference in the effects between the poor and poorest countries may be attributed to the characteristics of the poorest countries and less poor countries. The poorest countries are typically predominantly rural and less diversified compared to the less poor countries. The poorest countries have very limited infrastructure and more financially underdeveloped relative to the less poor countries. These differences in the level of development may exacerbate the negative effects of GATT/WTO accession. The case for adjustment policies

[11] https://ec.europa.eu/agriculture/sugar/doc/factsheet-end-sugar-quota_en.pdf

is most compelling for the poorest countries even though they can least afford such policies.

Table 2.2 – Unconditional quantile regression: RIF estimates

	(1)	(2)	(3)
	.25	.50	.75
GATT/OMC	2.61***	4.95***	13.89***
	(0.497)	(1.123)	(1.569)
GDP Per Capita (log)	-5.89***	-22.07***	-24.14***
	(0.301)	(1.480)	(1.465)
Export	0.07***	0.18***	-0.06
	(0.015)	(0.035)	(0.055)
Import	-0.05***	0.00	-0.05
	(0.010)	(0.025)	(0.052)
Investment (log)	-0.16*	0.08	-0.25
	(0.086)	(0.176)	(0.232)
Democracy	0.02	0.08***	-0.23***
	(0.013)	(0.028)	(0.042)
Education	-0.15***	-0.40***	-0.33***
	(0.010)	(0.039)	(0.039)
Constant	55.80***	184.87***	240.64***
	(3.553)	(11.955)	(12.769)
Time FE	Yes	Yes	Yes
Observations	3,564	3,564	3,564

Notes: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
Time fixed effects are included in all the regressions.
The standard errors are calculated using 200 bootstrap replications.

2.7. Robustness Checks and Extensions

Control variables in the quantile function in Firpo et al. (2009)'s estimator may bias the estimation and alter the interpretation of the estimated coefficient on the treatment variable (Powell, 2016). Moreover, Firpo et al. (2009) assume that the treatment is exogenous. However, if the GATT/WTO treatment is not random, treating it as exogenous may introduce a self-selection bias. Hence, we test the robustness of our Firpo et al. (2009)'s estimator using the generalized quantile regression estimator (Powell, 2016) and the quantile matching estimators developed by Firpo (2007) and Frölich and Melly (2013).

2.7.1. Generalized Quantile Regression Estimator

Traditional quantile estimators include additional control variables besides the treatment in the quantile function that may produce biased treatment estimates. Powell (2016) introduces the generalized quantile regression (GQR) method to estimate quantile treatment effect by conditioning on a separate set of covariates with nonadditive disturbance terms which are functions of observed and unobserved factors. The GQR model separates the explanatory variables into "treatment variable" and "control variables" to estimate the quantile function of interest. The treatment variable is included in the structural quantile function while the control variables are used for identification. Consequently, the treatment effects are "conditional" on the treatment variables and "unconditional" on the control variables. Hence, the GQR provides a clearly and robust estimation of quantile treatment effects.

The quantile treatment effects (QTEs) is:

$$\Delta_\tau = q_Y(d_1, \tau) - q_Y(d_0, \tau) \tag{2.12}$$

$q_Y(d_1, \tau)$ and $q_Y(d_0, \tau)$ are respectively the country's poverty level when it joins GATT/WTO and when it doesn't participate, $\tau \in \{0, 1\}$.

Each Y_d is a function of the treatment variable (GATT/WTO membership) and a structural error term following a normal distribution:

$$Y_d = \phi(d, U_d^*), \qquad U_d^* \sim U(0, 1)$$

The error term U_d^* determines the rank of potential latent outcomes Y and is interpreted by Doksum (1974) as the ability or the proneness (unmeasurable characteristics).[12] U_d^* is determined both by observed and unobserved factors.

The model is estimated using a linear quantile function. We estimate the QTEs using Markov Chain Monte Carlo method (MCMC). We estimate both a static and dynamic (with the lagged dependent variable) model including a set of control variables: the GDP per capita and the population growth rate to control for economic development and market size, the investment, exports and imports to control for country's openness to trade, an indicator of institutional quality (democracy level), education measuring human capital level, natural disasters.

Table 2.3 reports the GQR estimation results with the 25th quantile of the poverty distribution representing countries with lower poverty rates and the 75th quantile regrouping countries

[12] People with higher U^* have higher individual ability to remain poor.

with the highest poverty rates (the poorest). Trade liberalization increases poverty according to the static and dynamic models. GATT/WTO membership is associated with 1.9 and 3.2-9.5 percent respectively in less poor and poorest countries. Then, GATT/WTO membership increases more poverty in poorest countries than in the less poor countries and are consistent with the results obtained from Firpo et al. (2009)'s estimator.

Table 2.3 – Generalized Quantile Regression (dependent variable: poverty headcount)

	(1)	(2)	(3)	(4)	(5)	(6)
	Static model			Dynamic model		
	0.25	0.5	0.75	0.25	0.5	0.75
QTE	1.96***	6.30***	9.52***	1.93***	2.04**	3.21***
	(0.333)	(0.659)	(1.134)	(0.349)	(0.996)	(0.740)
Observations	4,125	4,125	4,125	4,125	4,125	4,125

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2.7.2. Selection bias - unconditional matching quantile regressions

GATT/WTO membership treatment is questionable and the non-randomness of the treatment may bias our results. The GATT/WTO membership may be determined by factors that also affect poverty. Such factors jointly impacting on the treatment and the outcome variable would cause a selection bias (**?**Li and Wu, 2004). To correct this selection bias, we use propensity score matching (henceforth PSM) method to estimate the quantile treatment effect on the treated (QTT). The logic of PSM is to find match non-member and member countries on several key characteristics to assess the QTT. The PSM observable characteristics which affect simultaneously the decision to join the GATT/WTO and poverty. Thus, the difference in poverty between GATT/WTO members and the control group is attributable to the treatment. To that end, we use both Firpo (2007)'s and Frölich and Melly (2013)'s unconditional exogenous and endogenous quantile treatment effect estimators.

Following **?** and Li and Wu (2004), we assume GATT/WTO membership is determined by economic and political or institutional variables. Then, we use as matching variables [13] the lagged per capita GDP, lagged trade to GDP ratio, socialist economic system (socialism), democracy level and regime durability as institutional variables (see Li and Wu, 2004; **?**).

Table B.3 in Appendix B.2 reports the results of the probit regression of the GATT/WTO membership. The probit regression predicts which countries would be qualified to be GATT/WTO members in time t. The results reveal that country's GDP per capita and its trade openness affect positively the propension of country to join GATT/WTO. Countries with a higher GDP

[13] Matching variables are the observable characteristics that determine GATT/WTO membership.

per capita and a higher trade openness, have a higher probability of being GATT/WTO members. In contrast, socialism and political regime durability reduce significantly the probability of GATT/WTO membership. A socialist country is less likely to join GATT/WTO than others. However, country's democracy level is not a significant predictor of its GATT/WTO membership. These results are consistent with **?** and **?** findings.

Firpo (2007) Unconditional exogenous quantile treatment effect

Firpo (2007)'s unconditional exogenous quantile treatment effect (QTE) estimator is a propensity score weighting estimator for quantile treatment analysis. Firpo (2007) defines the quantile treatment effect as "*the difference between the quantiles of the treated group and the counterfactual quantiles of the control group*".

The quantile treatment effect on the treated (QTT) [14] is:

$$\Delta_{\tau|d=1} = q_{1\tau|d=1} - q_{0\tau|d=1} \tag{2.13}$$

where $q_{j\tau|d=1}$ is $Pr[Y(j) \leq q|d=1] = \tau$, $\tau \in \{0,1\}$ and $j = 0,1$

To estimate the QTT, we use Firpo (2007)'s semiparametric two-step procedure. The identification strategy is based on the conditional independence and common support assumptions. The first step consists of computing the propensity score non parametrically because the joint distribution of Y, D and X is unknown. This has the advantage of not imposing any restriction on the joint distribution of (Y, D, X). The second step uses the propensity score (which corrects for the selection into the treatment) of step 1 to estimate the quantile treatment effect. The QTT is obtained by minimizing the following function for $j = 0, 1$:

$$\hat{q} = arg\min_{q} \sum_{i=1}^{N} \hat{w}_{j,i} \cdot \rho_{\tau}(Y_i - q) \tag{2.14}$$

where the check function $\rho_{\tau}(\cdot)$ evaluated at $(Y_i - q)$ is

$$\rho_{\tau}(Y_i - q) = (Y_i - q)(\tau - \mathbb{1}\{Y_i - q \leq 0\})$$

and the weights $\hat{w}_{1,i}$ and $\hat{w}_{0,i}$ are

$$\hat{w}_{1,i} = \frac{d_i}{N \cdot \hat{\rho}(X_i)} \text{ and } \hat{w}_{0,i} = \frac{1 - d_i}{N \cdot (1 - \hat{\rho}(X_i))}$$

[14] The Firpo (2007) quantile treatment effect on the treated is estimated with the STATA command IVQTE.

The check function $\rho_\tau(Y_i - q)$ in Eq. (2.14) is weighted by $\hat{w}_{j,i}$. This reflects the fact that the distribution of the covariates differs in the two groups (see Firpo, 2007).

We use both linear and logit models for the estimation of the propensity score with a different parameter value (λ) used to calculate the propensity score. The QTT results of GATT/WTO accession on poverty results reported in Table 2.4 confirms our previous results. The GATT/WTO treatment increases poverty and the treatment effect varies across quantiles with the poorest group experiencing the strongest poverty increase. The results are robust to different specifications of the model and the effect for the poorest countries (7.37-13.36%) is much larger than its counterpart for countries with lower poverty rates (1.39-2.51%).

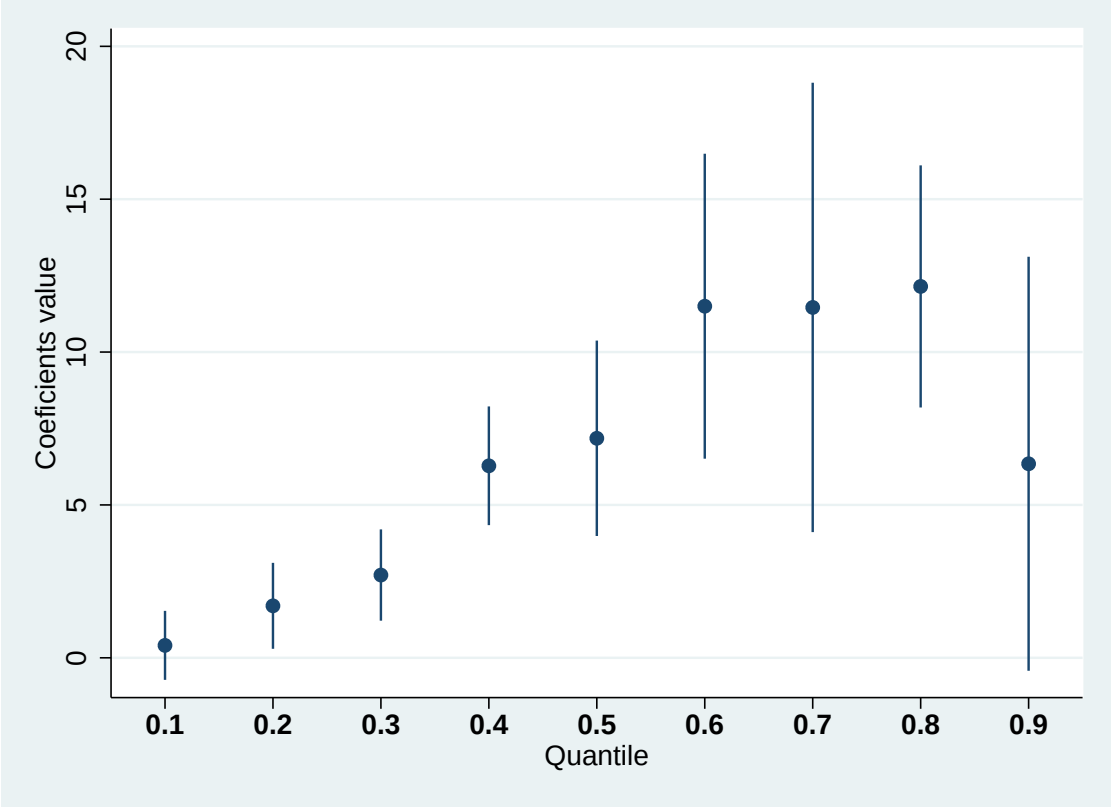
We plot (see Figure 2.2) the coefficients categorized by decile from the model of column (2) of the Table 2.4 to show clearly the difference of GATT/WTO membership on poverty between quantiles. Figure 2.2 reveals that poorest countries are more negatively affected than less poor countries.

Table 2.4 – QTT of exogenous GATT/WTO membership on poverty (dependent variable: poverty headcount)

	(1)	(2)	(3)	(4)	(5)	(6)
	Linear-PS		Logit-PS			
	$\lambda = 1$	$\lambda = 0.8$	$\lambda = 1$	$\lambda = 0.8$	$\lambda = 0.5$	$\lambda = 0$
QTT .25	2.51***	1.87***	1.87***	1.63**	1.39*	1.25
	(0.722)	(0.732)	(0.738)	(0.748)	(0.766)	(0.899)
QTT .5	7.98***	7.29***	7.66***	7.04***	6.64***	5.94***
	(1.581)	(1.634)	(1.608)	(1.653)	(1.695)	(2.356)
QTT .75	13.36***	11.57***	12.28***	10.95***	8.46***	7.37***
	(2.678)	(2.386)	(2.494)	(2.328)	(2.178)	(2.301)
Observations	4,096	4,096	4,096	4,096	4,096	4,096

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Linear-PS: Propensity score estimated by local linear regression
Logit-PS: Propensity score estimated by logit regression
λ is a parameter used to calculate the propensity score

Figure 2.2 – The plot of the unconditional quantile regressions for GATT/WTO membership



Unconditional endogenous quantile treatment effect

We endogenize the GATT/WTO membership to test the robustness of Firpo (2007)'s estimator. We use Frölich and Melly (2013)'s estimator with a binary instrument variable Z.

The quantile treatment effect on the treated (QTT) is:

$$\Delta_{\tau|c} = q_{Y_1\tau|c} - q_{Y_0\tau|c} \tag{2.15}$$

where c stands for compliers. The population is partitioned into four types (T_i). The compliers (($T_i = c$) are countries that respond favorably to the change in the instrument Z. If $D_{1i} > D_{0i}$, then $T_i = c$. Three other groups are defined: defiers ($D_{1i} < D_{0i}$, $T_i = d$), individuals that are always treated ($D_{1i} = D_{0i}$=1, $T_i = a$) and individuals that are never treated ($D_{1i} = D_{0i}$=0, $T_i = n$).

The identification strategy is based on i) the existence of compliers, i.e., $Pr(compliers) > 0$; ii) monotonicity, i.e., $Pr(defiers) = 0$; iii) independent instrument, i.e., $Y_0, Y_1, T \perp Z|X$.

We use as an instrument for GATT/WTO membership the date when a country is qualified

to join GATT/WTO or became an observer. The status of observer is a status granted to WTO non-members "to allow a government to better acquaint itself with the WTO and its activities, and to prepare and initiate negotiations for accession to the WTO Agreement". Countries may become GATT/WTO observers before they make application to join though this not mandatory. Observer status increases country's probability to join GATT/WTO and observer countries are expected to join GATT/WTO. However, some countries have joined GATT/WTO without being an observer. These countries (former colonies of GATT members) have joined through sponsorship or succession under the Article XXVI 5(c).[15] These countries are qualified to join GATT/WTO upon becoming independent. Thus, we use the independence date of these countries as the date they are qualified to join GATT/WTO.

The idea to choose 2 years is based on the average years developing countries took to join GATT/WTO after being observers. For instance, The accession of least developed countries (LDCs) on average takes 2 years and 4 months longer than the accession of the non-LDC countries.[16] Since the Frölich and Melly (2013)'s estimator imposes a binary instrument, we define $Z = 1$ if the country has been an observer for at least 2 years and zero otherwise following Li and Wu (2004). GATT/WTO membership is independent from country poverty level. In fact, GATT/WTO members are made up of rich and poor countries. Hence, we assume that our instrument (observation or qualification date) is independent.

The results (see Table 2.5) confirm our previous results generated with other estimators. Accounting for the endogeneity of GATT/WTO membership does not reverse the sign of the treatment. Taking into account both the endogeneity and selection bias of GATT/WTO membership, we find that GATT/WTO membership increases poverty by 2.61-2.72% in the less poor countries and by 8.81 to 14.45% in the poorest countries.

[15] The full text of the Article XXVI 5 (c) is as follow: "If any of the customs territories, in respect of which a contracting party has accepted this Agreement, possesses or acquires full autonomy in the conduct of its external commercial relations and of the other matters provided for in this Agreement, such territory shall, upon sponsorship through a declaration by the responsible contracting party establishing the above-mentioned fact, be deemed to be a contracting party". 64 of 128 countries that were members of GATT acceded through succession.

[16] (https://www.wto.org/english/res_e/reser_e/ersd201710_e.pdf)

Table 2.5 – QTT of endogenous GATT/WTO membership on poverty (dependent variable: poverty headcount)

	(1)	(2)	(3)	(4)	(5)	(6)
	Linear-PS		Logit-PS			
	$\lambda = 1$	$\lambda = 0.8$	$\lambda = 1$	$\lambda = 0.8$	$\lambda = 0.5$	$\lambda = 0$
QTT .25	2.72**	2.08	2.02	2.68*	2.61*	1.55
	(1.352)	(1.352)	(1.349)	(1.475)	(1.521)	(1.834)
QTT .5	8.26***	7.16***	7.36***	6.54**	5.67**	5.21
	(2.709)	(2.797)	(2.648)	(2.942)	(3.034)	(3.448)
QTT .75	14.45**	11.79***	12.32***	9.90***	8.86**	8.81**
	(5.978)	(4.478)	(4.463)	(3.987)	(3.802)	(4.101)
Observations	3,462	3,462	3,462	3,462	3,462	3,462

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Linear-PS: Propensity score estimated by local linear regression
Logit-PS: Propensity score estimated by logit regression
λ is a parameter used to calculate the propensity score

2.8. The GATT/WTO effects on poverty and comparative advantage

Many developing countries, rural population accounts for a large share of their population and agriculture is often the main source of employment and income. In the 1960s, developing countries as a whole were net exporter countries of agricultural products (Bruinsma, 2017). However, technological advances (the Green Revolution) in the 1970s and export subsidy wars in the 1980s between developed countries contributed to the decline of the agricultural trade surplus of developing countries. By the end of 1990s, many developing countries that had been net exporter of agricultural products had become net importers. Carter et al. (2009) point out that China accession into WTO had changed substantially its production pattern of agricultural products, favouring labor-intensive products at the expense of land-intensive products. Our theoretical model indicates that differences in factor endowments, country-specific productivity and in trade policy contribute to differentiate poverty responses to trade liberalization across countries. Accordingly, we split our sample and estimate the GATT/WTO effects for countries that have a comparative advantage in agricultural and countries that do not. A country is defined as a *net exporter* if in period t, its agricultural trade balance (difference between export value and import value of agricultural products) is positive, and *net importer* if the difference is negative. We estimate the effects of GATT/WTO on poverty according to countries' comparative advantage in agriculture using the baseline

model, i.e., Firpo et al. (2009) unconditional quantile regression based on the recentered influence function.

