Promotors: Prof. dr. ir. Jeroen Buysse

Prof. dr. ir. Guido Van Huylenbroeck

Dean: Prof. dr. ir. Marc Van Meirvenne

Rector: Prof. dr. Anne de Paepe

Assessment of public policies for the promotion of sustainable and legal wood

Jan Brusselaers

Thesis submitted in fulfilment of the requirements
for the degree of Doctor (PhD) in Applied Biological Sciences

GHENT UNIVERSITY

FACULTY OF BIOSCIENCE ENGINEERING

Dutch translation of the title:

Beoordeling van beleidsopties ter ondersteuning van duurzaam en legaal hout

Suggested way of citation:

Brusselaers, J. (2017). *Assessment of public policies for the promotion of sustainable and legal wood.* Doctoral dissertation, Ghent University, Belgium.

Members of the examination board

Prof. Dr. ir. Kris Verheyen (Chairman)

Department of Forest and Water Management

Ghent University, Belgium

Prof. Dr. ir. Hans Verbeeck (Secretary)

Department of Applied Ecology and Environmental Biology

Ghent University, Belgium

Prof. Dr. Bruno Merlevede

Department of General Economics

Ghent University, Belgium

Prof. Dr. ir. Stijn Speelman

Department of Agricultural Economics

Ghent University, Belgium

Dr. Serge Garcia

Laboratoire d'Économie Forestière

Institute National de la Recherche Agronomique, France

Preface / Voorwoord

Je weet nooit wat de toekomst brengt, maar het voorjaar van 2017 zal me allicht bij blijven als één van de meest hectische periodes in mijn leven. In januari besloot ik tezamen met mijn promotoren om het einde van mijn aanstelling als assistent niet af te wachten om mijn doctoraat af te werken. In plaats daarvan zouden we proberen de thesis in te dienen in april om dan hopelijk te verdedigen in het begin van de zomer. Op professioneel vlak stond ik dus voor een drukke periode, en op privé-vlak was het niet veel beter: we bouwen aan een huis, ik werd peter van Jerom, mijn 2-jarige dochter vraagt veel aandacht en mijn zwangere vriendin af en toe ook. Bovendien staat het voorjaar – uiteraard – gelijk aan koers. Het aangekondigde wielerafscheid van Tom Boonen verhoogde het stressniveau nog wat meer. Hectisch dus, maar kijk, het lijkt er op dat we alles tot een goed einde gaan brengen. En ik wil uitdrukkelijk de nadruk leggen op 'we', want alleen was ik niet geslaagd in deze onderneming. Daarom is een woord van dank hier zeker op zijn plaats.

In de eerste plaats ben ik mijn promotoren erkentelijk voor hun begeleiding. Wat mijn doctoraat betreft was Professor Buysse ontegensprekelijk mijn belangrijkste klankbord. Ik verwijs doorheen mijn doctoraatsthesis vaak naar academische artikels, boeken, etc. Spijtig genoeg bestaat er geen type referentie waarmee ik naar de talrijke discussies en feedback momenten met Jeroen kan verwijzen. Er waren geen taboes en soms waren de discussies confronterend, maar ik ben nooit met een negatief gevoel buiten gewandeld bij Jeroen en het onderzoek ging er steeds op vooruit. Professor Van Huylenbroeck was de laatste jaren iets minder aanwezig op de faculteit, maar ik apprecieer zijn steun en coaching in het kader van mijn onderwijsopdrachten. Guido verstaat de kunst om iemand snel vertrouwen en verantwoordelijkheden te geven en tegelijkertijd beginnersfouten door de vingers te zien, een aangename manier van werken.

In addition to my promoters, I would also like to thank all of the jury members for reading the PhD thesis thoroughly. Some of the comments were hard to address, but all of them were helpful and considerably increased the quality of the document.

Als assistent werkte ik, behalve met mijn promotoren, ook samen met professor Ludwig Lauwers en professor Wim Verbeke. Ludwig, het was voor mij een waar plezier om tezamen met een geïnspireerde lesgever de cursus doorheen de jaren te verbeteren. Ik had ook steeds het gevoel dat mijn input ten harte werd genomen. Wim, het vak aan de faculteit Diergeneeskunde is organisatorisch één van de minst evidente, maar ik vind het wel fijn om af en toe eens uit mijn comfortzone te treden. Ook jouw input bij het derde hoofdstuk van deze thesis wordt zeer geapprecieerd.