The results reported in Table 2.6 suggest that the GATT/WTO membership increases poverty in net importing countries for all quantiles and the effect is bigger in the poorest countries (upper quartile) than in the middle (50%) and in the less poor countries (lower quartile). Our theoretical model explains a larger increase in poverty in the poorest countries (with lower wages and land and skills rentals) by an increase in the prices of goods intensive in unskilled labor. While poverty increases, inequality decreases and while the poorest people (landless rural workers) remain poor, their income increase. One would expect net importers of agricultural products to specialize in labor intensive goods and see their terms of trade change accordingly when they liberalize trade. However, the effect is heterogeneous across net exporting countries. For the less poor countries, the GATT/WTO accession increases poverty by 1.84% while in the middle quantile (50%), its decreases poverty by 4.54%. The coefficient for the poorest countries is negative but statistically insignificant. Our theoretical model indicate that poverty reversal effects depends on the initial levels of the rural and urban wages of unskilled workers relative to the poverty line. A decrease in the price of the land intensive good (or a lower increase than in the price of the labor intensive good) can reduce poverty in less productive/poorer countries and have the opposite effect on the more productive countries. While endowed with more land than net importing countries, the developing countries that are net exporting countries of agricultural products must compete with developed countries whose farms are far more intensive in land (and in capital). Therefore, it is quite likely that their terms of trade after accession into GATT/WTO favor labor intensive goods. Carter et al. (2009)'s analysis of China is consistent with this argument.

Menezes-Filho and Muendler (2011) show that the absorption of trade-displaced workers by comparative-advantage sectors is incomplete and slow. Our theoretical model does not adress this issue. The poverty increasing effect in the less poor countries within the group of the net exporting countries could also be imputed to the fact that their imports adjust more quickly than their exports, impeding the reallocation process of resources.

Our results highlight the importance of agriculture in the fight against poverty. Our results also confirm the heterogeneous effect of trade liberalization on poverty across groups of countries differentiated by their level of poverty and comparative advantage. In terms of policy, our results that the poorest developing countries amongst net importers of agricultural products must receive assistance to mitigate the adverse consequences of trade liberalization on poverty. Such assistance can take different forms, like investment in education to boost their endowment skills, extension services to boost productivity, including in agriculture and greater access to the markets fo developed countries. Countries that both maintain comparative advantage in agriculture and that are in the middle quartile benefit from the GATT/WTO membership in terms of poverty alleviation.

Table 2.6 – Agricultural comparative advantage and GATT/WTO effects on poverty: RIF estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Net importing countries			Net exporting countries		
VARIABLES	.25	.50	.75	.25	.50	.75
GATT/WTO	2.529***	9.467***	19.75***	1.840**	-4.544**	-1.222
	(0.685)	(1.684)	(2.506)	(0.884)	(2.079)	(3.059)
GDP per capita (log)	-4.798***	-23.53***	-19.80***	-7.353***	-18.95***	-27.44***
	(0.459)	(2.503)	(1.965)	(0.582)	(1.481)	(2.187)
Export	0.0652***	0.264***	-0.123*	-0.0160	-0.0297	0.0721
	(0.0191)	(0.0633)	(0.0650)	(0.0354)	(0.0686)	(0.103)
Import	-0.0568***	0.0643**	-0.0213	0.0400	0.0411	-0.245**
	(0.0142)	(0.0313)	(0.0535)	(0.0279)	(0.0677)	(0.109)
Investment (log)	0.0780	0.0157	-0.941***	-0.265**	0.632**	0.879**
	(0.107)	(0.247)	(0.265)	(0.112)	(0.245)	(0.424)
Democracy	0.0457***	0.196***	-0.221***	-0.0430*	-0.109**	-0.287***
	(0.0141)	(0.0325)	(0.0575)	(0.0227)	(0.0528)	(0.0868)
Education	-0.195***	-0.510***	-0.336***	-0.132***	-0.278***	-0.295***
	(0.0134)	(0.0771)	(0.0594)	(0.0161)	(0.0430)	(0.0591)
Constant	44.64***	193.4***	227.5***	68.41***	155.2***	245.6***
	(4.451)	(19.16)	(16.16)	(5.042)	(11.18)	(18.30)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,852	1,852	1,852	1,712	1,712	1,712

Notes: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
Time fixed effects are included in all the regressions.
The standard errors are calculated using 1000 bootstrap replications.

2.9. Conclusion

Despite the fact that trade liberalization is considered as en engine of development, recent empirical studies on the trade liberalization-poverty link provide diverse and complex evidence. Early empirical studies by (Desai and Rudra, 2018; Kis-Katos and Sparrow, 2015; Le Goff and Singh, 2014; Topalova, 2007) about the effect of trade liberalization on poverty estimated a mean effect averaging over countries experiencing heterogenous poverty effects. The heterogeneity in the poverty effect of trade liberalization across countries has not received as much attention as one would expect. A few authors have focussed on the role of structural characteristics and complementary policies to explain the signs and magnitudes of poverty effects (e.g., Le Goff and Singh, 2014; Foellmi and Oechslin, 2010; Harrison and McMillan, 2007; Banerjee and Newman, 2003).

We developed a Heckscher-Ohlin model with a rural-urban segmentation allowing some fac-

tors like land and skills to be region-specific and regions to produce different goods. Our model supports a rural-urban wage gap and derive conditions for poverty alleviation linked to changes in output prices. Poverty effects depends not only on changes in output prices, but also by the levels of factor prices . To this end, we explore Hicks-neutral technological differences as in Trefler (1995). This neutralizes the comparative advantage effects on poverty and highlights possible non-monotonic poverty effects. Our theoretical model suggests that countries differentiated by their initial poverty level and by comparative advantage are likely to experience different poverty effects when they join GATT/WTO and engage in trade liberalization. Empirically, we analyze the GATT/WTO treatment on poverty by using unconditional quantile regression methods that allow to estimate the effects of trade liberalization on the full distribution of poverty.

Our pooling all countries together regardless of comparative advantage results suggest that GATT/WTO membership increases significantly poverty across the entire unconditional poverty distribution. Countries with higher poverty rates experience a higher increase in poverty after joining the GATT/WTO than countries with lower initial poverty rates. These results are robust across different unconditional quantile regression methods and to the selection bias. When our sample is split into net exporting and net importing countries, our results show that countries that are in the middle poverty quartile in the group of net exporting countries and are in the middle quartile, experience a reduction in poverty after joining the GATT/WTO.

While our results show that GATT/WTO membership increases poverty in many developing countries, we are not saying that trade liberalization is bad for developing countries. Our theoretical results that poverty and inequality may move in opposite directions, making it harder for policymakers interested in distributional effects to assess policies and regulatory impacts. The same goes for poverty and other performance criteria like economic growth. Still, the estimated GATT/WTO poverty effects for the poorest countries amongst developing countries that are net importers of agricultural products are high and this suggests that these countries should be assisted in mitigating adverse poverty effects. Domestic policies encouraging the development of human capital and regulatory changes encouraging productivity-enhancing investments should be implemented. In agriculture, Adamopoulos and Restuccia (2014) show that developing countries exploit a small fraction of their production potential. Developing countries can help by reducing tariff and non-tariff barriers, especially for sensitive agricultural products. The WTO must remain sensitive to the adjustment constraints faced by these countries. As stated by Leibovici and Crews (2018) "Understanding the differential responses to trade liberalization across income groups is important for designing effective policies that allow low-income countries to fully benefit from openness to international trade". Future research should focus on the role of complementary policies and country's structural characteristics in a dynamic framework to better assist poor countries in securing gains from trade without hurting their poorest citizens. It would also be interesting to analyze the incidence of

GATT/WTO membership (and trade liberalization) on poverty and inequality in developed countries.

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Chapter 3

Trade tax reforms and poverty in developing countries: why do some countries benefit and others lose?

3.1. Résumé

Ce chapitre analyse les effets des politiques tarifaires consistant à réduire la taxe sur le commerce international couplé de l'augmentation des taxes domestiques sur la pauvreté dans les pays en développement. Nous modélisons le lien entre les réformes tarifaires et la pauvreté comme hétérogène entre les pays en utilisant un échantillon de 91 pays en développement sur la période 1980-2016. Nos résultats montrent que le passage des taxes sur le commerce international aux taxes nationales avec neutralité des recettes fiscales réduit la pauvreté dans les pays qui ont consolidé en moyenne leur avantage comparatif dans le secteur agricole ; cependant la pauvreté augmente dans les pays qui sont passés d'exportateurs nets à des importateurs nets de produits agricoles. Les biens publics jouent un role non significatif dans la relation entre les réformes de taxes sur le commerce international et la pauvreté.

3.2. Abstract

This paper studies the relationship between trade tax and domestic tax reforms and poverty in developing countries and explore whether the role of public goods provision matters in this relationship. Using a sample of 91 developing countries over the 1980-2016 period, I model the trade tax reforms-poverty nexus as heterogeneous across countries with cross-sectionally dependent errors. I find that a shift from taxes on international trade towards domestic

taxes under revenue-neutrality reduces poverty in the countries that have consolidated on average over time their comparative advantage in agriculture while it increases poverty in countries that moved from net exporters to net importers of agricultural products. Public goods however, don't play a significant role in the relationship.

Keywords: Trade tax and domestic tax reforms, Trade liberalization, Government spending, Taxation and poverty, Common factor model,

JEL Classification: H2; F13; I38; C23

3.3. Introduction

In the early 1980s, many developing countries have engaged in trade and tax reforms to initiate trade liberalization process under the guidance of international institutions such as the World Bank, the International Monetary Fund (IMF) and the World Trade Organization (WTO). This was to allow them to be more integrated into world trading system. This process consisted of a reduction or a cut in trade taxes considered as a distortionary tax and their replacement by non-distortionary domestic taxes such as value added tax (VAT), necessary for economic growth and development. According to Baier and Bergstrand (2001), "Tariff reductions still explain almost three times as much trade growth as transport-cost declines". Accordingly, a reduction in trade taxes is likely to increase exports of developing countries and contribute to poverty reduction. The neoclassic mainstream international trade theories claim that free trade increases welfare by generating consumption and production efficiency gains. In addition, tariff reduction favours rapid economic growth. There is a consensus that open economies perform better than closed ones due to the exploitation of comparative advantage (Krueger, 1985). Nevertheless, the way the welfare gain is redistributed among people remains an important question. Some people benefit while others lose.

However, recovering revenue loss due to trade liberalization is a major concern of developing countries. Many developing countries rely heavily on the trade taxes as a source of government revenue (Easterly and Rebelo, 1993; Greenaway and Milner, 1991). According to Zee (1996), the average trade taxes in percentage of total tax revenue of government in Africa was 36.4% over the period 1974-79, 34.8% over 1980-84 and 32.5% over 1985-89 whereas in Asia this share was respectively 26.5%, 24.8% and 23.8%. This share might be high with respect to each individual country. For example, in the early 1990s, the share of trade taxes in total tax revenue was nearly 40% in Pakistan (Lahiri and Nasim, 2005). According to the World Bank, import duties over government total tax revenue in 2010 in Maldives, Ethiopia, Swaziland, Madagascar were respectively 70%, 52%, 51% and 47%. These tax revenues are used by the government to provide good social amenities to its citizens such as health care and education, good roads and security which are of benefit to poor in particular. Accordingly, decline in trade tax revenues without replacement may be harmful for poor people.

The government revenue consequences of trade policies have received a considerable interest but there are controversies about the direction of the effect, i.e., revenue decreasing or increasing. Concerning developing countries, the empirical literature in general, concludes that trade liberalization may lead to revenue depletion even though the potential decrease in tariff revenue has been replaced by alternative sources of taxes to offset the loss in trade tax revenue. This loss of tax revenues can worsen the budget deficit and reduce government public spending; accordingly dampen the provision of public goods and services. Moreover, this will generate structural macroeconomic instability problems that can be harmful for the

economy overall.

Indeed, the structural characteristics of developing countries limit their ability to shift from trade taxes to domestic taxes, then trade liberalization reduces trade taxes ratio to GDP (Khattry and Rao, 2002) and the total government revenue (Devarajan et al., 1999). According to McCulloch et al. (2001), taxes on foreign trade are administratively easier to collect than taxes on domestic goods. Then trade integration should shift the tax revenue easy to collect - *trade taxes* - towards hard to collect - *taxes on income, production and consumption* - (Aizenman and Jinjarak, 2009). Besides, the informal sector accounts for a relatively high share in the economic activity that limits the base of domestic taxes collection.

Baunsgaard and Keen (2010) show that the replacement of trade taxes by other taxes (domestic taxes such as the taxes on consumption, income and profit) doesn't compensate totally the loss of trade tax revenue. For the authors, government revenues in most developing countries depend heavily on trade taxes. For one dollar lost due to liberalization, middle-income countries are able to recover 40-60 cents through the implementation of other internal taxes while low income countries recover at the most 30 cents. The loss in trade tax revenue may exert a downward pressure on some public goods provision (Khattry, 2003). School access (education) for example is a relevant determinant of the well-being and productivity of a country. Yet, education can be provided by either private or public sector. Rich people can acquire it privately while the poor cannot and therefore, this service is a source of inequality if it is not publicly provided. In developing countries, governments are the major stakeholders in education and a large share of the population relies on public education. There is strong empirical evidence that public education expenditure is positively associated to economic growth by favouring human capital accumulation (Kaganovich and Zilcha, 1999; Blankenau and Simpson, 2004; Blankenau, 2005; Blankenau et al., 2007). Consequently, the decline in the public education provision may lead to an increase in poverty.

The effect of the reform of trade taxes and domestic taxes on welfare has received considerable attention but this attention is more theoretical than empirical. This theoretical predictions on the effects of trade tax and domestic tax reforms on welfare are very mixed (e.g., Kreickemeier and Raimondos-Møller, 2008; Keen, 2008; Emran, 2005; Emran and Stiglitz, 2005; Keen and Ligthart, 2002; Falvey, 1994). To my knowledge, very few papers paid attention on the effect of trade tax and domestic tax reforms on poverty directly and particularly on developing countries. While a reduction in trade taxes with an increase in VAT has been in the center of policies that developing countries implemented in 1980s and 1990s under the structural adjustment policies of the IMF and the World Bank, as mentioned above, Baunsgaard and Keen (2010) show that developing countries have failed to recover the lost trade tax revenue or increase government revenue. For instance, Anderson (1996) shows that in Korea, a reduction in trade taxes with a revenue-neutral increase in VAT reduces welfare. Thus, there is a doubt on welfare improvement or poverty alleviation of a reduction in the trade taxes coupled with

an increase in value-added tax.

In this paper, I investigate the heterogeneity effects of the trade tax and domestic tax reforms on poverty in developing countries but also I explore the role of public goods in this relationship. This entails investigating how a decrease in trade taxes combined with an increase in domestic taxes affects poverty in developing countries. The literature assumes homogeneity of the effect of trade taxes reforms on poverty. The originality of this paper arises first from the adoption of recent panel time series methods that allow to account for cross-section dependence and to characterize whether the effect of trade tax reforms on poverty differs substantially across countries. Second, I consider the role of public goods and revenue-neutral reforms of trade taxes and domestic taxes in this relationship.

Using a panel data of 91 developing countries over 1980-2016 period, I at first find that a reduction of trade taxes on average increases poverty significantly but this effect varies widely across countries. Second, I show that a reduction in trade taxes combined with an increase in domestic taxes under revenue-neutrality increases on average poverty with considerable cross-countries heterogeneity in parameters. Countries that benefit in terms of poverty reduction are those that have consolidated their comparative advantage in agriculture as their trade balances of agricultural products increase while countries that lose out are those that have moved from net exporters to net importers of agricultural products. Third, when taking into consideration the role of government public education and health expenditures, I find that public goods do not affect significantly poverty when a country moves from trade taxes towards domestic taxes under revenue neutrality.

The remainder of the paper is structured as follow: Section 3.4 presents a short theoretical review on the welfare effects of trade tax and domestic tax reforms. Section 3.5 discusses the empirical strategy and data while Section 3.6 presents the empirical results. Section 3.7 concludes.

3.4. Brief synopsis of earlier theoretical work

I present a brief synopsis of the theory of tariff-tax reforms effects on income distribution. Mostly, the existing work on the tariff-tax reforms effects on income distribution in the literature are theoretical. This theoretical literature highlights that trade tax and domestic tax reforms improve welfare under some sufficient conditions such as the share of informal sector in the economy, the presence of non-tradeable goods, revenue-neutral reforms and perfect competition (e.g., Fujiwara, 2013; Naito and Abe, 2008; Hatzipanayotou et al., 1994; Michael et al., 1993; Keen, 1989).

A reduction in trade taxes combined with an increase in domestic taxes such as VAT, tax

on income has been considered in the literature for improving government revenue and welfare in developing countries. The conventional advice prescribed to the developing countries under the IMF and World Bank's policy conditionalities consider VAT as a better and non-distortionary tax instruments to raise government revenue and to improve efficiency in resource allocation for better economic performance. Thus, a reduction in trade taxes accompanied by an increase in VAT improves welfare (e.g., Fujiwara, 2013; Michael et al., 1993).

Keen and Ligthart (2002) in the case of small economy where all goods are tradeable and under perfect competition show that a tariff cut combined with one-to-one increase in domestic consumption tax leaving consumer prices unchanged, increases both welfare and government revenue. This occurs because the tariff cut combined with point-by-point consumption tax increase enables resources to be efficiently allocated which in turn lead to a production efficiency that drives mostly the raise in welfare. However, in the presence of non-tradeable goods and tradeable intermediate inputs in the model, it is extremely difficult if not impossible to ensure clearly welfare improvement.

Keen and Ligthart (2005) themselves challenge this increase in welfare and public revenue by showing that under imperfect competition, a tariff reduction reduces national welfare using a two-country and two-good (tradeable goods) general-equilibrium model. In the model, two identical firms serve and compete in the home market: one domestic firm and one foreign firm. The two firms face the same consumption tax in the home market but the foreign firm also pay a tariff imposed by the home country. Raising the tariff increases the cost for the foreign firm (and then reduces its production and increases the production of the home country) while an increase in the consumption tax increase both firms' cost and reduces their output. Accordingly, a tariff reduction combined with one-for-one increases in consumption tax reduces the production of the domestic firm (and reduces therefore its profits), increases the production of the foreign firm (and an increase of its profits) and raises the consumer price. Thus, the welfare falls.