Obviously, I want to thank all of my colleagues. I tried to list all colleagues with whom I shared an office, but they turned out to be too numerous. Compared to the day I started, only Bérénice, Gwen and Evy (also co-author of the 3rd chapter!) are still present. I am afraid to miss out on one of you and

therefore I will not name all of you individually (except for those mentioned above). I really enjoyed the atmosphere in our office which allows us to assist and help each other, but also question and challenge each other. This is very valuable in the type of work we do. In 2012, I was hesitant to quite a super-job and leave superb colleagues at the LEI – Wageningen UR in the Netherlands, but you all made it worthwhile. In Ghent, I found an environment full of opportunities to develop myself, attend courses, grow a network, participate in congresses, participate in proposals and projects, travel, and enjoy sufficient freedom to manage work-life balance. I truly believe that if you are willing to seize these opportunities, the process towards a PhD is more interesting than the actual diploma itself.

Work is fun, but fun is even more fun. At our department, it is not too hard to motivate people for non-professional activities. Multi gracias to Juan and Hans with whom I try to play squash without hitting each other too much. High five as well to the colleagues who are willing to make use of any excuse to have a drink. Especially the trips to bicycle races are memorable. We even ended up at the 'derny criterium' in Wetteren once, I think this demonstrates perseverance.

Van Gent naar Kruibeke. Het is niet mijn ambitie om zeer persoonlijk te worden in een voorwoord van een doctoraatsthesis, maar ik zou in het bijzonder mijn ouders willen danken voor de voortdurende steun en alle kansen die ze me hebben gegeven om te studeren. En daarna nog wat bij te studeren. Nu ik zelf vader ben begin ik stilletjes aan te beseffen dat ik hen allicht een hoop slapeloze nachten heb bezorgd. Misschien was al die steun toch niet zo evident als ik toen dacht.

Behalve mijn eigen familie moet ik ook mijn schoonfamilie bedanken. De combinatie doctoraat-nieuwbouw was gedoemd om te falen zonder jullie steun in de vorm van een tijdelijke woonst en praktische hulp. Ik ben gezegend met een schoonpa die al eens graag in een ruwbouw werkt en de echte werfleider is geworden. Ik verdenk hem er van dat hij mijn verbouw-skills nog niet volledig naar waarde schat, maar ik beloof beterschap Pat.

Ik las in enkele andere voorwoorden van doctoraten ook dankwoorden voor de vrienden. Nu durf ik in mijn persoonlijk geval er toch sterk aan te twijfelen dat het zootje ongeregeld dat ik mijn vrienden mag noemen ook maar enige positieve invloed heeft gehad op het behalen van een doctoraat. Maar het dient gezegd: ik kan op jullie rekenen (zeker vanaf de late middag), alles kan, niets moet, en er wordt nooit van iets een probleem gemaakt. Het is steeds zeer ontspannend om jullie te zien.

Afsluiten doe ik in stijl, met Ineke, Flo en ons dochtertje-in-spe. Ineke, ik weet natuurlijk al lang dat ik met mijn gat in de boter ben gevallen met jou. Toch verbaasde ik me er over hoe makkelijk je het me de laatste maanden hebt gemaakt. Ik weet niet of de verhaallijn van de afstuderende doctoraatstudent Bob in de televisiesoap Thuis er iets mee te maken heeft, maar je vond het blijkbaar normaal dat ik veel werk had en je klaagde nooit wanneer ik 's avonds en in de weekends achter mijn computer ging zitten. Indien Thuis er effectief iets mee te maken heeft wil ik ook de makers van Thuis bedanken, we zijn nu toch bezig. En dan nog een klein woordje voor een klein meisje. Flo, in tegenstelling tot je