Moreover, the positive effects of the shift from trade taxes towards domestic taxes may be undermined by the presence of higher share of informal sector in the economy that escape the VAT net (Gordon and Li, 2009; Keen, 2008; Emran and Stiglitz, 2005; Piggott and Whalley, 2001). In fact, in developing countries, according to Schneider and Enste (2000), the average size of the informal sector is 39% of GDP, ranging from 25-35% in Colombia, Paraguay, Brazil, Chile, Costa Rica, Venezuela to 68-76% in Nigeria and Egypt over 1990-93 period. This higher share of informal sector shrinks the fiscal base and reduces government revenue that is harmful for reducing poverty.

Emran and Stiglitz (2005) establish the conditions under which a shift from trade taxes to a revenue-neutral increases in VAT is welfare-worsening in the context of developing countries taking into account the implications of a large informal sector in the economy. Taxes on goods

such as VAT can only be levied in the formal sector. Then, a tax on formal sector may lower the demand of the goods produced in the formal sector and increases the production in the informal sector. VAT is likely to entail a shift from the formal to informal sectors and home production; providing more distortion source of revenue. Consequently, the welfare decreases when moving from trade taxes to domestic taxes.

Furthermore, trade tax and domestic tax reforms affect welfare through public goods provision because government may use tax revenue to provide public goods. Abe (1992) using a general equilibrium model shows that tariff reductions can reduce welfare in a small open economy if public goods are initially under produced. However, if public goods are over supplied, tariff reduction increases welfare in a small open economy.

Given that the share of informal sector in the economy, public goods provision, sources of government revenue, economy policies, institutional environment may vary across developing countries, in this paper, I investigate empirically heterogeneous effects across countries of the trade tax and domestic tax reforms on poverty in developing countries.

3.5. Empirical strategy and data

3.5.1. Empirical strategy

I examine the relationship between trade tax and domestic tax reforms and poverty by adopting a dynamic linear model of poverty assuming heterogeneity across countries. In fact, trade tax reforms may affect differently countries depending on their economic characteristics and their capacity to respond to the international competition arising from trade liberalization. The replacement of taxes on international trade by domestics taxes are the sorts of institutional adjustments to the implementation of trade agreements. I then consider the differences in the relationship across countries modelling the relationship between trade tax and domestic tax reforms on poverty as not common but heterogeneous across countries since the effects of trade tax reforms may depend on countries characteristics and domestic concurrent policies reforms that countries implement. This is the reason that estimating the average effect basing on pooled sample might not result to satisfactory policy prescriptions (Santos-Paulino, 2012). I then depart from the conventional panel econometrics models that assume homogeneous parameters across all countries by estimating country specific coefficients. Doing so, I am able to provide policy recommendations to countries to take advantage of the trade tax reforms leading to trade liberalization.

The starting model for the empirical analysis allows for heterogeneous coefficients drawing on dynamic common correlated effects estimator (Chudik and Pesaran, 2015) and is specified as follow:

$$y_{it} = \beta_0 y_{it-1} + \beta_1 tradetax_{it} + \beta_2 domestictax_{it} + \Gamma X_{it} + \alpha_i + u_{it} \tag{3.1}$$

$$u_{it} = \lambda_i' f_t + \varepsilon_{it} \tag{3.2}$$

where in Eq. (3.1), y_{it} is the poverty headcount in country i at the time t, y_{it-1} is the lagged values of poverty, *tradetax* is trade tax revenue in percentage of GDP, *domestictax* is the domestic tax revenue in percentage of GDP, X control variables including is agricultural land per capita, capital stock per capita based on Fischer (2001), GDP per capita and non tax revenue, α_i represents country fixed effects and, u_{it} represents the multifactor error structure. All the variables are in logarithm. In Eq. (3.2), f_t is a vector of unobserved time-specific common factors, λ_i is the heterogeneous factor loadings, ε_{it} represents the idiosyncratic errors in the multifactor error structure. The heterogeneous coefficients are randomly distributed around a common mean β_{MG}, such that $\beta_i = \beta_{MG} + v_i$, $v_i \sim IID(0, \Omega_v)$ (Pesaran and Smith, 1995).

To estimate the model, I am concerned about the cross-section dependence arising from geographic or economic proximity (weak cross-section dependence) or unobserved common factors called strong cross-section dependence (Chudik et al., 2011). The cross-section dependence might occur through a commodity price fluctuations, trade or tax agreements (McNabb, 2018), currency unions or world economic or financial crisis. Weak cross-section dependence arises from the fact that countries with geographic or economic proximity will have similar characteristics that can lead to a correlation in outcomes between neighboring countries (Totty, 2017).In the other hand, strong cross-section dependence arises from unobserved common factors that affect differently countries. For instance, shocks such as commodity price fluctuations and tax agreements may lead a number of countries reduce tariffs on each other's imports McNabb (2018) or change their domestic tax policies. Hence, in my case, tax variables (trade tax revenue, domestic tax revenues) are likely to be affected by unobserved common shocks leading to residual cross-section dependence. Do not account for cross-section dependence using conventional panel estimators such as fixed or random effects results econometrically in an inconsistent estimates and misleading inference (Phillips and Sul, 2003; Andrews, 2005; Phillips and Sul, 2007). This inconsistency in general, occurs when the unobserved factors and the included regressors or observed explanatory variables are correlated (Pesaran, 2006).

Many econometric approaches were developed in the literature to deal with cross-section dependence in panel data (e.g., Coakley et al., 2002; Robertson and Symons, 2000, 2007; Pesaran, 2006; Bai, 2009; Pesaran and Tosetti, 2011; Kapetanios et al., 2011; Chudik and Pesaran, 2015). For instance, Coakley et al. (2002, hereafter CFS) propose a principal component approach with two-stage estimation method. The CFS method consists first of extracting principal components from residuals obtained from the first stage regression of y_{it} on x_{it} for each i. Then, these principal components (one or more) are used to augment the

original regression equations to proxy possible omitted variables. However, Pesaran (2006) points out that the CFS estimator is not consistent if the unobserved factors and the included regressors are correlated.

Pesaran (2006)'s common correlated effects estimator (henceforth CCE) accounts for unobserved factors through an augmentation of the regression equation with cross-sectional averages of the dependent and independent variables. The CCE estimator is robust to different types of cross section dependence errors, possible unit roots in independent variables, serial correlation in errors and slope heterogeneity (Kapetanios et al., 2011; Pesaran and Tosetti, 2011; Chudik et al., 2011).[1] However, Chudik and Pesaran (2015) show that the CCE approach is not valid in the case of dynamic panel and/or in the presence of weakly exogenous dependent variables[2] because the CCE estimator is subject to a small sample bias, in particular when the time series dimension of the panel is not sufficiently large.[3] Chudik and Pesaran (2015) extend then the CCE approach to allow for dynamic panel and/or weakly exogenous regressors. In the presence of weakly exogeneous regressors, the CCE estimator provides inconsistent estimates. As a remedy, the authors suggest including further lags of cross-section averages in addition to the cross-section averages of all variables in the model. In this paper, I use Chudik and Pesaran (2015)' estimator to identify trade tax reforms effects on poverty in a linear dynamic model because "many large cross country or cross regional panels tend to be subject to error cross-sectional dependence and slope heterogeneity and are likely to contain weakly exogenous regressors" (Chudik and Pesaran, 2015, page 394). The CCE estimator has been used in the literature to investigate the economic consequences of tax structure or tax policies (e.g., McNabb, 2018; Arachi et al., 2015; Arnold et al., 2011).

[1] A serie has unit roots if it is characterized as non-stationary, i.e., has a variable variance and a mean that does not return to a long-run mean over time or fluctuates around a non-constant long run mean. In the presence of non-stationnary series, the estimates from OLS, 2SLS regressions for instance are inaccurate or so called spurious regression problem (Newbold and Granger, 1974).

[2] The weak exogeneity is "the requirement for conditional estimation to be without loss of information from conditioning"(Ericsson et al., 1998).

[3] The Pesaran (2006) CCE estimator assumes strict exogeneity of the observable regressors. Chudik and Pesaran (2015) approach relaxes the assumption of strict exogeneity for the regressors and thus allows for the feedback between the dependent variable and regressors.

The cross-sectionnaly augmented estimation equation is thus:

$$y_{it} = \beta_0 y_{it-1} + \beta_1 tradetax_{it} + \beta_2 domestictax_{it} + \Gamma X_{it} + \alpha_i + \sum_{l=0}^{P_T} \theta_{il}^{'} \overline{z}_{t-l} + u_{it} \tag{3.3}$$

$$\overline{Z}_t = (\overline{Y}_t, \overline{Y}_{t-1}, \overline{X}_t), \quad \overline{X} \text{ includes all the control variables}$$

where $\overline{z}_{t-l}$ is cross-sectional (CS) averages of all the dependent and independent variables, p_T is the number of lags of cross-sectional averages.

The mean group estimates $\beta_{MG} = E(\beta_i)$ are given by

$$\hat{\beta}_{MG} = \frac{1}{N} \sum_{i=1}^{N} \hat{\beta}_i$$

$\hat{\beta}_i$ and $\hat{\beta}_{MG}$ are consistently estimated with convergence rate $\sqrt{N}$ if $(N, T, p_T) \to \infty$.

This specification allows slope coefficients to vary across countries, i.e., each country has its own set of slope coefficients both on the observed regressors and on the unobserved common factors. In fact, as countries differ in some economic, social and political characteristics, the effect of tariff on poverty may differ from one's to another.

Chudik and Pesaran (2015)[4] show that the CCE mean group estimator once augmented with sufficient number of lags and cross-sectional averages perform well even in the case of dynamic models with weakly exogenous regressors. To estimate the model, I follow the authors' rule of thumb recommending that $p = int(T^{1/3}) = 3$. This is equivalent to adding up to three lagged differences in my model. Moreover, I add country specific linear trend in each model.

3.5.2. Data

My sample is comprised of 91 developing countries (see the list of the countries in Appendix C.1) spanning the period from 1980 to 2016. The selection of the countries in the sample is based on the availability of the relevant data notably on the availability of data on trade tax revenue. Tax data are collected from Government Revenue dataset (GRD) 2018 of ICTD/UNU-WIDER. The GRD offers a "significantly more complete and accurate source of revenue data than any other single source, particularly for developing countries" (McNabb, 2018). I complete (some missing values) my data with the OECD Revenue Statistics and Baunsgaard and Keen (2010) datasets.

[4] Chudik and Pesaran (2015) model is estimated using Ditzen (2016) ***xtdcce2*** command, version 1.33d - August 2018

The poverty indicator used in this paper is the poverty headcount index which is a measure of absolute poverty. The poverty headcount index measures the proportion of the population whose consumption or income is below a certain poverty line. I consider in this paper the $1.90 a day poverty line used by the World Bank. This poverty indicator is used often in the literature (e.g., Le Goff and Singh, 2014; Santos-Paulino, 2017). The complete definition of variables and data sources are presented in Appendix C.2.

Trade tax revenue measures import and export duties. Domestic tax revenue is defined as total tax revenue excluding trade tax revenue. Domestic tax revenue includes taxes on payroll and workforce, value added tax (VAT), taxes on property, axes on income, profits and capital gains among others.

The descriptive statistics of variables used in the empirical analysis are reported in the Table 3.1. The descriptive statistics reveal that trade taxes account for up to 36 percent of GDP while domestic taxes represent up to 35% of GDP.

Table 3.1 – Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Headcount	3302	31.37	26.487	0	96.42
Trade tax (% of GDP)	3096	3.434	3.412	-1.569	36.116
Domestic tax (% of GDP)	3059	10.958	5.655	.06	35.351
Total tax (% of GDP)	3238	14.396	6.552	.6	53.868
Land pc	3252	2.304	6.593	.019	73.737
Capital pc	3204	.451	.538	.003	3.384
GDP pc	3347	114.76	854.255	0	15019.63
Non tax revenue	2859	3.715	4.311	0	46.918
Education	1584	15.352	5.501	.46	45.883
Health	1550	127.129	97.681	.35	797.71
Government expenditure	1582	25.692	9.671	9.806	100
Population growth	2250	2.161	1.035	-6.185	7.918

3.6. Empirical results

Before running the regressions, I carry out Pesaran (2004) cross-sectional dependence test of the raw variables. The results reported in the Table C.1 in Appendix C.3 suggest that the raw variables are subject to considerable cross-section dependence (the presence of common factors in each dataset). The the presence of common factors in each dataset validates the common factor model approach.

3.6.1. Trade taxes effects on poverty

The results (the mean group coefficients) of the effects of trade taxes on poverty are reported in the Table 3.2. I start the estimation using Pesaran and Smith (1995) mean group estimator (MG) in the first column which ignores the presence of the cross-section dependence and Pesaran (2006) CCE estimator in the second column. The estimated coefficient of trade taxes is negative and equal to -0.3 for the MG estimator. However, the CD statistic is statistically different from zero indicating the presence of cross-section dependence implying that my two models were misspecified. Accordingly, my estimates may be biased due to the presence of the cross-section dependence. Using Chudik and Pesaran (2015)'s linear dynamic model and including additional lags of cross-section average in the CCE Mean Group model (columns 3-5), the cross-section dependence disappears with a CD statistics indicating that the null-hypothesis of cross-section independence cannot be rejected for the models with two and three lags of cross-sectional average. The coefficients of trade taxes are still negative, equal to -0.14 and -0.3 and significant at 5%, respectively for models with two and three lags. The result for the model with one lag is not significant. The negative coefficients of taxes on international trade reveal that an increase in trade taxes reduce on average poverty. Given that the dependent and independent variables are expressed in logarithm, the coefficients of the independent variables are interpreted as elasticities. An increase of 1% in taxes on international trade reduces poverty from 0.14% to 0.3%. My findings are consistent with the literature on tariff revenues and poverty (e.g., Topalova, 2007) stating that developing countries rely heavily on trade taxes that allow them to finance public goods necessary for poverty alleviation.

Nevertheless, the effects of taxes on international trade vary widely across countries. Figure 3.1 shows the heterogeneity effect across countries of trade tax revenue on poverty, meaning that a group of countries (36 countries) are beneficiaries whereas other groups (24 countries) lose out.[5] While most of countries in my sample benefit from an increase in trade tax revenue in terms of poverty reduction, size of the effect varies widely between countries. Figure 3.1 indicates a non-linearity in the relationship between trade taxes and poverty and a conclusion about the role of trade taxes level in this heterogeneity cannot be drawn. Hence, this heterogeneity may imply that the effects of trade tax revenue is not automatic and may depend on country characteristics and some domestic complementary policies. Countries that experience a poverty reduction associated to the increase in the taxes on international trade may have a

[5]The 36 countries in which an increase in trade taxes reduce poverty are: Belize, Benin, Bhutan Cameroon, Central African Republic, Chile, Comoros, Republic of Congo, Costa Rica, Cote d'Ivoire, Dominican Republic, Egypt, El Salvador, Fiji, Ghana, Guinea, Honduras, Iran, Jordan, Kenya, Lesotho, Madagascar, Mali, Mongolia, Morocco, Namibia, Nepal, Niger, Paraguay, Sierra Leone, South Africa, Sri Lanka, Thailand, Togo, Venezuela, Zimbabwe. The 24 countries that lose out are: Botswana, Burkina Faso, Burundi, Cabo Verde, Colombia, Ethiopia, Guatemala, India, Malawi, Mauritius, Mozambique, Pakistan, Peru, Philippines, Rwanda, and Principe, Senegal, Tanzania, Tunisia, Uganda, Uruguay, Vietnam, Zambia. The coefficients of trade taxes for Gambia and Malaysia are zero; meaning that trade taxes effects on poverty are null in these two countries.

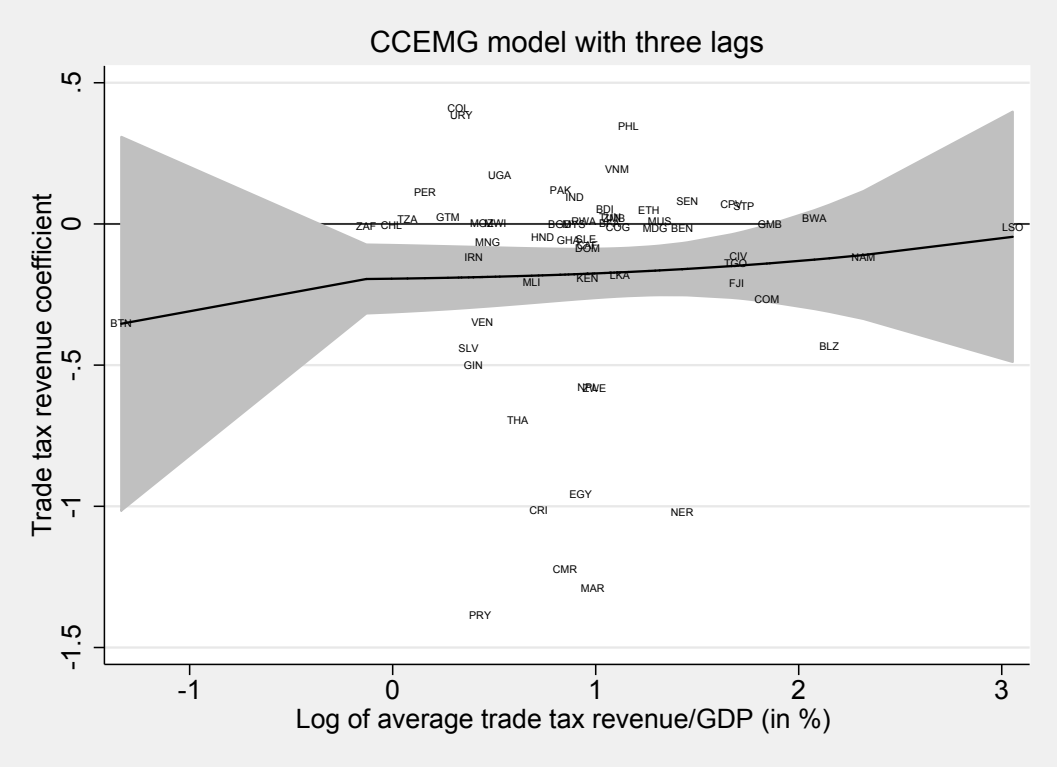
better distribution policy that benefit low earnings people, or are those that have increased the domestic production (import substitution) by raising tax on international trade. The data show that countries that observe poverty reduction have remained on average net exporters of agricultural products over time while countries in which poverty increases have moved from net exporters to net importers of agricultural products (see Figure C.1 in Appendix C.4). For the latter groups of countries, it means that imposing taxes on international trade could be detrimental for their exports and their partners may take retaliatory measures that may reduce their access to foreign markets.