mama kon jij niet begrijpen dat mijn doctoraat even het middelpunt van de aarde was. En je had natuurlijk gelijk: het allerbelangrijkste ben en blijf jij (nu wordt het toch persoonlijk). De volgende jaren ga je met een tandje minder op de klasfoto's staan, maar ik ben er zeker van dat je de ster blijft. Binnenkort komt er een zusje bij, het kan alleen maar nog beter worden.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AIC	Akaike Information Criterion
ANOVA	Analysis Of Variance
BIC	Bayesian Information Criterion
CI	Confidence Interval
CIFOR	Center for International Forestry Research
COP21	The twenty-first session of the Conference of the Parties (COP)
DDS	Due Diligence System
EC	European Commission
EU	European Union
EUROSTAT	Statistical office of the European Union
EUTR	EU Timber Regulation
FAO	Food and Agriculture Organization of the United Nations
FLEGT	Forest Law Enforcement, Governance and Trade
FSC	Forest Stewardship Council
FTA	Free Trade Agreement
GPP	Green Public Procurement
Gt CO_2	Gigaton Carbon Dioxide
HS	Harmonized System – Nomenclature EUROSTAT
ITTC	International Tropical Timber Council
MANOVA	Multivariate Analysis of Variance
NAP	National Action Plan
NEP	New Environmental Paradigm
OLS	Ordinary Least Squares
PCE	Perceived Consumer Effectiveness
PEFC	Programme for Endorsement of Forest Certification Schemes
REDD+	Reduce Emissions from Deforestation and forest Degradation
SEM	Spatial Equilibrium Model
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VAR	Vector Autoregression
VARX	Vector Autoregression with exogenous variable
VPA	Voluntary Partnership Agreement
WTA	Willingness To Accept
WTP	Willingness To Pay

Chapter 1. Introduction

1. Natural resource management: the oldest topical problem

This thesis is focused on the economic analysis of policy instruments that aim to sustain the extraction of wood from forests. Forest management, together with all other types of natural resource[1] management (and exploitation), has become a highly topical problem in the light of the ongoing discussions on climate change. Academics have also paid close attention to natural resource management. Figure 1-1 demonstrates how this has resulted in a steep increase in the (indexed) number of publications on the topic of natural resource management across all academic disciplines[2], compared to the body of publications in the entire field of economics. The index year is set in 1996, 20 years ago. The number of publications on forest governance has increased more rapidly, reaching an index of over 30,000 in the year 2016.

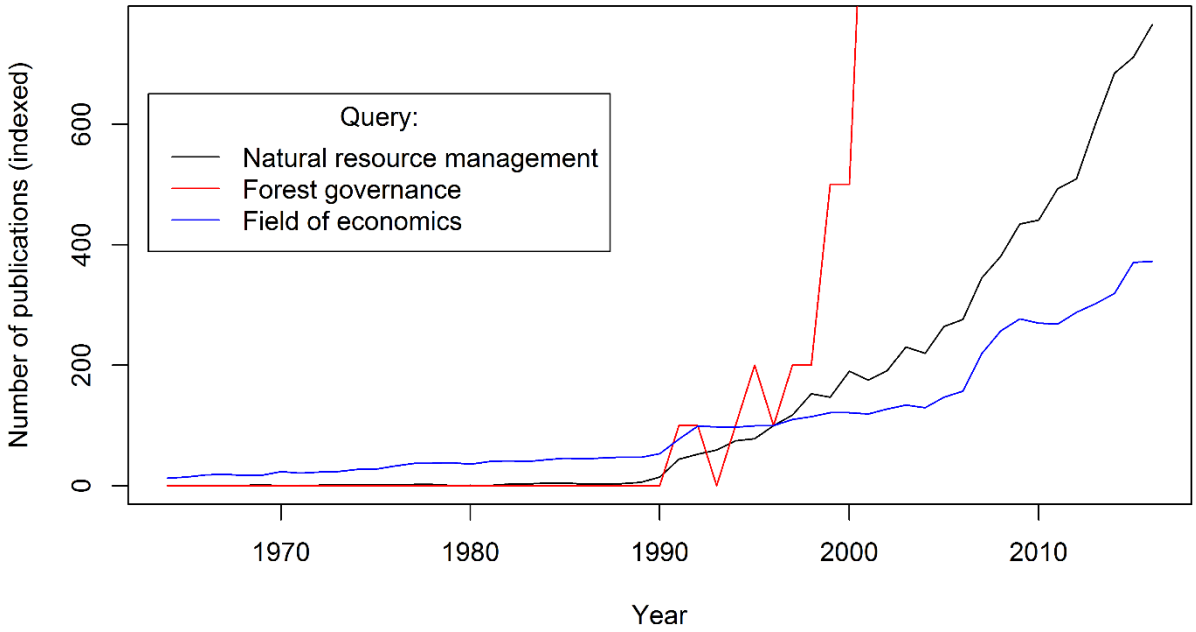

Figure 1-1: Overall number of publications in the field of economics, related to natural resource and forest management.
NOTE.- Data presented per query for period 1964 – 2016, Index year 1996 = 100. Data: Web of science query on "natural resource management" and "forest governance", and the total number of publications in the field of economics. In reference year 1996, a total of 1180 economic publications were recorded via Web of Science, 273 publications addressed natural resource management and 1 single publications addressed forest management issues. In 2016, these numbers increased to respectively 4396, 2089, and 322.

The increased academic interest in natural resources has resulted in the emergence of 'Resource and environmental economics' as a sub-discipline within economics (Perman 2003). However, the attention paid to natural resources in economic theory is not just a contemporary phenomenon. Perman (2003) described how resource and environmental economics has its roots in the era of the industrial

[1] Perman et al. (2003) define natural resources (or natural capital) as all naturally provided stocks. A non-exhaustive list includes aquifers and water systems, fertile land, crude oil and gas, forests, fisheries and other stocks of biomass, genetic material, and the earth's atmosphere.
[2] Web of Science records over 100 scientific disciplines reporting on the topic of natural resource management. Important examples are Economics, Ecology, Geography, Forestry, Anthropology, …

revolution in Europe. Natural resources and environmental issues were already major concerns for the 18th and 19th century classical economists. Adam Smith (1776) was the first to stress the importance of markets in resource allocation. Thomas Malthus (1798) and David Ricardo (1817) furthered Smith's conclusions and considered natural resources (and notably land) as determinants of national wealth and growth. They assumed that land had limited availability and was a necessary input for production. The limited availability should eventually result in a steady-state economy[3]. Conservationist thinking first appeared in the work of John Stuart Mill (1806-1873) who attributed amenity values to land (e.g. intrinsic beauty of the countryside).

Going back even further, the Old Testament commands mankind to properly manage natural resources and prohibits unnecessary waste (Sedlacek 2011). In Greek mythology, King Erysichthon of Thessaly was cursed after cutting down all the trees in the sacred grove of Demeter. He needed the wood to build a banqueting hall, which was considered a waste of natural resources. The curse was an insatiable hunger which eventually made King Erysichthon of Thessaly eat himself (Robertson 1984). The oldest reference to natural resource management is found in one of the oldest written texts ever found: the epic of Gilgamesh, from the Babylonian era, ca 1200 BC. The epic describes how King Gilgamesh makes use of cedar trees for the first time as the raw material for the construction of a city. Before Gilgamesh, forests were considered too dangerous to enter, and no cedar trees were extracted. Gilgamesh for the first time 'domesticates' nature (Sedlacek 2011).

To summarize, natural resources and the environment are indeed topical issues in the light of the current climate change debate. However, the attention given to natural resources is not a contemporary phenomenon. The relationship between mankind and natural resources has been documented throughout our entire history and economists have devoted ample attention to these issues since the 18th century.