Table 3.2 – Trade taxes incidence on poverty estimation

	(1)	(2)	(3)	(4)	(5)
	MG	CCEMG	CCEMG with lags		
CA Additional lags			1^{st} lag	2^{nd} lag	3^{rd} lag
Dependent variable: poverty headcount ratio (in log)					
L.Headcount	0.589***	0.388***	0.266***	-0.098	0.254**
	(0.033)	(0.039)	(0.064)	(0.388)	(0.106)
Trade tax	-0.030*	-0.026	-0.032	-0.139**	-0.299**
(% of GDP)	(0.017)	(0.019)	(0.053)	(0.063)	(0.135)
Domestic tax	-0.052***	-0.059**	-0.057	-0.053	0.056
(% of GDP)	(0.019)	(0.028)	(0.101)	(0.092)	(0.213)
Capital pc	0.145	-0.075	-0.145	0.234	-1.870**
	(0.126)	(0.136)	(0.399)	(0.788)	(0.800)
Land pc	0.052	-0.031	-0.289	0.141	0.197
	(0.139)	(0.168)	(0.615)	(0.759)	(1.046)
GDP pc	-0.437***	-0.691***	-0.624**	-2.172	-2.070**
	(0.097)	(0.129)	(0.297)	(1.403)	(1.034)
Non tax revenue	-0.002	0.019	0.029	0.025	0.143
	(0.009)	(0.013)	(0.038)	(0.065)	(0.105)
Constant	-0.723	-0.034	-12.060	-13.821	-14.504
	(0.630)	(1.257)	(10.767)	(11.663)	(9.542)
RMSE	0.097	0.067	0.094	0.084	0.087
CD test	9.915	1.68	4.66	0.67	1.47
CD p-value	0.000	0.094	0.000	0.506	0.142
Number of Countries	81	81	65	63	62
Observations	2,360	2,360	1,979	1,860	1,765

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses are constructed nonparametrically following Pesaran and Smith (1995).
All the regressors are in the log. Country-specific linear trend is included in each model. CD test reports the Pesaran (2015) test for weak cross-sectional dependence, which under the null hypothesis of weak cross-sectional dependence of the error term, the CD-statistic is distributed $\sim N(0,1)$. RMSE is the root mean squared error.

Figure 3.1 – Trade tax coefficients heterogeneity



Notes: I plot the country specific coefficients for trade tax revenue from Chudik and Pesaran (2015) CCEMG model with three additional lags (column (5) in Table 3.2). The figure shows that the poverty effect of trade tax revenue varies widely across countries. 36 countries have negative coefficients meaning that poverty decreases with an increase in trade taxes while 24 countries have positive coefficients suggesting that an increase in trade taxes is associated to an increase in poverty. The coefficients for two countries are zero. Jordan has been excluded from the graph sample to ensure homogeneity.

3.6.2. Revenue-neutral tax policy

I analyze the effects of tax policy consisting of replacing the trade taxes by domestic taxes (VAT, tax on income, production, etc) on poverty under revenue-neutral reduction in trade taxes. The revenue-neutral tax reforms involve a reduction in trade taxes offset by an increase in domestic taxes. This implies that one unit loss of trade taxes is totally offset by an increase in domestic taxes. To test empirically the trade taxes decreasing revenue-neutral effects on poverty, I include in my model total tax revenues and domestic tax revenues but omit trade tax revenues in the regression equation following McNabb (2018), Arachi et al. (2015) and Arnold et al. (2011). The omitted trade tax revenues are assumed to adjust to absorb changes in domestic tax revenues included in the regression, to maintain revenue neutrality. I transform the domestic taxes data using the share of domestic taxes over the total tax revenue to ensure

that the sum of taxes on international trade and the domestic taxes are equal to the total tax revenues.

The results reported in Table 3.3 indicate that the revenue-neutral shift from trade taxes towards domestic taxes (the mean of coefficients across countries) increases poverty on average between 0.07 - 0.96 significantly at 10% level. One can explain these results by the fact that a reduction in trade taxes coupled with one-to-one increase in domestic taxes may increase the production cost for domestic firms and also increases the import and therefore employment decreases (e.g., Keen and Ligthart, 2005). In fact, Keen and Ligthart (2005) finds that tariff reduction combined with one-for-one increases in consumption tax reduces the production of the domestic firm (and reduces therefore its profits), increases the production of the foreign firm (and an increase of its profits) and raises the consumer price and accordingly, welfare falls. The decline in domestic production may raise unemployment and therefore poverty increases. Alternatively, Alavuotunki et al. (2017) finds that on average, value added tax (VAT) adoption has led to increased inequality (using a disposable income of inequality). The increase in inequality may lead to an increase in poverty.

However, the revenue neutrality effects of domestic taxes on poverty is very heterogeneous when examining the effects individually across countries (see Figure 3.2). I highlight that a shift from trade taxes towards domestic taxes is associated with poverty reduction in a group of countries (25 countries) while poverty increases in other group of countries (33 countries).[6] Figure 3.2 reveals that the nexus between the impact of the shift from taxes on international trade towards domestic taxes and the trade taxes-to-GDP ratio is not linear and accordingly, I can't explain the heterogeneity across countries by the level of domestic taxes. I then document the factors that can drive this heterogeneity and point out the role of comparative advantage in agriculture products export. Moreover, Figure 3.2 shows that most of countries that benefit from an increase in trade taxes are those that lost from the shift from trade taxes towards domestic taxes under revenue neutrality; and inversely most of those that lost from an increase in trade taxes benefit from an increase in domestic taxes under revenue neutrality.

The data (see Figure C.2 in appendix C.4) show that countries that experienced a poverty alleviation have consolidated their comparative advantage in agriculture as their agricultural trade balances have increased on average over time (overall agriculture trade surplus have increases). The increase of their exports results from better terms of trade or an increase in

[6]The 25 countries that reduce poverty by liberalization trade are: Bangladesh, Botswana, Burkina Faso, Burundi, Cabo Verde, Central African Republic, Costa Rica, Dominican Republic, El Salvador, India, Kenya, Lesotho, Malawi, Mongolia, Morocco, Namibia, Peru, Rwanda, Senegal, Sierra Leone, South Africa, Thailand, Tunisia, Uganda, Uruguay. The group of 33 countries in which trade liberalization is harmful for poverty is: Belize, Benin, Bhutan, Cameroon, Chile, Colombia, Comoros, Republic of Congo, Cote d'Ivoire, Egypt, Ethiopia, Fiji, Ghana, Guatemala, Guinea, Iran, Jordan, Madagascar, Mali, Mauritius, Mozambique, Nepal, Niger, Pakistan, Paraguay, Philippines, Sao Tome and Principe, Sri Lanka, Tanzania, Togo, Venezuela, Zambia, Zimbabwe. Furthermore, the effects of the shift from trade taxes towards domestic taxes under revenue neutrality is null in Gambia, Honduras, Malaysia, Vietnam.

price of agricultural products due to the Stolper-Samuelson theorem. Besides, a reduction in trade barriers (for example within the WTO framework consisting of multilateral reduction in trade barriers under the Doha Round, regional trade agreements, etc) led them to have a larger access to market and then growing their exports through the reduction in fixed cost of trade (e.g., Dutt et al., 2013; Chaney, 2008). For instance, Uruguay accession into Mercosur in 1991 has boosted its export of beef and the country has been able to export to more distant markets such as Japan. McCaig (2011) analyzing the effect of US-Vietnam bilateral trade agreements on poverty in Vietnamese provinces and US market access shows that provinces that were more exposed to the U.S. tariff cuts (greater access to the US market) experienced faster decreases in poverty. Likewise, Porto (2003) obtains similar results in Argentina's case by revealing that domestic tariff reduction and better access to foreign market has decreased poverty. As agriculture is the main source of employment and income in most of developing countries, increase in the export of agricultural products is likely to raise employment and income for rural or poor people and therefore decreases poverty. My findings are also in line with Christiaensen et al. (2011) who find that increases in agricultural GDP per capita are five times more powerful in reducing poverty than a similar increase in GDP per capita in non-agricultural sector.

In contrast, the countries in which poverty increases have moved from net exporters of agricultural products to net importers over time: their agricultural trade balances declined and their agricultural trade deficit has increased after 2010. This could be associated to the fact that trade liberalization has exposed them to international competition leading to the disappearance of their producers and an increase in domestic taxes doesn't offset the lost due to the production decline. As a large share of population in developing countries lives in the rural areas and depends on agriculture, a decline in agricultural exports reduces their income and raises unemployment and accordingly poverty increases. As most of countries that benefit from an increase in trade taxes are those that lost from a shift from trade taxes towards domestic taxes under revenue neutrality, it seems that their firms especially in agricultural sector are less competitive and the protection should be profitable to them in order to maximize domestic welfare over time.

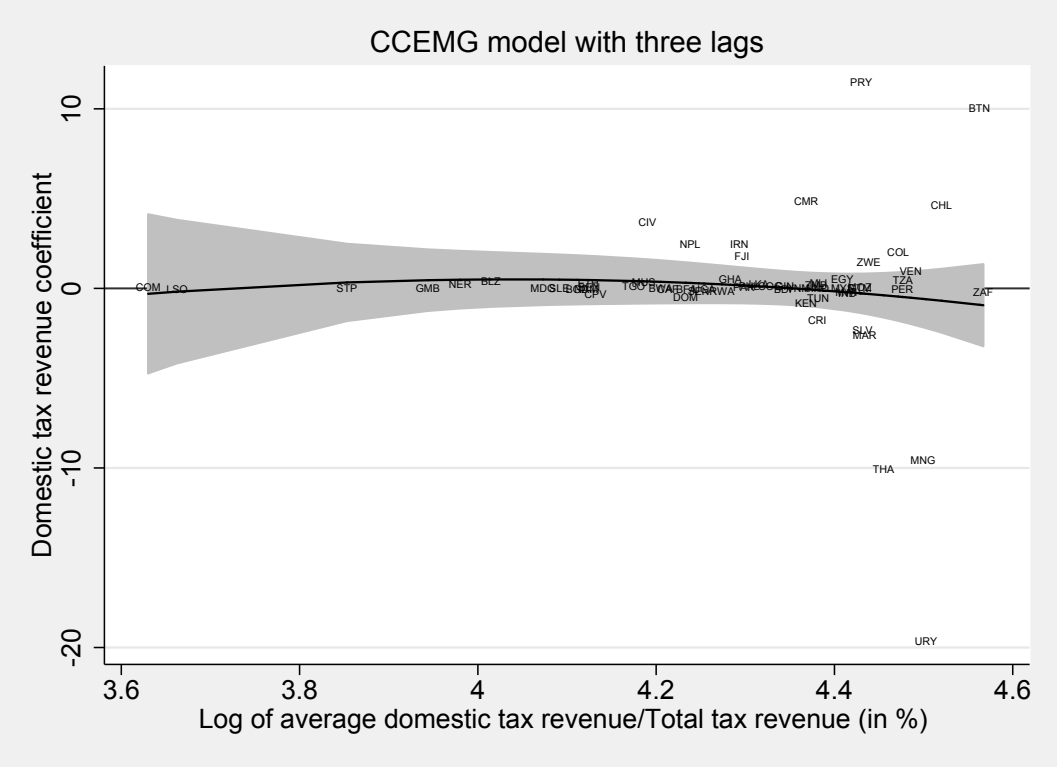
My results are in the line with Fujiwara (2013), Keen and Ligthart (2002), Hatzipanayotou et al. (1994) and Michael et al. (1993) who show that a reduction in trade taxes with a revenue-neutral increases in indirect taxes (VAT) increases welfare. However, there is also a dispersion of total tax revenues effects on poverty across countries.

Table 3.3 – Effects of domestic taxes on poverty under revenue neutrality

	(1)	(2)	(3)	(4)	(5)
	MG	CCEMG	CCEMG with lags		
CA Additional lags			1^{st} lag	2^{nd} lag	3^{rd} lag
Dependent variable: poverty headcount ratio (in log)					
L.Headcount	0.589***	0.429***	0.308***	0.321***	0.338***
	(0.034)	(0.042)	(0.054)	(0.073)	(0.121)
Domestic tax	0.036	0.071*	0.261	0.439	0.762
(% of total tax)	(0.045)	(0.036)	(0.276)	(0.304)	(0.904)
Total tax	-0.037	-0.057	-0.362**	-0.412**	-0.496***
(% of GDP)	(0.036)	(0.036)	(0.149)	(0.197)	(0.163)
Capital pc	0.142	-0.037	1.003	-0.067	-1.806**
	(0.134)	(0.155)	(0.613)	(0.948)	(0.754)
Land pc	0.038	0.165	0.119	-0.309	1.029
	(0.137)	(0.146)	(0.433)	(0.845)	(0.985)
GDP pc	-0.461***	-0.614***	-0.644**	-1.742*	-0.826
	(0.095)	(0.118)	(0.325)	(0.964)	(0.740)
Non tax revenue	0.002	0.012	-0.002	-0.074	-0.062
	(0.008)	(0.014)	(0.044)	(0.094)	(0.073)
Constant	-1.406*	1.375	-1.727	-0.642	-7.209
	(0.760)	(2.003)	(4.448)	(2.223)	(7.889)
RMSE	0.096	0.067	0.091	0.092	0.094
CD test	9.438	2.07	4.59	0.30	1.06
CD p-value	0.000	0.038	0.000	0.761	0.290
Number of Countries	82	82	65	63	62
Observations	2,377	2,377	1,979	1,860	1,765

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses are constructed nonparametrically following Pesaran and Smith (1995).
All the regressors are in the log. Country-specific linear trend is included in each model.
CD test reports the Pesaran (2015) test for weak cross-sectional dependence, which under the null hypothesis of weak cross-sectional dependence of the error term, the CD-statistic is distributed $\sim N(0,1)$. RMSE is the root mean squared error.

Figure 3.2 – Domestic tax revenue coefficients heterogeneity



Notes: I plot the country specific coefficients for domestic tax revenue from Chudik and Pesaran (2015) CCEMG model with three additional lags (column (3) in Table 3.3). The figure shows that the poverty effects of domestic tax revenue vary widely across countries. 25 countries have negative coefficients while 33 countries have positive coefficients. The coefficients for four countries are equal to zero. Jordan has been excluded from the graph sample to ensure homogeneity.

3.6.3. Robustness checks

Due to the relevance of China in the world economy particularly in the world trade, it is possible that China drives my results and accordingly, one can cast doubt on my results. Moreover, in my sample, Lesotho has the highest share of trade tax over GDP and can potentially also drive my results as an outlier. Hence, I test the robustness of my results by excluding both China and Lesotho from the sample. The results reported in the Tables C.2 and C.3 in Appendix C.5 reveal that my results are not affected by China and Lesotho and accordingly are consistent.

3.6.4. The role of public spending

I interest in the role of public spending in the relationship between a shift from trade taxes towards domestic taxes under revenue neutrality. Public goods such as public education and public health play an important role in poverty reduction in developing countries. In most developing countries, there are regional significant imbalances in education and health. For instance, rich people can afford private education and health while poor people rely more on public education and health. Poor people have worse health status on average than others, and public health spending tend to matter more to the poor (Bidani and Ravallion, 1997). Heltberg et al. (2001) find in Mozambique that public expenditures on health and education are likely to have significant poverty reducing effects.

Most empirical works highlight the negative association between domestic taxation (income tax, VAT, etc) and human capital (Lin, 1998; Trostel, 1993; Lucas, 1990). Then a shift from taxes on international trade towards domestic taxes may affect adversely poor people's human capital accumulation and hence their income if there is no safety net to help them profit from public education or public health. Tax revenues may reduce poverty if they are redistributed to benefit people with low earnings. Government, in order to achieve poverty reduction or to reduce income inequality, might combine taxes and public spending to provide easy access of public goods to poor people. Thus, government redistributes tax revenues from people who are better off to those who are worse off. Hence, I investigate the role of public goods provision proxied by public spending in the relationship between the shift from trade taxes towards domestic taxes under revenue neutrality.

I consider two kinds of public spending. First, public education expenditures consists of pointing out that government uses total tax revenue to finance public education. Doing so, government favours poor people to have access to formal education and consequently to accumulate human capital. There is an evidence that countries with higher education expenditures have greater economic performance. The endogenous growth theory provides a link between public education expenditures and long term economic growth. This theory concludes that public education expenditures promote human capital accumulation and therefore fosters economic growth. Consequently, the growth and human capital accumulation may reduce poverty.

Second, I use public health expenditures as an alternative proxy for public spending to assess the robustness of my result using public education expenditures.

For the empirical estimation considering the role of public spending, I am constrained by the data availability. I use data on public education and health expenditures from the IMF. These data are available for the 1985-2009 period for a sample of 90 countries. Due to the short temporal dimension of my data (25 years), I am unable to use Chudik and Pesaran (2015) estimator that requires a longer temporal dimension. Accordingly, I carry out my

estimation using first, two-way fixed effects estimator (2FE), second the Blundell and Bond (1998) system-GMM estimator and finally Pesaran and Smith (1995) Mean group estimator and Pesaran (2006) CCE Mean Group estimator.

The role of public education and health expenditures is assessed by interacting the government public education and health expenditures with trade tax revenue. The results for all the estimators reported in the Tables 3.4 and 3.5 indicate that the mean of coefficient is not significant for both public education and health expenditures interaction terms with total tax revenues. The results hold when controlling for the government total expenditures and the population growth. My results are consistent with the non-significant effect of public social spending (public education and public health spending) found by Castro-Leal et al. (1999). Examining the effect of public education and health spending on poverty in a group of Africa countries, Castro-Leal et al. (1999) show that these programs favour not the poor, but those who are better-off.

The absence of the significant effects suggests that the effects may depend on country characteristics, complementary policies such as labour market or employment policies, the pattern of education output, the structure of labour demand. For instance, a country may invest heavily in public education but if the unemployment rate is high and individuals may not find a job after their graduation, the poverty level may not be affected. In contrast, a country with low unemployment rate, by investing more in education can absorb the new graduates and accordingly may reduce poverty. Furthermore, a country may benefit more from the public education expenditures if the type of education financed suits well with the patterns of the demand in the labour market. For instance, Jung and Thorbecke (2003) show that in Tanzania, to maximize the benefits from education expenditure, complementary factors are needed such as high level of physical investment, measures that improve the match between the pattern of educational output and the structure of effective demand for labour.

My result may suggest that, to clearly identify the role of the public spending in the process of trade liberalization, I should consider the role of the labour market and country socio-economic characteristics that can play a key role in the poverty-tax reforms nexus.