2. Background

2.1. Importance of forests

Economists rightfully pay a great deal of attention to forests since, in the context of problems associated with climate change and biodiversity, they are important for two reasons. First, forests provide services that can mitigate the current and future effects of climate change on people. CIFOR (2016) provides a non-exhaustive list of mitigating services provided by forests: regulating waterways, protecting soil, cooling cities and entire regions. In rural areas, forests can prevent communities from losing all income and food sources in the case of (climate change initiated) disasters and agricultural

[3] Hence, they did not advocate, or predict unlimited growth or wealth accumulation.

crop failure. This thesis does not discuss the (biological) nature of the processes in detail. Second, forests are key in halting climate change. The FAO (2016a) identified four major roles for forests in climate change:

1. Forests can potentially absorb one-tenth of the global carbon emissions projected for the first half century into their biomass, soils, and products 'and store them in perpetuity'[4]. Research presented by the The Global Carbon Project (2016) finds that forests can store up to 31% of annual emissions;
2. In contrast, forests contribute about one-sixth of global carbon emissions when cleared, overused or degraded. Simultaneously, The Global Carbon Project (2016) reports that deforestation (not including forest degradation) accounts for 9% of global emissions;
3. Forests react sensitively to climate change;
4. Sustainably managed forests produce fuel wood as a less harmful alternative to fossil fuels.

Tropical forests are particularly important in this respect, as they account for 55% of the global forest stock. In addition, the Amazon basin and the Congo basin are the largest contiguous blocks (Pan et al. 2011, Hansen et al. 2013, Doetterl et al. 2015).

For these reasons, forestry has acquired a prominent role in initiatives that aim to address climate change, since the start of an international coordinated initiative in Kyoto, Japan, 1997 (FAO 2016a). More recently, this resulted in the organization of the FAO's XIV World Forestry Congress, in Durban, South Africa, 2015. This congress provided a key message to the United Nations Framework Convention on Climate Change (UNFCCC) on the potentially important role of forests for the adoption of the 2030 agenda for sustainable development (FAO 2015a). The message targeted policy makers prior to the start of the negotiations on the new climate change agreement in December 2015, Paris, France. Chapter 2 of this thesis has been presented at the XIV World Forestry Congress.

2.2. Deforestation and forest degradation: definition and drivers

The second role identified by the FAO (2016a) describes how clearance, overuse, and degradation of forest increases carbon emissions and threatens forests. In the context of carbon emissions, the most commonly used terminology is forest degradation and deforestation. Olander et al. (2008) define both concepts as follows:

- Deforestation: a measurable, and sustained decrease in crown cover below a 10-30% threshold

[4] The usefulness and reliability of studies that aim to calculate carbon storage capacity 'in perpetuity' is not clear as a tree cannot store carbon in perpetuity. In addition, the prospected carbon emissions also are subject to a degree of uncertainty.

- Forest degradation: a loss of biomass density without a change in the area of forest cover (i.e. the decrease in crown cover does not fall below the threshold)

The measurement and quantification of deforestation and forest degradation is challenging because it requires a combination of remote sensing and field inventory measurements. This is a time-consuming and expensive activity (Goetz et al. 2015). At present, the lack of reliable data on deforestation and forest degradation impedes the discussion on both phenomena and their contribution to carbon emissions and climate change (Federici et al. 2015, Doetterl et al. 2015, De Frenne and Verheyen 2016). Countries seem wary to publicly share information on their forest cover and forest change. In 2013, Brazil was the only country to produce and share spatially explicit information on annual forest extent and change (Hansen et al. 2013). However, this discussion goes beyond the scope of this thesis.

Earlier research has identified numerous drivers for deforestation and forest degradation. While often those drivers differ between regions, in general the main cause of deforestation is commercial agriculture – including commercial livestock and major crops – followed by subsistence agriculture (Hosonuma et al. 2012, Kissinger et al. 2012). In addition, mining, hydroelectricity, and other infrastructure projects also put pressure on forests. New roads can indirectly impact on forested areas since they open up new areas to settlers and for agriculture.

Forest degradation is mainly driven by wood extraction and logging, 'followed by fuel wood collection and charcoal production, uncontrolled fire and livestock grazing' (Hosonuma et al. 2012, Kissinger et al. 2012). Also, in the case of forest degradation, some drivers might be more influential in one region compared to another[5].

FAO (2015c) calculated how 129 million hectares of forested area have been lost since 1990. Also, taking into account the changes in natural forests over planted forests, 239 million hectares of forested area have been lost. This lost forest area is larger than the Democratic Republic of Congo, or 78 times the size of Belgium. The forest loss is mainly in the tropics, while the temperate forest area has slightly increased in size (Keenan et al. 2015). This thesis acknowledges the usefulness of planted forests as providers of wood, resources, and economic development. Nevertheless, natural forests are more valuable as a provider of ecosystem services (Gamfeldt et al. 2013).