Table 3.4 – The role of the public education expenditure in trade tax reforms - poverty nexus

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	2FE		GMM		MG		CCEMG	
	Dependent variable: poverty headcount ratio (in log)							
L.Headcount (log)	0.860***	0.860***	1.027***	0.928***	0.377***	0.203***	0.323***	0.154
	(0.0466)	(0.0465)	(0.0888)	(0.124)	(0.048)	(0.057)	(0.086)	(0.117)
Tax revenue (log)	-0.0952**	-0.122**	0.146	-0.0396	-0.697	-0.155	-0.228	-0.043
	(0.0438)	(0.0506)	(0.204)	(0.187)	(0.705)	(0.774)	(0.416)	(0.170)
Domestic tax(log)	0.0205	0.0234	-0.0428	-0.0192	-0.002	-0.143*	0.140*	0.059
(% of total tax)	(0.0318)	(0.0307)	(0.0503)	(0.0752)	(0.064)	(0.078)	(0.080)	(0.130)
Education (log)	-0.0311	-0.0236	0.171	-0.0532	-0.561	-0.060	-0.124	0.046
(% of total expenditure)	(0.0469)	(0.0511)	(0.187)	(0.167)	(0.692)	(0.793)	(0.311)	(0.192)
Education*Tax revenue	0.0245	0.0286	-0.0564	0.0142	0.231	0.072	0.025	-0.011
	(0.0216)	(0.0217)	(0.0655)	(0.0572)	(0.253)	(0.283)	(0.132)	(0.079)
Land pc (log)	0.0857	0.0871	-0.169	-0.243	-0.219	-0.612**	0.120	-0.363**
	(0.102)	(0.102)	(0.198)	(0.505)	(0.224)	(0.277)	(0.205)	(0.153)
Capital pc (log)	0.0616	0.0592	-0.314	-0.0749	0.127	0.108	-0.104	-0.059
	(0.0413)	(0.0418)	(0.438)	(0.297)	(0.233)	(0.274)	(0.206)	(0.075)
GDP pc (log)	-0.240***	-0.234***	0.100	-0.245	-0.607***	-0.724***	-0.397***	0.205
	(0.0725)	(0.0727)	(0.378)	(0.267)	(0.124)	(0.189)	(0.152)	(0.299)
Government expenditure		0.00184		7.90e-05		-0.003		0.010**
(% of GDP)		(0.00157)		(0.00231)		(0.002)		(0.005)
Population growth		0.00685		-0.0133		-0.090		-0.071
		(0.00896)		(0.0340)		(0.062)		(0.064)
Constant	-0.776**	-0.803**	-0.235	-1.119	2.871	1.135	0.625	-0.826
	(0.319)	(0.327)	(1.676)	(1.612)	(2.869)	(2.947)	(2.727)	(3.875)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RMSE					0.0693	0.0546	0.0252	0.00458
CD test					5.55	2.83	3.47	-1.617
CD p-value					0.000	0.005	0.001	0.106
Number of countries	83	83	83	83	70	68	70	68
Observations	1,462	1,462	1,462	1,462	1,371	1,348	1,371	1,348

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
CD test reports the Pesaran (2015) test for weak cross-sectional dependence, which under the null hypothesis of weak cross-sectional dependence of the error term, the CD-statistic is distributed $\sim N(0,1)$. RMSE is the root mean squared error.

Table 3.5 – The role of the public health spending in trade tax reforms - poverty nexus

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	2FE		GMM		MG		CCEMG
	Dependent variable: poverty headcount ratio (in log)						
L.Headcount (log)	0.901***	0.900***	1.024***	1.043***	0.381***	0.359***	0.197**
	(0.0236)	(0.0235)	(0.0868)	(0.0823)	(0.054)	(0.070)	(0.082)
Tax revenue (log)	-0.0200	-0.0220	0.0508	0.0479	-0.221	0.218	0.038
	(0.0157)	(0.0155)	(0.0602)	(0.0749)	(0.245)	(0.406)	(0.107)
Domestic tax (log)	0.0307	0.0317	-0.0377	-0.0230	0.005	0.077	-0.041
(% of total tax)	(0.0259)	(0.0261)	(0.0581)	(0.0568)	(0.083)	(0.081)	(0.094)
Health	0.0322	0.0364	-0.0182	0.0409	-0.210	0.302	0.065
	(0.0254)	(0.0259)	(0.0481)	(0.0698)	(0.358)	(0.604)	(0.055)
Health*Tax revenue	-0.00406	-0.00466	-0.00233	-0.0195	0.041	-0.104	-0.020
	(0.0124)	(0.0123)	(0.0263)	(0.0309)	(0.150)	(0.226)	(0.046)
Land pc (log)	-0.0235	-0.0160	-0.000913	0.0181	-0.129	-0.193	0.071
	(0.0563)	(0.0555)	(0.0390)	(0.0783)	(0.241)	(0.320)	(0.109)
Capital pc (log)	0.0516	0.0548	0.0311	0.000189	0.246	0.263	-0.078
	(0.0350)	(0.0353)	(0.154)	(0.143)	(0.306)	(0.327)	(0.055)
GDP pc (log)	-0.188***	-0.194***	0.00388	-0.00375	-0.654***	-0.755***	-0.359***
	(0.0534)	(0.0551)	(0.0597)	(0.115)	(0.159)	(0.268)	(0.129)
Government expenditure		0.000699		0.000820		-0.003*	
		(0.000711)		(0.00181)		(0.002)	
Population growth		-0.00212		0.00230		-0.066	
		(0.00505)		(0.0298)		(0.097)	
Constant	-0.844***	-0.885***	-0.0103	-0.254	-0.554	0.186	-0.585
	(0.268)	(0.277)	(0.384)	(0.826)	(2.048)	(2.718)	(2.202)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RMSE					0.0564	0.0471	0.0173
CD test					5.31	4.44	-0.88
CD p-value					0.000	0.000	0.378
Number of countries	85	85	85	85	81	68	81
Observations	1,443	1,441	1,443	1,441	1,417	1,266	1,417

Notes: Robust Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.
CD test reports the Pesaran (2015) test for weak cross-sectional dependence, which under the null hypothesis of weak cross-sectional dependence of the error term, the CD-statistic is distributed $\sim N(0,1)$. RMSE is the root mean squared error.
Due to missing values in public health spending data, I am unable to implement the Chudik and Pesaran (2015) estimator.

3.7. Conclusion

The replacement of taxes on international trade by domestic taxes after trade liberalization policies adopted by developing countries in the 1980s to finance anti-poverty policies necessary to achieve the millennium development goals (MDGs) has been a concern for developing countries these last decades. Trade liberalization is one of these strategies through which poverty could be reduced. Developing countries rely heavily on taxes on international trade that they use for social spending or for public goods financing. Then, switching from taxes on international trade to local taxes may have poverty and inequality implications because this change affects social spending or public goods provision. In this paper, I investigate the effects of taxes on international trade revenues diminution on poverty in developing countries and the role that public goods can play in this relationship. I adopt empirical specifications which allow for heterogeneity across countries.

I first find evidence that taxes on international trade are negatively associated to the poverty implying that an increase in taxes on international trade reduces poverty on average in developing countries. However, the effect is heterogeneous across countries indicating that poverty decreases in a group of countries while poverty increases in other group countries. Categorizing the two groups of countries (countries in which poverty decreases relatively to those in which poverty increases), I find that countries that benefit from the taxes on international trade are on average over time net exporters of agricultural products while those that lose out have shifted from net exporters of agricultural products to net importers on average over time. Second, I show that a shift from taxes on international trade to domestic taxes under revenue-neutrality increases on average poverty. The effects also vary largely across countries and some countries benefit while others lose. The group of countries that benefit in terms of poverty reduction are countries that have consolidated their comparative advantage in agriculture as agricultural trade balances increase on average over time. In contrast, countries that lose, have moved from net exporters to net importers of agricultural products on average over time. My results also suggest that shift from taxes on international trade towards domestic taxes reduces on average significantly poverty through the total tax revenue but the effects is as well heterogeneous across countries. Finally, I show that the public education and health expenditures don't play a significant role in the relationship between trade tax reforms and poverty under revenue-neutrality.

My results suggest that, for developing countries to benefit from tariff liberalization, they have to implement policies that promote agricultural sector as well as agricultural exports-led policies. In fact, agricultural employment and agricultural share in GDP is higher in developing countries. Besides, as it is clearly identified that the poor pay more tax relatively to their income, my results suggest that developing countries might implement revenue redistribution policies that favour poor people, i.e., allow them to benefit more from redistributive policies.

Further researches in this area would consider the role of income redistribution channels in the relationship between a shift from taxes on international trade towards domestic taxes on poverty to clearly identify the relationship. Moreover, the role of labour market characteristics and the composition of the government public education expenditures should be explored to clearly investigate the role of public goods provision in the relationship between trade tax reforms and poverty in developing countries.

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Conclusion

This thesis scrutinizes critically and rigorously the effects of trade policies on poverty in developing countries. We first examine the effects of GATT/WTO membership on poverty. We find evidence that GATT/WTO membership increases poverty. Moreover, more interestingly, we find that GATT/WTO membership increases poverty in countries that are net importers of agricultural products while its decreases poverty in countries that are net exporters. Second, we investigate the heterogeneity according to countries' poverty level in the effects of GATT/WTO accession on poverty. Our results reveal that GATT/WTO membership increases significantly poverty across the entire conditional poverty distribution. The poorest countries lose more from trade liberalization than less poor countries. Finally, we investigate the effects of trade tax reforms, i.e. a shift from trade taxes towards domestic taxes on poverty. We highlight that taxes on international trade reduce poverty. Nevertheless, the effect is heterogeneous across countries and we show that poverty decreases in countries that are net exporters of agricultural products while poverty increases in countries that are net importers of agricultural products. Besides, we show that a shift from taxes on international trade towards domestic taxes under revenue-neutrality increases on average poverty but this effect varies largely across countries when considering the countries individually. Some countries benefit while others lose out. The group of countries that benefit in terms of poverty reduction are countries that have consolidated their comparative advantage in agriculture as their agricultural trade balances have increased over time. Countries that lose out have moved from net exporters to net importers of agricultural products. Finally, we show that public goods (public education and public health spending) don't play a significant role in the relationship between trade tax reforms and poverty.

The results of this thesis show that trade liberalization is not beneficial to all developing countries as suggested by international organization such as the World Bank and the International Monetary Fund. The effects of trade liberalization on poverty in developing countries depend on countries characteristics. The main contribution of this thesis is that trade liberalization effects on poverty in developing countries depend on how countries' agricultural sector is affected by the liberalization. As the population in developing countries relies heavily on agriculture, developing countries benefit from trade liberalization if the later boosts

their agricultural sector by increasing their exports of agricultural products. In contrast, if trade liberalization hinders their agricultural sector, they lose out; this occurs because many developed countries subsidize their agriculture that push down the international price and consequently affect negatively developing countries' agricultural sector. The findings of this thesis contrast with the World Bank and the IMF points of view suggesting that trade liberalization is always good for developing countries and encouraged them to liberalize their trade. As policy recommendations, this thesis suggests that, in order to benefit from trade liberalization in terms of poverty reduction, developing countries have to implement policies that promote their agricultural sector especially export-oriented agricultural policies.

As it is clearly identified that the poor pay more tax relatively to their income and the trade liberalization implies an increase in domestic taxes to replace the reduction in trade taxes, developing countries might implement revenue redistribution policies that favour poor people, i.e., allow them to benefit more from redistribution policies. Further researches in these areas should consider the role of income redistribution channels in the relationship between a shift from taxes on international trade towards domestic taxes on poverty to clearly identify the relationship. Moreover, the role of labour market characteristics, the composition of the government public education expenditures should be explored to clearly investigate the role of public goods provision in the relationship between trade tax reforms and poverty in developing countries.

Appendix A

Appendix chapter 1

A.1. List of countries

Table A.1 – List of GATT/WTO member countries

Countries	**GATT/WTO date**	**Countries**	**GATT/WTO date**
Angola	1994/1996	Malawi	1964/1995
Argentina	1967/1995	Malaysia	1957/1995
Bangladesh	1972/1995	Maldives	1983/1995
Belize	1983/1995	Mali	1993/1995
Benin	1963/1996	Mauritania	1963/1995
Bolivia	1990/1995	Mauritius	1970/1995
Botswana	1987/1995	Mexico	1986/1995
Brazil	1948/1995	Morocco	1987/1995
Burkina faso	1963/1995	Mozambique	1992/1995
Burundi	1965/1995	Namibia	1992/1995
Cameroon	1963/1995	Nicaragua	1950/1995
Central African Rep.	1963/1995	Niger	1963/1996
Chad	1963/1996	Nigeria	1960/1995
Chile	1949/1995	Pakistan	1948/1995
Colombia	1981/1995	Papua New Guinea	1994/1996
Congo	1963/1997	Paraguay	1994/1995
Costa Rica	1990/1995	Peru	1951/1995
Czech Republic	1993/1995	Philippines	1979/1995
Djibouti	1994/1995	Poland	1967/1995
Dominican Republic	1950/1995	Romania	1971/1995
Egypt	1970/1995	Rwanda	1966/1996
El Salvador	1991/1995	Senegal	1963/1995
Fiji	1993/1996	Sierra Leone	1961/1995
Gabon	1963/1995	Slovak Republic	1993/1995
Gambia	1965/1995	Slovenia	1994/1995
Ghana	1957/1995	South Africa	1948/1995
Guatemala	1991/1995	Sri Lanka	1948/1995
Guinea	1994/1995	St. Lucia	1993/1995
Guinea-Bissau	1994/1995	Surinam	1978/1995
Guyana	1966/1995	Swaziland	1993/1995
Haiti	1950/1996	Tanzania	1961/1995
Honduras	1994/1995	Thailand	1982/1995
Hungary	1973/1995	Togo	1964/1995
India	1948/1995	Trinidad and Tobago	1962/1995
Indonesia	1967/1995	Tunisia	1990/1995
Ivory Coast	1963/1995	Turkey	1951/1995
Jamaica	1963/1995	Uganda	1962/1995
Kenya	1964/1995	Uruguay	1953/1995
Lesotho	1988/1995	Venezuela	1990/1995
Madagascar	1963/1995	Zambia	1982/1995

Table A.2 – List of GATT/WTO non member countries (joined WTO later than 1995 or not)

Countries	**WTO date**	**Countries**	**WTO date**
Albania	2000	Seychelles	2015
Algeria	Observer	Sudan	Observer
Armenia	2003	Syria	Observer
Azerbaijan	Observer	Tajikistan	2013
Belarus	Observer	Timor-Leste	
Bulgaria	1996	Turkmenistan	
Buthan	Observer	Ukraine	2008
Bosnia and Herzegovina	Observer	Vietnam	2007
Cabo Verde	2008	Yemen	2014
Cambodia	2004		
China	2001		
Comoros	Observer		
Congo Dem. Rep.	1997		
Croatia	2000		
Ecuador	1996		
Estonia	1999		
Ethiopia	Observer		
Georgia	2000		
Iran	Observer		
Iraq	Observer		
Jordan	2000		
Kazakhstan	2015		
Kyrgyz Republic	1998		
Lao	2013		
Latvia	1999		
Liberia	2016		
Lithuania	2001		
Macedonia	2003		
Micronesia			
Moldova	2001		
Montenegro	2012		
Nepal	2004		
Panama	1997		
Russia	2012		
Sao Tome and Principe	Observer		
Serbia	Observer		

Table A.3 – List of exporting countries

Countries	**Export status**	**Import status**
Albania	11 (1980-1989, 2012)	22 (1990-2011)
Algeria	1 (2012)	32 (1980-2011)
Angola	1 (2012)	32 (1980-2011)
Argentina	33 (1980-2012)	
Armenia	13 (1980-1991, 2012)	20 (1992-2011)
Azerbaijan	13 (1980-1991, 2012)	20 (1992-2011)
Bangladesh	1 (2012)	32 (1980-2011)
Belarus	16 (1980-1991, 2009-2012)	17 (1992-2008)
Belize	33 (1980-2012)	
Benin	14 (1989, 1995-2001, 2003-2005, 2009-2010, 2012)	19 (1980-1988, 1990-1994, 2002, 2006-2008, 2011)
Buthan	5 (1984-1986, 1988, 2012)	27 (1980-1983, 1987, 1989-2011)
Bolivia	23 (1989-1991, 1993-2012)	10 (1980-1988, 1992)
Bosnia and Herzegovina	13 (1980-1991, 2012)	20 (1992-2011)
Botswana	1 (2012)	32 (1980-2011)
Brazil	33 (1980-2012)	
Bulgaria	32 (1980-2006, 2008-2012)	1 (2007)
Burkina faso	14 (1980, 1990, 1998, 2001-2007, 2009-2012)	19 (1981-1989, 1991-1997, 1999-2000, 2008)
Burundi	27 (1980-2001, 2005, 2008, 2010-2012)	6 (2002-2004, 2006-2007, 2009)
Cabo Verde	1 (2012)	32 (1980-2011)
Cambodia	7 (1986-1991, 2012)	1980-1985, 1992-2011
Cameroon	32 (1980-2007, 2009-2012)	1 (2008)
Central African Rep.	16 (1980-1991, 1993, 1999, 2002, 2012)	17 (1992, 1994-1998, 2000-2001, 2003-2011)
Chad	29 (1980-2007, 2012)	4 (2008-2011)
Chile	28 (19985-2012)	5 (19980-1984)
China	2 (1986, 2012)	31 (1980-1985, 1987-2012)
Colombia	33 (1980-2012)	
Comoros	6 (1982-1983, 1985, 1986, 1988, 2012)	27 (1980, 1981, 1984, 1987, 1989-2011)
Congo Dem. Rep.	6 (1980, 1982-1984, 1986, 2012)	27 (1981, 1985, 1987-2011)
Congo Rep.	1 (2012)	32 (1980-2011)
Costa Rica	33 (1980-2012)	
Ivory Coast	33 (1980-2012)	

Table A3 Continued: List of exporting countries

Countries	**Export status**	**Import status**
Croatia	13 (1980-1991, 2012)	20 (1992-2011)
Czech Republic	15 (1980-1993, 2012)	18 (1994-2011)
Djibouti	1 (2012)	32 (1980-2011)
Dominican Republic	17 (1980-1991, 1997-1999, 2001, 2012)	16 (1992-1996, 2000, 2002-2011)
Ecuador	33 (1980-2012)	
Egypt	1 (2012)	32 (1980-2011)
El Salvador	18 (1980-1995, 1997, 2012)	(1996, 1998-2011)
Estonia	14 (1980-1992, 2012)	19 (1992-2011)
Ethiopia	30 (1980-1993, 1995-2000, 2002, 2004-2012)	3 (1994, 2001, 2003)
Fiji	30 (1980-2008, 2012)	3 (2009-2011)
Gabon	1 (2012)	32 (1980-2011)
Gambia	1 (2012)	32 (1980-2011)
Georgia	13 (1980-1991, 2012)	(1992-2011)
Ghana	32 (1980-2000, 2002-2012)	1 (2001)
Guatemala	33 (1980-2012)	
Guinea	1 (2012)	32 (1980-2011)
Guinea-Bissau	12 (1984, 1997-2002, 2004, 2005, 2008, 2011, 2012)	21 (1983-1996, 2003, 2006, 2007, 2009, 2010)
Guyana	33 (1980-2012)	
Haiti	1 (2012)	32 (1980-2011)
Honduras	33 (1980-2012)	
Hungary	33 (1980-2012)	
India	33 (1980-2012)	
Indonesia	33 (1980-2012)	
Iran	1 (2012)	32 (1980-2011)
Iraq	1 (2012)	32 (1980-2011)
Jamaica	2 (1991, 2012)	31 (1980-1990, 1992-2011)
Jordan	1 (2012)	32 (1980-2011)
Kazakhstan	25 (1980-1991, 1993, 1995-2004, 2008, 2012)	8 (1992, 1994, 2005-2007, 2009-2011)
Kenya	33 (1980-2012)	
Kyrgyz Republic	24 (1980-1991, 1994-2004, 2012)	9 (1992, 1993, 2005-2011)
Lao	10 (1985-1993, 2012)	23 (1980-1984, 1994-2011)

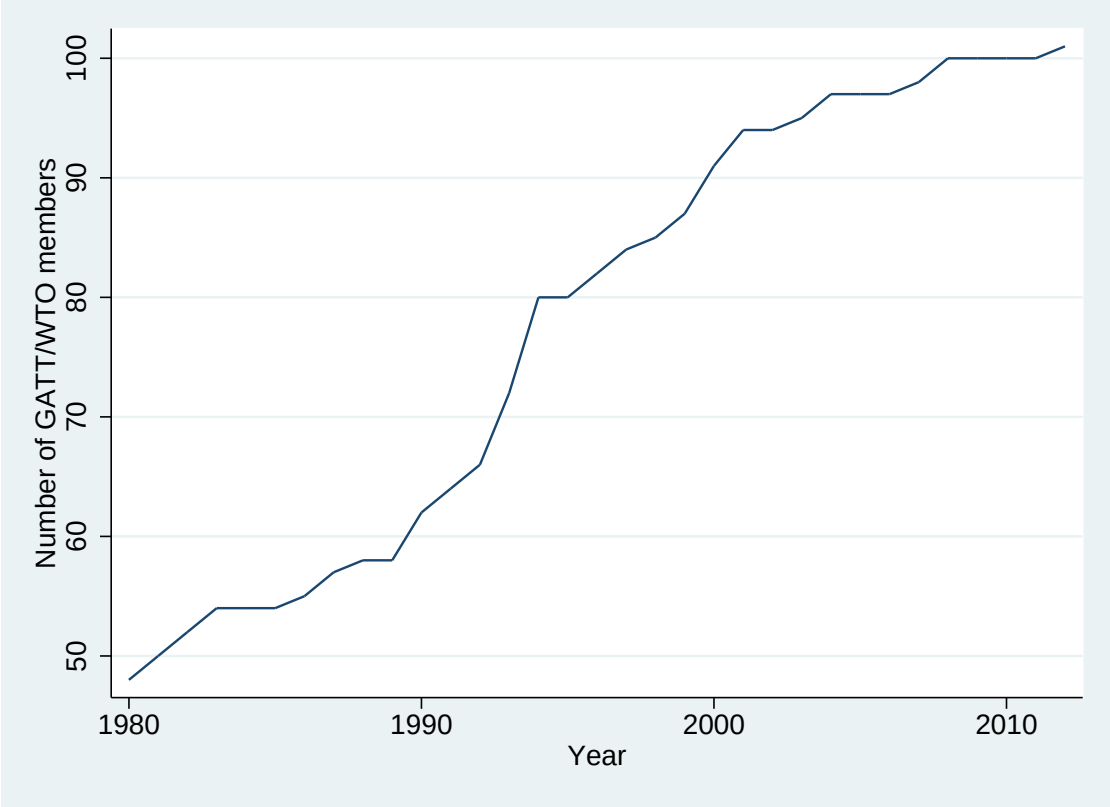
Table A3 Continued: List of exporting countries

Countries	**Export status**	**Import status**
Latvia	15 (1980-1993, 2012)	18 (1993-2011)
Lesotho	1 (2012)	32 (1980-2011)
Liberia	13 (1980,1981, 1982-1989, 2001, 2002, 2011, 2012)	20 (1983, 1990-2000, 2003-2010)
Lithuania	24 (1980-1995, 2005-2012)	9 (1996-2011)
Macedonia	14 (1980-1992, 2012)	19 (1993-2011)
Madagascar	26 (1980-2004, 2012)	7 (2005, 2011)
Malawi	33 (1980-2012)	
Malaysia	33 (1980-2012)	
Maldives	1 (2012)	32 (1980-2011)
Mali	28 (1980-2006, 2012)	5 (2007-2011)
Mauritania	1 (2012)	32 (1980-2011)
Mauritius	24 (1980-1999, 2001-2003, 2012)	9 (2000, 2003-2011)
Mexico	4 (1986, 1987, 1995, 2012)	29 (1980-1985, 1988-1994, 1996-2012)
Micronesia	1 (2012)	32 (1980-2011)
Moldova	33 (1980-2012)	
Montenegro	27 (1980-2004, 2012)	6 (2005-2012)
Morocco	1 (2012)	32 (1980-2011)
Mozambique	4 (1980-1982, 2012)	29 (1983-2011)
Namibia	21 (1980-1996, 1998, 2003, 2004, 2012)	12 (1997, 1999-2002, 2005-2012)
Nepal	5 (1980-1982, 1985, 2012)	28 (1983, 1984, 1986-2011)
Nicaragua	31 (1980-1991, 1993-1998, 2000-2012)	2 (1992, 1999)
Niger	3 (1980, 1984, 2012)	30 (1981-1983, 1985-2011)
Nigeria	1 (2012)	32 (1980-2011)
Pakistan	8 (1980-1983, 1987-1989, 2012)	25 (1984-1986, 1990-2011)
Panama	18 (1980-1995, 1997, 2012)	15 (1996, 1998-2011)
Papua New Guinea	32 (1980-1990, 1992-2012)	1 (1991)
Paraguay	33 (1980-2012)	
Peru	5 (2006, 2009-2012)	28 (1980-2005, 2007, 2008)
Philippines	13 (1980-1989, 1991, 1992, 2012)	
Poland	12 (1990, 1991, 2003-2012)	21 (1980-1989, 1992-2002)

Table A3 Continued: List of exporting countries

Countries	**Export status**	**Import status**
Romania	6 (1982, 1983, 1985, 1987, 1988, 2012)	27 (1980, 1981, 1984, 1986, 1989-2011)
Russia	13 (1980-1991, 2012)	20 (1992-2011)
Rwanda	15 (1980-1992, 2008, 2012)	
Sao Tome and Principe	10 (1980-1988, 2012)	23 (1989-2011)
Senegal	1 (2012)	32 (1980-2011)
Serbia	33 (1980-2012)	
Seychelles	1 (2012)	32 (1980-2011)
Sierra Leone	1 (2012)	32 (1980-2011)
Slovak Republic	14 (1980-1992, 2012)	19 (1993-2011)
Slovenia	13 (1980-1991, 2012)	19 (1992-2011)
South Africa	31 (1980-1983, 1984-2006, 2008-2012)	2 (1984, 2007)
Sri Lanka	29 (1980-1992, 1995-2005, 2008-2012)	4 (1993, 1994, 2006, 2007)
St. Lucia	11 (1983-1992, 2012)	22 (1980-1982, 1993-2011)
Sudan	33 (1980-2012)	
Surinam	7 (1980, 1984-1988, 2012)	26 (1981-1983, 1989-2011)
Swaziland	29 (1980-2003, 2006, 2008, 2010-2012)	4 (2004, 2005, 2007, 2009)
Syria	8 (1997, 1998, 2001, 2002, 2006-2008, 2012)	25 (1980-1996, 1999, 2000, 2003-2005, 2009-2012)
Tajikistan	20 (1980-1991, 1995-1998, 2002-2004, 2012)	2005-2011)
Tanzania	29 (1980-1997, 1999-2005, 2008-2010, 2012)	13 (1992-1994, 1999-2001, 4 (1998, 2006, 2007, 2011)
Thailand	33 (1980-2012)	
Timor-Leste	1 (2012)	32 (1980-2011)
Togo	24 (1985-1987, 1990-2001, 2003-2005, 2007-2012)	9 (1980-1984, 1988, 1989, 2002, 2006)
Trinidad and Tobago	1 (2012)	32 (1980-2011)
Tunisia	" (1991, 2006, 2012)	30 (1980-1990, 1992-2005, 2007-2011)
Turkey	32 (1980-2006, 2008-2012)	1 (2007)
Turkmenistan	29 (1980-2007, 2012)	4 (2008-2011)
Uganda	32 (1980-2002, 2004-2012)	1 (2003)
Ukraine	31 (1980-1991, 1994-2012)	2 (1992, 1993)
Uruguay	33 (1980-2012)	
Venezuela	1 (2012)	32 (1980-2011)
Vietnam	30 (1983-2012)	3 (1980-1982)
Yemen	1 (2012)	32 (1980-2011)
Zambia	12 (1999-2001, 2004-2012)	21 (1980-1998, 2002, 2003)

Figure A.1 – Evolution of the number of GATT/WTO members over the 1980-2012 period



A.2. List of variables

Table A.4 – Definitions and sources

Variables	Description	Data Source
HEADCOUNT	It measures the share of population which income is less than $1.25 a day	Povcalnet, World Bank
POVGAP	It measures the relative average gap between the poverty line and the average expenditure of the poor households in the whole population	World Bank
DISASTER	It is a binary indicator measuring the occurrence of large disaster. It is obtained from the number of people killed by a natural disaster. We use 75th percentile of the world distribution of the number of people killed as cut-off value to define large disaster. It takes value one if the number of people killed is higher than 75th percentile and zero if not (Cavallo et al., 2013)	EM-DAT database
GATT/WTO	It takes a value 1 if the country is GATT/WTO member by the end of 1994 and 0 if not	WTO website
RTA	It takes value from 0 to 5 and measures the number of regional trade agreements in which country participates. This variable takes value 0 if the country does not participate to any regional free trade agreements	WTO website
NET EXPORTER	It is a binary variable which measures the agricultural trade status of the country. It takes value one if the country is net agricultural products exporter in the year t and zero if the country is net importer of agricultural products trade in the year t. It is calculated by making difference between value of agricultural products exports and imports. The value is one if the difference is positive and zero if it is negative.	Food and Agriculture Organization of the United Nations (FAO) Statistics

Table A4 Continued: Definitions and sources

Variables	Description	Data Source
TRADEBALANCE	It measures the trade balance of country i in period t. It is calculated as the difference between the value of exports and imports of goods and services.	World Development Indicators (WDI), World Bank
TERMSTRADE	It measures terms of trade of agricultural products. It is calculated as the ratio of exports and imports of agricultural products.	FAO Statistics
GDP PER CAPITA	This variable measures the Gross Domestic Product per capita	WDI
INVESTMENT	It measures the logarithm of the gross fixed capital formation as a percentage of GDP.	WDI
POPGROWTH	It measures the annual growth rate of the population.	WDI
INFLATION	It is the annual consumer price index.	WDI
CREDITPRIV	It measures the domestic credit (financial resources) as a percentage of GDP provided to private sector by financial intermediaries.	WDI
SCHOOL	It measures the gross enrollment ratio in secondary school.	WDI
DEMOCRACY	It is a measure of institutional quality. This variable measures a degree of democracy. It ranges from zero to ten, where higher value indicates a higher degree of democracy.	Polity IV

Table A4 Continued: Definitions and sources

Variables	Description	Data Source
DECENTRALIZATION	It measures the executive system and takes three values: zero (0) if the system is presidential, one (1) if assembly-elected president and three (2) if parliamentary. We use this variable as an ordinary variable rather than dummy variable to avoid monotonous effect.	World Bank Database on political Institutions (DPI)
DURABLE	It measures the regime durability especially the number of years since the most recent change of regime.	Polity IV
GOV1RLC	It measures the largest government orientation: Right, Center and Left wings.	DPI database, World Bank
CHECKS	It measures the number of veto players.	DPI database, World Bank
FRAC	This is a measure of country fractionalization index.	DPI database, World Bank
YRSOFF	It measures the years the Chief executive has been in office.	DPI database, World Bank

A.3. The propensity score and covariates balancing test

A.3.1. The propensity score

Table A.5 – Probit estimation results (dependent variable = GATT/WTO membership)

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: GATT/WTO membership (Yes=1)				
gdppercapita	0.065**	0.062**	0.003	-0.020	-0.006
	(0.031)	(0.031)	(0.032)	(0.033)	(0.033)
popgrowth	0.105***	0.106***	0.115***	0.113***	0.125***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.023)
tradebalance	0.008***	0.008***	0.007***	0.007***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
investment	0.012	0.011	0.018*	0.026***	0.027***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)
rta	0.094	0.089	0.016	-0.020	-0.009
	(0.070)	(0.071)	(0.073)	(0.074)	(0.075)
democ	0.003*	0.003*	0.002	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
durable	-0.008***	-0.008***	-0.008***	-0.007***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
decentralization	0.002***	0.001***	0.002***	0.002***	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
gov1rlc		0.000	-0.000	0.000**	0.000
		(0.000)	(0.000)	(0.000)	(0.000)
checks			0.173***	0.096***	0.119***
			(0.025)	(0.028)	(0.029)
frac				0.695***	0.656***
				(0.125)	(0.127)
yrsoffc					0.003***
					(0.000)
Constant	-0.108	-0.054	-0.149	-0.234	-0.414
	(0.336)	(0.343)	(0.345)	(0.347)	(0.351)
Observations	2,224	2,224	2,224	2,224	2,224
Pseudo R^2	0.131	0.131	0.150	0.161	0.171

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Time fixed effects are included in all models

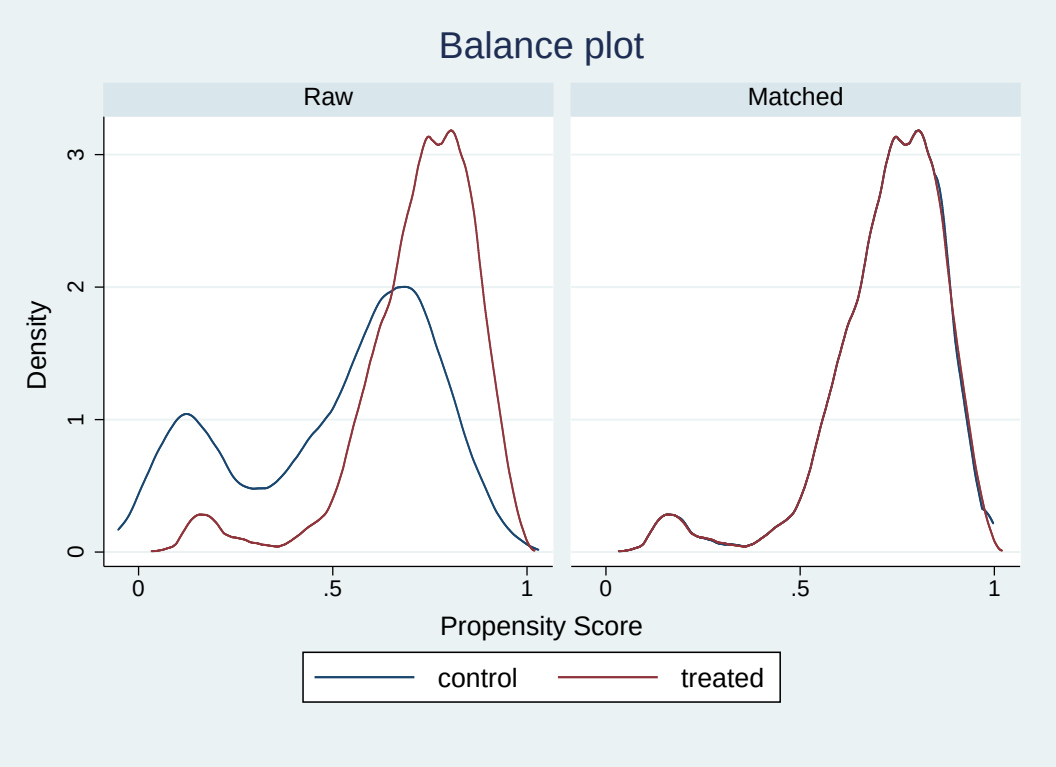
A.3.2. Covariates balancing test

Table A.6 – Balancing properties of the covariates after matching

	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
GDP Per Capita	.0363469	.0554991	.9354676	.9434034
Poplation Growth	.3964429	-.0650745	.5149643	.756229
Trade Balance	.2745235	.0653768	.7204286	1.3054
Investment	.0852407	.0452493	.60265	.6291992
RTA	.0764239	.0079058	1.093859	1.008656
Democracy	.0819567	.0735017	.8503182	1.189325

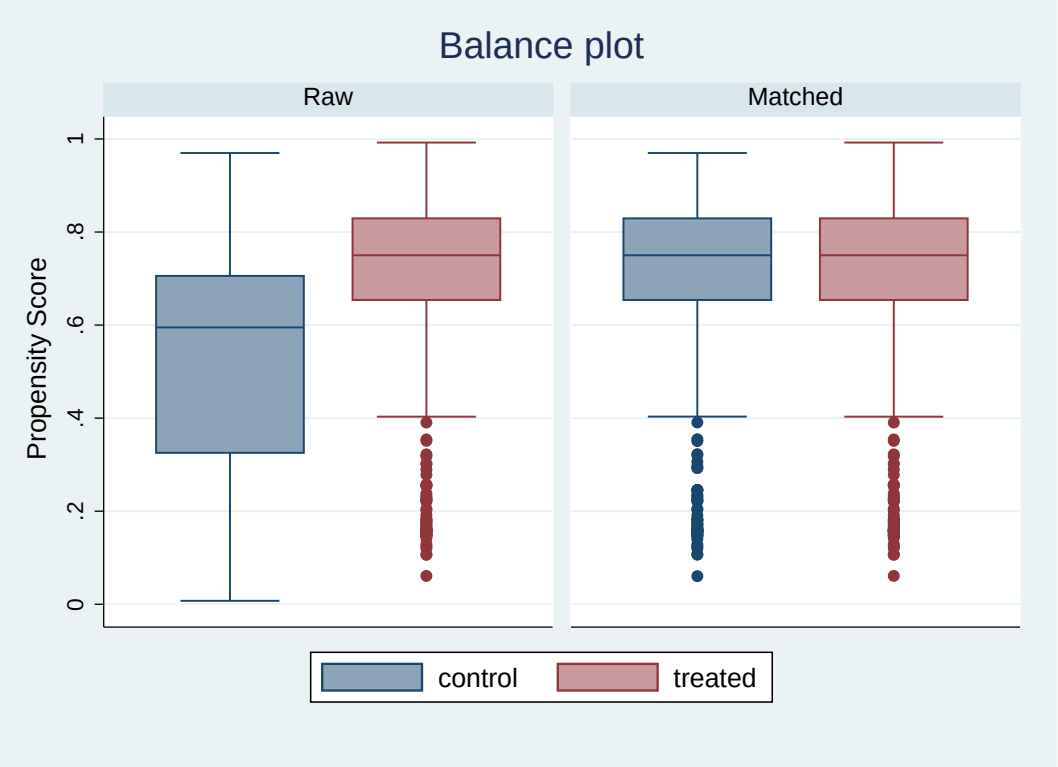
Notes: The standardized differences for the matched sample are all close to zero, and the variance ratios are all clos to one. Accordingly, we conclude for the matched sample that matching on the estimated propensity score balanced th covariates.