The above describes a negative trend in the global forested area. However, some regions experienced a recovery of their forested area. According to Barbier and Tesfaw (2015), forest recovery is occurring for decades in developed regions, but more recently also occurs in developing countries (e.g. Bangladesh, China, Costa Rica, Dominican Republic, India, Morocco, and Vietnam). Mather (1992) first introduced the concept of 'forest transition' to refer to the turnaround from deforestation into forest recovery. In the rationale of forest transition, a decline in a country's forest cover predominantly

[5] Hosonuma et al. (2012) distinguished regions at continent level (i.e. Africa, Asia, and Latin America)

occurs in the country's early stages of economic development. Following this period, the forest area is likely to (partially) recover through the conservation of remaining primary forest, the emergence of plantations and reforestation. As such, the forest transition coincides with the country's era of economic prosperity. This offers a 'long-run perspective on land-use management; a country that is deforesting today may not necessarily continue to convert forest land in the future but eventually transition to a stage of forest recovery' (Barbier and Tesfaw 2015).

Empirical data of Hansen et al. (2013), gathered through applied earth observation satellite data, compares the global forest loss and the global forest recovery. They found higher losses (2.3 million square kilometers) compared to gains (0.8 million square kilometers) from 2000 to 2012.

2.3. Consequences of unsustainable forest management

The second role identified by the FAO (2016a) indicates that deforestation and forest degradation contribute about one-sixth of global carbon emissions. Both phenomena are a consequence of the deployment of human activities in forests. Federici et al. (2015) investigated the emissions more thoroughly by making use of the most recent Forest Resource Assessment[6] by FAO (2015c) and considered the impact of deforestation and forest degradation separately. They found that emissions through deforestation have decreased significantly (from an average of 4.0 Gt CO_2 per year during 2001-2010, to 2.9 Gt CO_2 per year during 2011-2015). Longitudinal analysis demonstrates that as such, the importance of land-use change in global CO2 emissions decreased from 36% in 1960 to 9% in 2006-2015 (The Global Carbon Project 2016). Brazil accounts for half of this reduction on its own, indicating that deforestation remains problematic in other countries and regions. Indeed, tropical South America is held responsible for 1.3 Gt of CO2 emissions, but simultaneously Brazil managed to achieve the largest decline in annual forest loss (20 000 km2/year) in this region. This indicates that other countries in the tropical region experience greater percentage of forest cover loss (Hansen et al. 2013). Note that part of the carbon emissions related to land-use change is a consequence of specific (accidental) events. Increased fires during dry El Niño conditions in Asia for example resulted in above average emissions in 2015 (The Global Carbon Project 2016). Concerning forest degradation, Federici et al. (2015) observe an opposite trend: emissions from forest degradation have increased three-fold (from 0.35 Gt CO_2 during 1991-2000 to 0.9 Gt CO_2 during 2011-2015).

Note that the decreasing emissions from deforestation do not suggest deforestation has been halted. In contrast, due to continuous deforestation and forest degradation, forests perform worse as a net carbon sink at global level. During 2001-2010, forests removed 2.2 Gt CO_2 per year. However, they could

[6] These assessments monitor the state of the world's forests on a five to ten year interval. The most recent available assessment was published in 2015.

only remove 2.1 Gt CO_2 per year during 2011-2015. As such, forests have lost 5% of their capacity to contribute as global carbon sinks (Federici et al. 2015).

A well-known indicator for the human pressure on nature is the environmental footprint[7] (Galli 2015). The environmental footprint quantifies the 'human appropriation of natural capital as a source or a sink' (Hoekstra and Wiedmann 2014). This provides an estimate of the surface of land required as a resource and the surface of land needed as a carbon sink. At present, human appropriation of bio productive area requires the equivalent of 1.6 Earths, with per capita footprints being much higher in high-income countries compared to middle- and low-income countries (Global Footprint Network 2017).