Figure A.2 – Covariates balance density



Notes: We plot the kernel density of the propensity score to check for covariates balance after matching implementation. The density plots of the propensity score for the matched sample are nearly indistinguishable, implying that matching on the estimated propensity score balanced the covariates.

Figure A.3 – Covariates balance box



Notes: We plot the box of the propensity score to check for covariates balance after matching implementation. The box plots of the propensity score for the matched sample are very similar, indicating that matching on the estimated propensity score balanced the covariates.

A.4. Robustness checks

A.4.1. Use of lagged values of matching variables in the propensity score estimation

Table A.7 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: Baseline results using lagged matching variables

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	6.33***	7.70***	7.65***	7.15***	6.99***	5.03***
	(1.995)	(1.661)	(2.372)	(1.526)	(1.417)	(1.371)
Observations	2,099	2,099	2,099	1,819	2,099	2,098
Treatment group	1,360	1,360	1,360	1,190	1,360	1,360
Control group	739	739	739	629	739	738

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

A.4.2. Use of alternative poverty line of $1.90 a day

Table A.8 – Average Treatment Effect on treated (ATT) on poverty headcount ratio: Baseline results using a poverty line of $1.90 a day

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty headcount ratio					
ATT	12.40***	11.38***	12.13***	0.319	12.16***	7.040***
	(1.298)	(1.586)	(2.372)	(0.214)	(1.361)	(1.141)
Observations	2,128	2,128	2,128	1,726	2,128	2,126
Treatment group	1,405	1,405	1,405	1,155	1,405	1,405
Control group	723	723	723	629	571	721

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

A.4.3. The poverty gap as an alternative measure

Table A.9 – Sensitivity test of GATT/WTO's ATT on poverty

	(1) NN-PSM	(2) Kernel-PSM	(3) LLR-PSM	(4) RA	(5) IPW	(6) IPWRA
	Dependent variable: poverty gap					
ATT	4.91***	5.18***	5.02***	5.72***	4.76***	4.27***
	(1.012)	(0.811)	(1.039)	(0.813)	(0.774)	(0.716)
Observations	2,224	2,224	2,224	1,819	2,224	2,222
Treatment group	1,440	1,440	1,440	1,190	1,440	1,440
Control group	784	784	784	629	784	782

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
PSM: Propensity score Matching, NN: Nearest-Neighbor, LLR: Local Linear Regression
IPW: Inverse Probability Weighting, RA: Regression Adjustment
IPWRA: Inverse Probability Weighted Regression Adjustment

A.4.4. Sensitivity tests: Rosenbaum bounds

The table reports P-value for Wilcoxon sign-rank test for significance of the hidden bias

Table A.10 – Rosenbaum critical P-values for treatment effects

Γ	Upper bound	Lower bound
1	0.00	0.00
1.5	0.00	0.00
2	0.96	0.00
2.5	1.00	0.00
3	1.00	0.00
3.5	1.00	0.00
4	1.00	0.00
4.5	1.00	0.00
5	1.00	0.00

A.5. Comparative advantage and land endowment

Figure A.4 – Export and Import trend of labour and land intensive agricultural products

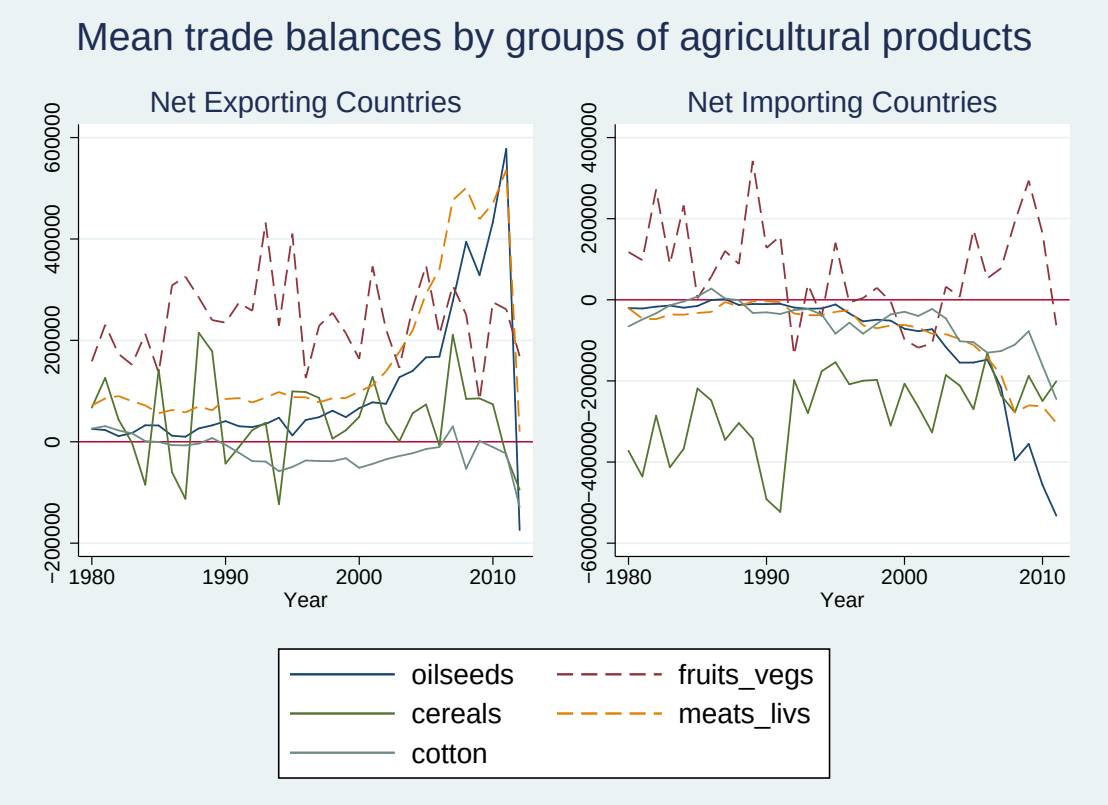
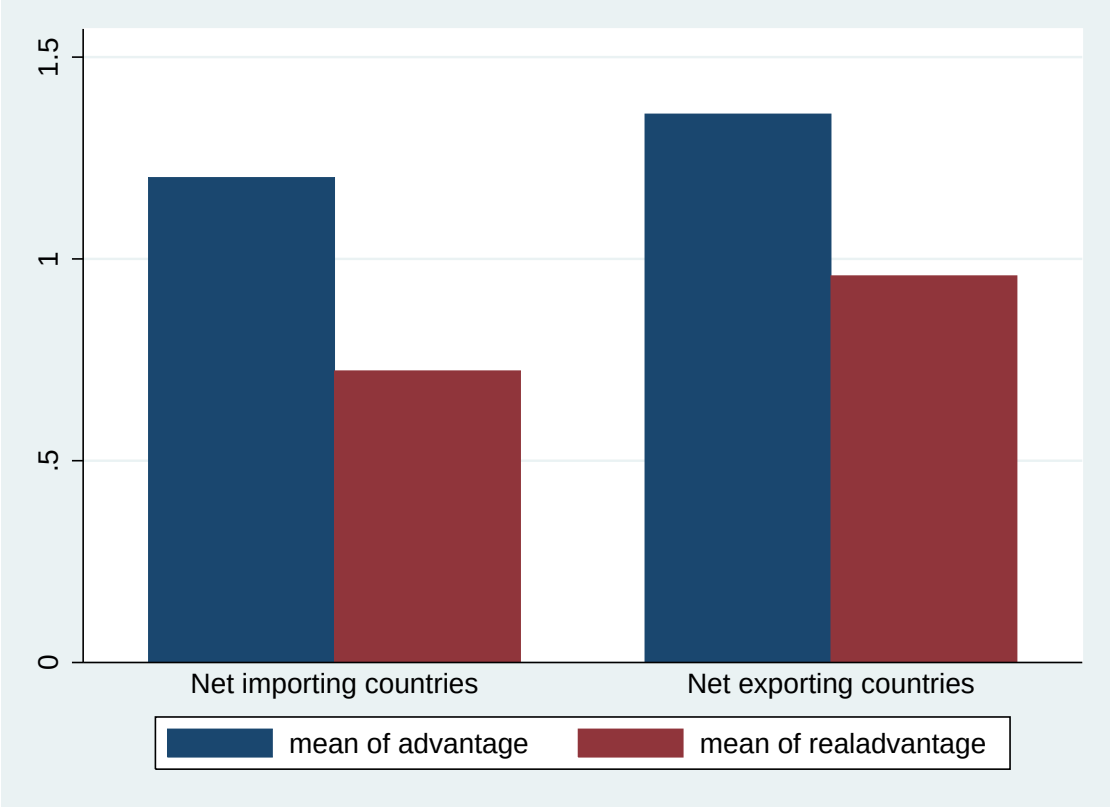


Figure A.5 – Relative abundance in arable land, with and without productivity adjustments



Notes:
For each country i, we compute the country's share of the world's endowment of arable land Li/Lw and subtract the country's share of world GDP, $GDPi/GDPw$. Thus relative land abundance is defined as: $RLAi = Li/Lw\breve{}GDPi/GDPw$. The land endowment of each country can be adjusted for productivity, as in Feenstra and Taylor, with $lia = li * vi$, where $vi = productivity\ of\ country\ i$, to generate a corrected measure
$RLACi = (Li * vi)/sum(Li * vi)$ with the sum over all of the countries in the world.
$RLACi > 0$ indicates that country i is relatively abundant in arable land. We computed simple group averages for net exporters and net importers. A t-test rejected the absence of a difference in group means.

Figure A.6 – Agricultural trade balance trend in net exporting and importing countries

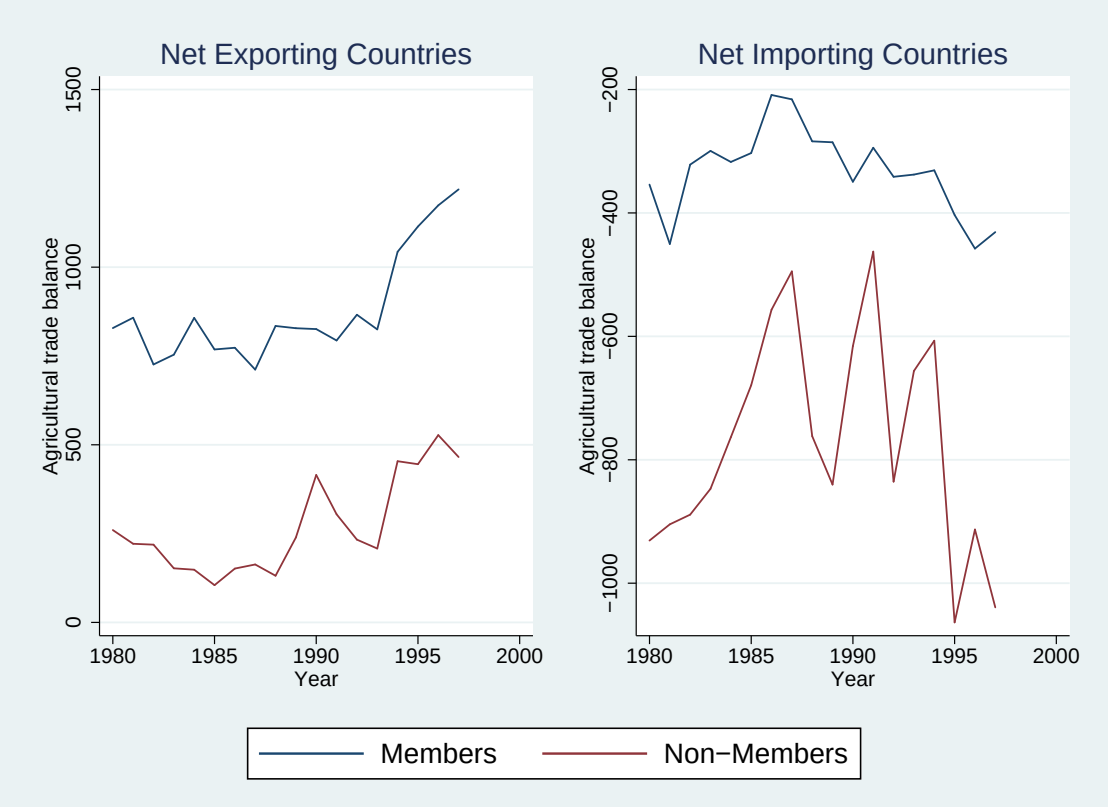
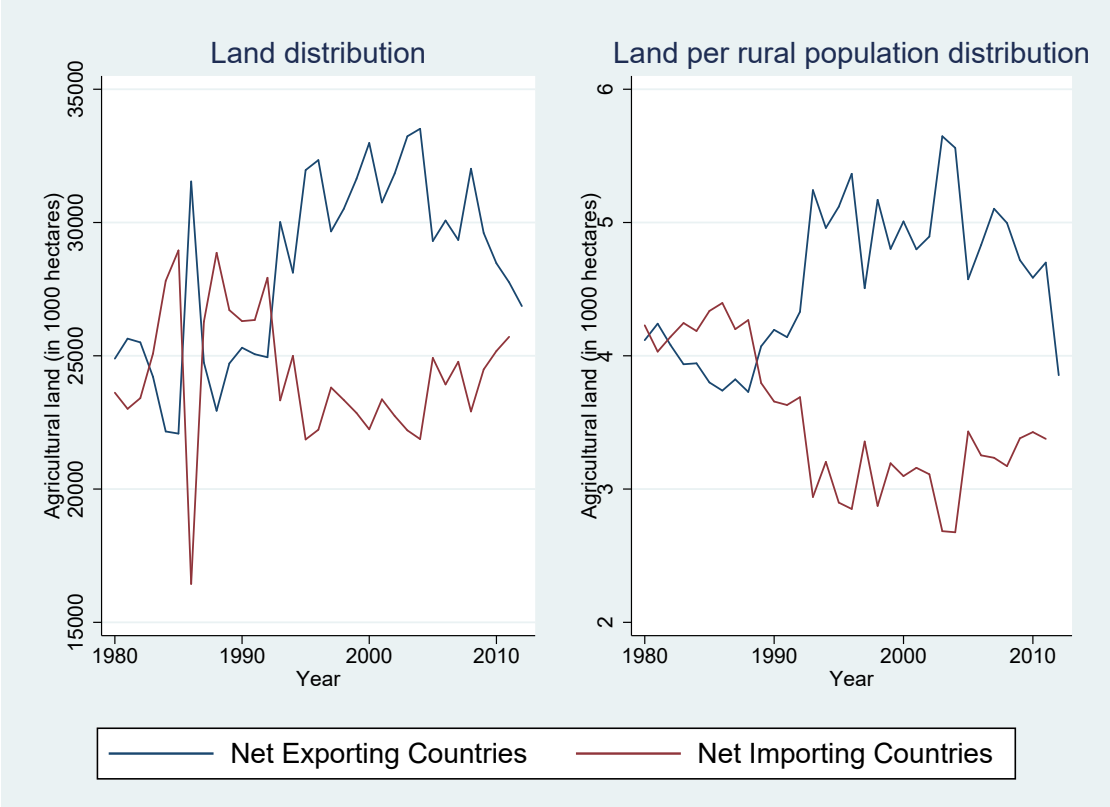


Figure A.7 – Agricultural land distribution in net exporting and importing countries



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Appendix B

Appendix chapter 2

B.1. List of variables and countries

Table B.1 – Definitions and sources of variables

Variables	Description	Data Source
HEADCOUNT	It measures the share of population which income is less than $1.25 a day	Povcalnet, World Bank
DISASTER	It is a binary indicator measuring the occurrence of large disaster. It is obtained from the number of people killed by a natural disaster. We use 75th percentile of the world distribution of the number of people killed as cut-off value to define large disaster. It takes value one if the number of people killed is higher than 75th percentile and zero if not (Cavallo et al., 2013)	EM-DAT database
GATT/WTO	It takes a value 1 if country i joins GATT or WTO in time t and zero otherwise	WTO website
EXPORT	It measures the value over GDP of exports of goods and services of the country i in period t.	World Development Indicators (WDI), World Bank
IMPORT	It measures the value over GDP of imports of goods and services of the country i in period t.	WDI
TRADE	It measures the value of total trade (export + import) of goods and services over GDP of the country i in period t.	WDI

Table B1 Continued: Definitions and sources of variables

Variables	Description	Data Source
GDP PER CAPITA	This variable measures the Gross Domestic Product per capita	WDI
INVESTMENT	It measures the gross fixed capital formation as a percentage of GDP.	WDI
EDUCATION	It measures the gross enrollment ratio in secondary school.	WDI
SOCIALISM	It measures the country economic system, i.e if the country is socialist economy or not. It takes value 1 if the country economic system is socialism and zero otherwise.	La Porta et al. (1999)
DEMOCRACY	It is a measure of institutional quality. This variable measures a degree of democracy. It ranges from zero to ten, where higher value indicate a higher degree of democracy.	Polity IV
DURABILITY	It measures the regime durability especially the number of years since the most recent regime change.	Polity IV
OBSERVATION DATE	It measures date from which countries became observers. I takes value one if the country is observer since 2 years and zero otherwise following Davis and Wilf (2011)	WTO website

Table B.2 – List of countries with GATT/WTO status

Countries	**GATT/WTO date**	**Countries**	**GATT/WTO date**
Angola	1994/1996	Malaysia	1957/1995
Argentina	1967/1995	Maldives	1983/1995
Bangladesh	1972/1995	Mali	1993/1995
Belize	1983/1995	Mauritania	1963/1995
Benin	1963/1996	Mauritius	1970/1995
Bolivia	1990/1995	Mexico	1986/1995
Botswana	1987/1995	Morocco	1987/1995
Brazil	1948/1995	Mozambique	1992/1995
Burkina faso	1963/1995	Namibia	1992/1995
Burundi	1965/1995	Nicaragua	1950/1995
Cameroon	1963/1995	Niger	1963/1996
Central African Rep.	1963/1995	Nigeria	1960/1995
Chad	1963/1996	Pakistan	1948/1995
Chile	1949/1995	Papua New Guinea	1994/1996
Colombia	1981/1995	Paraguay	1994/1995
Costa Rica	1990/1995	Peru	1951/1995
Czech Republic	1993/1995	Philippines	1979/1995
Djibouti	1994/1995	Poland	1967/1995
Dominican Republic	1950/1995	Romania	1971/1995
Egypt	1970/1995	Rwanda	1966/1996
El Salvador	1991/1995	Senegal	1963/1995
Fiji	1993/1996	Sierra Leone	1961/1995
Gabon	1963/1995	Slovak Republic	1993/1995
Gambia	1965/1995	Slovenia	1994/1995
Ghana	1957/1995	South Africa	1948/1995
Guatemala	1991/1995	Sri Lanka	1948/1995
Guinea	1994/1995	St. Lucia	1993/1995
Guinea-Bissau	1994/1995	Surinam	1978/1995
Guyana	1966/1995	Swaziland	1993/1995
Haiti	1950/1996	Tanzania	1961/1995
Honduras	1994/1995	Thailand	1982/1995
Hungary	1973/1995	Togo	1964/1995
India	1948/1995	Trinidad and Tobago	1962/1995
Indonesia	1967/1995	Tunisia	1990/1995
Ivory Coast	1963/1995	Turkey	1951/1995
Jamaica	1963/1995	Uganda	1962/1995
Kenya	1964/1995	Uruguay	1953/1995
Lesotho	1988/1995	Venezuela	1990/1995
Madagascar	1963/1995	Zambia	1982/1995
Malawi	1964/1995		

Table B2 Continued: List of countries with GATT/WTO status

Countries	**WTO date**	**Countries**	**WTO date**
Albania	2000	Armenia	2003
Bulgaria	1996	Cabo Verde	2008
Cambodia	2004	China	2001
Congo Dem. Rep.	1997	Congo Rep.	1997
Croatia	2000	Ecuador	1996
Estonia	1999	Georgia	2000
Jordan	2000	Kazakhstan	2015
Kyrgyz Republic	1998	Lao	2013
Latvia	1999	Liberia	2016
Lithuania	2001	Macedonia	2003
Moldova	2001	Montenegro	2012
Nepal	2004	Panama	1997
Russia	2012	Seychelles	2015
Tajikistan	2013	Ukraine	2008
Vietnam	2007	Yemen	2014
Algeria	Observer	Azerbaijan	Observer
Belarus	Observer	Buthan	Observer
Bosnia and Herzegovina	Observer	Comoros	Observer
Ethiopia	Observer	Iran	Observer
Iraq	Observer	Sao Tome and Principe	Observer
Serbia	Observer	Sudan	Observer
Syria	Observer	Micronesia	
Timor-Leste		Turkmenistan	

B.2. Selection bias

Table B.3 – A Probit Regression of GATT/WTO Membership

	GATT/WTO membership (Yes=1) (panel data probit with random effect)			
	(1)	(2)	(3)	(4)
Lagged_GDP Per Capita	2.22***	2.28***	2.29***	2.33***
	(0.138)	(0.133)	(0.115)	(0.138)
Lagged_Trade	1.82***	1.94***	1.80***	1.88***
	(0.217)	(0.242)	(0.194)	(0.228)
Democracy		-0.00	-0.00	-0.00
		(0.003)	(0.003)	(0.003)
Socialism			-5.49***	-8.08***
			(0.496)	(0.806)
Durability				-0.02***
				(0.006)
Constant	-21.59***	-22.61***	-20.85***	-19.60***
	(1.414)	(1.565)	(1.185)	(1.408)
Observations	3,462	3,462	3,462	3,462

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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Appendix C

Appendix chapter 3

C.1. List of countries

Algeria	Cote d'Ivoire	Lesotho	Rwanda
Argentina	Djibouti	Liberia	Sao Tome and Principe
Azerbaijan	Dominican Republic	Madagascar	Senegal
Bangladesh	Ecuador	Malawi	Sierra Leone
Belize	Egypt, Arab Rep.	Malaysia	Solomon Islands
Benin	El Salvador	Maldives	South Africa
Bhutan	Ethiopia	Mali	Sri Lanka
Bolivia	Fiji	Mauritania	St. Lucia
Botswana	Gabon	Mauritius	Suriname
Brazil	Gambia, The	Mexico	Syrian Arab Republic
Burkina Faso	Ghana	Mongolia	Tanzania
Burundi	Guatemala	Morocco	Thailand
Cabo Verde	Guinea	Mozambique	Togo
Cameroon	Guinea-Bissau	Myanmar	Tunisia
Central African Republic	Haiti	Namibia	Turkey
Chad	Honduras	Nepal	Uganda
Chile	India	Nicaragua	Uruguay
China	Indonesia	Niger	Uzbekistan
Colombia	Iran, Islamic Rep.	Nigeria	Venezuela, RB
Comoros	Jamaica	Pakistan	Vietnam
Congo, Dem. Rep.	Jordan	Paraguay	Zambia
Congo, Rep.	Kenya	Peru	Zimbabwe
Costa Rica	Lao PDR	Philippines	

C.2. Variable definition and sources

Variables	Description	Source
Headcount	It represents the poverty headcount ratio which measures the percentage of people living under $1.90 a day at 2011 international prices (% of population)	World Bank poverty database and WDI (Povcalnet)
Trade tax	Import and export duties (% of GDP)	GRD, Baunsgaard and Keen (2010) and OECD
Domestic tax	It measures the total tax revenue excluding trade tax revenue (% of GDP)	GRD, Baunsgaard and Keen (2010) and OECD
Total tax	It measures the total tax revenue as the sum of trade tax revenue and domestic revenue (% of GDP)	GRD, Baunsgaard and Keen (2010) and OECD
Non-tax revenue	It measures revenue from both resource and non-resource sources other than tax revenue (% of GDP)	GRD, Baunsgaard and Keen (2010) and OECD
Democracy	Average of political rights and civil liberties of the Gastil index. It ranges from 1 for democracy to 7 for dictatorship (see Paldam and Gundlach, 2012)	Freedom House
Land pc	It measures the agricultural area per capita in hectares	FAO statistics
Capital pc	It is defined as capital stock per capita at constant 2011 national prices (US $)	IMF
Education	Government expenditure on education as a percentage of government total expenditures	IMF
Health	Government expenditure on health as a percentage of government total expenditures	IMF
Government expenditures	Government total expenditures as a percentage of GDP	IMF
Population growth	It measures the annual population growth rate	WDI

C.3. Cross-section dependence

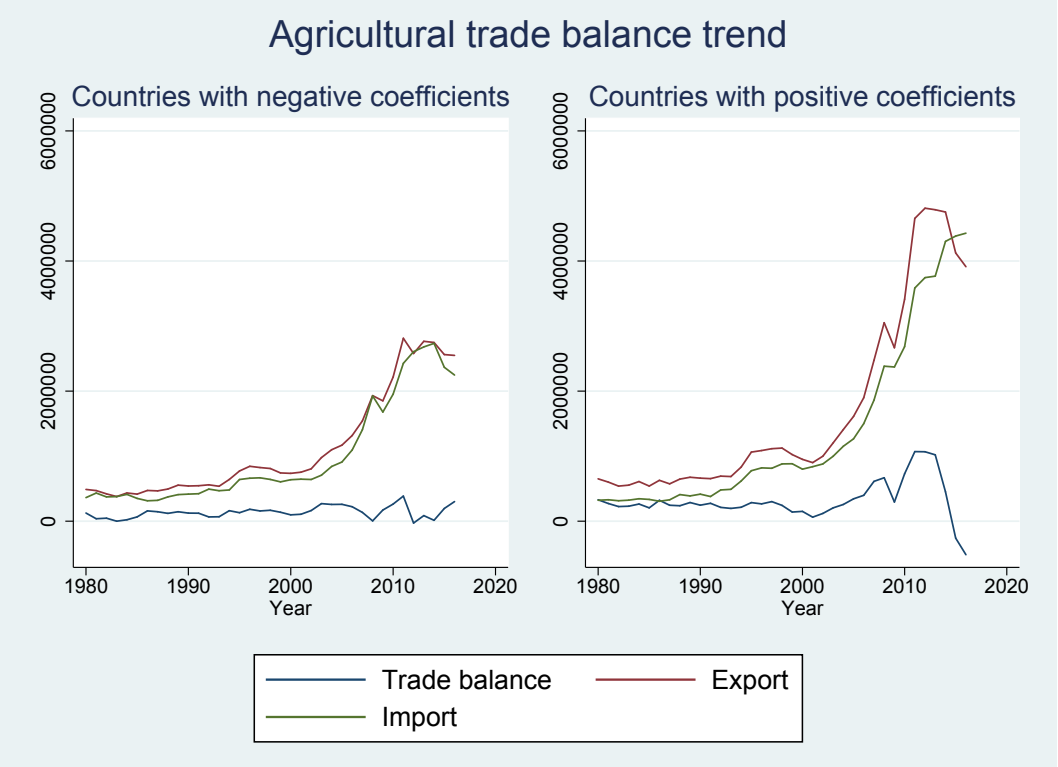
Table C.1 – Cross-section correlation

	CD	p-value	avg ρ	$\lvert\rho\rvert$
Headcount	87.49	0.00	0.229	0.491
Domestic tax	89.62	0.00	0.243	0.473
Total tax	54.06	0.00	0.142	0.405
Land pc	322.84	0.00	0.847	0.866
Capital pc	53.59	0.00	0.143	0.650
GDP pc	377.72	0.00	0.977	0.977
Population growth	88.04	0.00	0.278	0.568
Health	48.02	0.00	0.204	0.405
Trade tax	202324.52	0.00	0.16	0.37
Non tax revenue	202324.52	0.05	0.01	0.31
Education	255895.06	0.00	0.05	0.33
Democracy	255895.06	0.00	0.07	0.37
Government Expenditure	255895.06	0.00	0.03	0.32

Notes: I use the Stata command *xtcd* which calculates the CD-test for cross-sectional dependence of Pesaran (2004) under the null hypothesis of strict cross-sectional independence. I present the average correlation and average absolute correlation coefficients across the N(N-1) correlations between country i and all other countries. The null hypothesis of strict cross-sectional independence is rejected at one-percent level for all variables except for the non-tax revenue variable for which the null hypothesis is rejected at five-percent level. This suggests the presence of cross-section dependence in each dataset.
For the variables trade tax, non tax revenue, education expenditures, and government total expendutures, I use stata routine *xtcdf* to carry out the CD-test for cross-sectional dependence due to some missing data leading to unbalanced panel, accordingly, I cannot use the routine the CD-test for cross-sectional dependence *xtcd*.

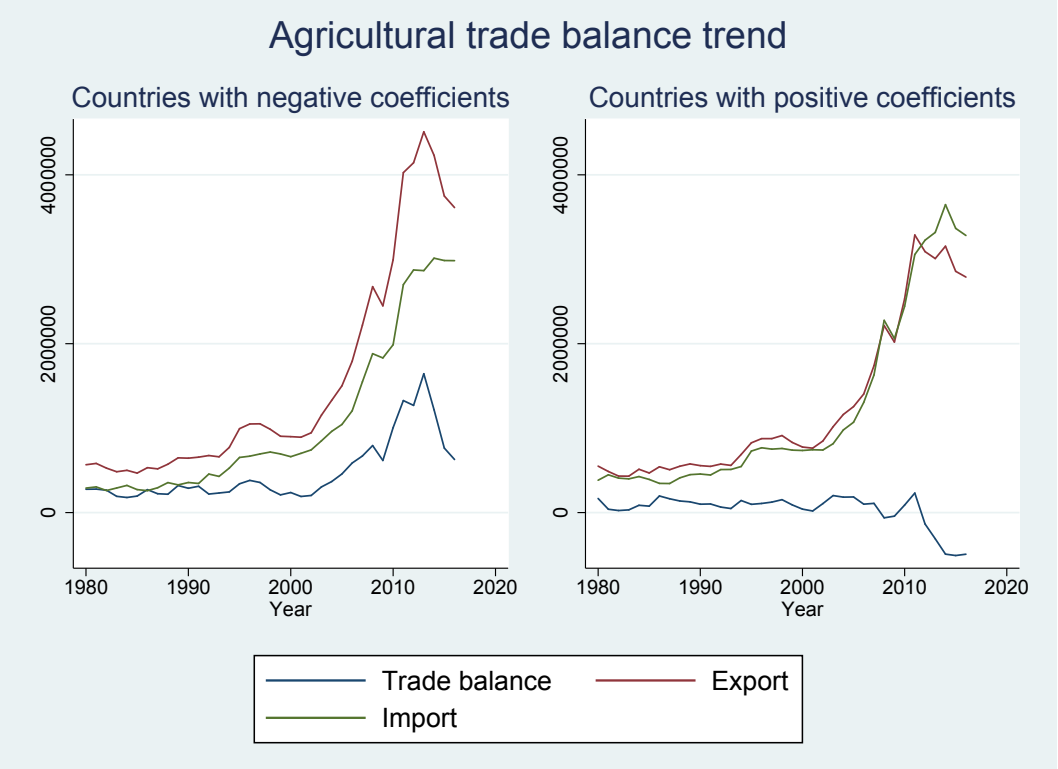
C.4. Heterogeneity effects

Figure C.1 – Evolution of agricultural trade balance trend by group of countries: heterogeneity effects of trade tax



Notes: I plot the trend (average) of trade balance of agricultural products over the period 1980-2016 to identify the role of comparative advantage in agriculture in the heterogeneity effects across countries. The countries with negative coefficients refer to the countries that benefit from an increase in trade taxes in terms of poverty reduction. The countries with positive coeffcients are those in which an increase in taxes on international trade is associated to an increase in poverty. The figure shows that countries that experience a poverty-increasing effects of trade taxes have shift from net exporters to net importers of agricultural products while countries in which trade taxes is associated to the reduction in poverty, remained on average net exporters of agricultural products over time.

Figure C.2 – Evolution of agricultural trade balance trend by group of countries: heterogeneity effects of domestic tax



Notes: I plot the trend (average) of trade balance of agricultural products over the period 1980-2016 to identify the role of comparative advantage in agriculture in the heterogeneity effects across countries of a shift from taxes on international trade towards domestic taxes on poverty. The countries with negative coefficients refer to the countries that benefit from an increase in trade taxes in terms of poverty reduction. The countries with positive coeffcients are those in which an increase in taxes on international trade is associated to an increase in poverty. The figure shows that countries that experience a poverty-increasing effects of trade taxes have shift from net exporters to net importers of agricultural products while countries in which trade taxes is associated to the reduction in poverty, consolidated their comparative advantage in agriculture as agricultural trade balance increases on average over time.

C.5. Robustness checks

Table C.2 – Trade taxes incidence on poverty estimation exclusing China and Lesotho from the sample

	(1)	(2)	(3)	(4)	(5)
	MG	CCEMG	CCEMG with lags		
CA Additional lags			1^{st} lag	2^{nd} lag	3^{rd} lag
Dependent variable: poverty headcount ratio (in log)					
L.Headcount	0.587***	0.363***	0.238***	0.143	0.381***
	(0.034)	(0.044)	(0.067)	(0.169)	(0.142)
Trade tax	-0.032*	-0.034*	-0.023	-0.138**	0.229
(% of GDP)	(0.017)	(0.018)	(0.050)	(0.066)	(0.414)
Domestic tax	-0.053***	-0.049**	-0.133	-0.090	-1.193
(% of GDP)	(0.020)	(0.025)	(0.116)	(0.086)	(1.039)
Capital pc	0.147	-0.068	-0.735	0.387	-0.646
	(0.129)	(0.147)	(0.599)	(0.573)	(1.635)
Land pc	0.050	-0.089	-0.197	-0.082	-4.199
	(0.142)	(0.162)	(0.609)	(0.705)	(3.315)
GDP pc	-0.442***	-0.673***	-0.794**	-2.084*	4.035
	(0.099)	(0.130)	(0.337)	(1.228)	(5.169)
Non tax revenue	-0.001	0.010	0.009	0.026	-0.381
	(0.009)	(0.012)	(0.031)	(0.062)	(0.496)
Constant	-0.649	0.876	-14.109	-13.519	45.403
	(0.639)	(1.274)	(10.237)	(10.296)	(52.121)
RMSE	0.0960	0.0682	0.0936	0.0857	0.0880
CD test	9.840	2.304	3.84	1.28	2.24
CD p-value	0.000	0.021	0.000	0.202	0.025
Number of groups	79	79	64	62	61
Observations	2,310	2,310	1,945	1,827	1,733

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses are constructed nonparametrically following Pesaran and Smith (1995).

All the regressors are in the log. Country-specific linear trend is included in each model.

CD test reports the Pesaran (2015) test for weak cross-sectional dependence, which under the null hypothesis of weak cross-sectional dependence of the error term, the CD-statistic is distributed $\sim N(0,1)$. RMSE is the root mean squared error.

Table C.3 – Domestic taxes incidence on poverty estimation exclusing China and Lesotho from the sample

	(1)	(2)	(3)	(4)	(5)
	MG	CCEMG	CCEMG with lags		
CA Additional lags			1^{st} lag	2^{nd} lag	3^{rd} lag
Dependent variable: poverty headcount ratio (in log)					
L.Headcount	0.582***	0.398***	0.277***	1.036	0.180**
	(0.035)	(0.040)	(0.053)	(0.715)	(0.084)
Domestic tax	0.037	0.029	0.269	0.669*	0.085
(% of total tax)	(0.045)	(0.048)	(0.284)	(0.401)	(0.557)
Tax revenue	-0.038	-0.076*	-0.343**	-0.515*	-0.427***
(% of GDP)	(0.037)	(0.043)	(0.143)	(0.271)	(0.127)
Capital pc	0.141	-0.094	1.001*	4.055	-2.414**
	(0.137)	(0.149)	(0.586)	(3.484)	(1.107)
Land pc	0.035	0.183	0.360	0.611	0.429
	(0.140)	(0.151)	(0.381)	(1.537)	(0.596)
GDP pc	-0.465***	-0.622***	-0.684**	0.224	-2.044***
	(0.097)	(0.118)	(0.328)	(2.831)	(0.539)
Non tax revenue	0.003	0.015	0.012	-0.030	-0.073
	(0.008)	(0.015)	(0.040)	(0.167)	(0.104)
Constant	-1.420*	1.055	-2.694	1.762	-4.250
	(0.776)	(2.022)	(4.988)	(3.792)	(6.057)
RMSE	0.0957	0.0683	0.0927	0.0924	0.0956
CD test	9.321	1.659	4.20	1.59	0.65
CD p-value	0.000	0.097	0.000	0.112	0.514
Number of countries	80	80	64	62	61
Observations	2,326	2,326	1,945	1,827	1,733

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses are constructed nonparametrically following Pesaran and Smith (1995).
All the regressors are in the log. Country-specific linear trend is included in each model. CD test reports the Pesaran (2015) test for weak cross-sectional dependence, which under the null hypothesis of weak cross-sectional dependence of the error term, the CD-statistic is distributed $\sim N(0,1)$. RMSE is the root mean squared error.

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