A two-step procedure determines the environmental footprint. At the first stage, 'unit' environmental footprints are calculated for a single human activity or process. At the second stage, those unit environmental footprints can be aggregated in order to calculate the footprint of a product, consumer, producer, or for an entire geographical region. Hence, the footprint can also be calculated at global level by aggregating the footprints of all human activities across the globe (Hoekstra and Wiedmann 2014).

Aggregation also allows us to determine the share of the footprint related to demand for forest products within the global environmental footprint. Three types of primary products compose the overall forest products footprint: fuel wood, wood and pulp used as raw material to produce derived wood products (Lin et al. 2016). The forest products' footprint can be interpreted as the area of forest land which is needed to supply the required volume of wood for fuel and derived products[8]. In 2016, the forest product footprint accounted for 9.63% of the total global environmental footprint (Global Footprint Network 2016). This is a higher share than the footprint of built-up land[9] (2.26%) fishing grounds (3.10%) and grazing land (5.58%). Only cropland (19.85%) and the carbon footprint (59.57%) account for higher shares in the total global environmental footprint. Note, however, that the carbon and forest products' footprints are presented separately. This results in an underestimation of the contribution of forests to global carbon emissions, since forest degradation and deforestation has an indirect relationship to the carbon footprint[10] (Lin et al. 2016).

[7] This metric only considers the aspect of bio capacity (to produce for example fuel wood and wood products) in order to assess the impact of human pressure on nature. It does not take other negative externalities into account (e.g. pollution, loss of habitat,…) (Galli 2015). The environmental footprint is different from the ecological footprint which quantifies the amount of the Earth's energy that someone uses.

[8] The footprint of forest products is calculated by comparing wood harvests to annual net growth rates of forests at global level. The required data for these calculations stems from numerous databases including FAO statistics and the Intergovernmental Panel on Climate Change (Lin et al. 2016).

[9] The built-up land footprint equals the area of bio productive land which is occupied by human activities.

[10] The carbon footprint equals the required forested area to sequester carbon emissions. The amount of carbon which can be allocated to a specific region/country depends on the conversion factor which is calculated by taking four factors into account: 1) yield of productive land required to absorb carbon, 2) amount of carbon into

2.4. Sustainable forest management: climate change mitigation and economic opportunity

According to Federici et al. (2015), maintaining and increasing the importance of forests as a carbon sink can be achieved through:

- Avoiding deforestation
- Avoiding forest degradation
- Afforestation of degraded land

Theoretically, both deforestation and forest degradation can be avoided through sustainable forest management (Brandt et al. 2016). Hence, sustainable forest management becomes an important instrument for climate change mitigation (and biodiversity conservation). Sustainable forest management does not necessarily imply that the forests should become non-productive. Instead, forests are, and should be, 'more than trees' and are essential for food security and improving livelihoods (FAO 2015a). This is confirmed by Canadell and Raupach (2008) who state that 'with political will and the involvement of tropical regions, forests can contribute to climate change protection through carbon sequestration as well as offering economic, environmental, and sociocultural benefits'. Also the outcomes of the FAO's XIV World Forestry Conference stress the economic importance of forests by emphasizing the role of 'forests, trees, and forestry in national economic development' (FAO 2015a).

An non-exhaustive list of economic benefits of the presence and exploitation of forests in a region includes employment and income generation in forest restoration, forest conservation, wood production and wood-based manufacturing; tenure reform which can guarantee local communities' rights; payments for forest-related services; providing food, energy, shelter, fodder and fiber; and sustaining agriculture (FAO 2015a, FAO 2013).

The reason to stress the economic importance of forests in sustainable forest management is twofold. First, the economic importance of forests at present is considerable. The World Bank (2016) calculated how forests annually generate a gross value added of about 1% of the global GDP, this is the equivalent of 560 billion euro. In some countries, forests account for a more important share in national GDP (e.g. 6% in Cameroon). About 350 million people depend on forests for subsistence and income. Of those, 60 million people are completely dependent on forests[11] (Newton et al. 2016, World Bank 2016).

oceans, 3) an equivalence factor for carbon as land type, 4) adjustment factor for temporal changes in forest yields (Lin et al. 2016).

[11] An entire debate on the definition of 'forest-dependent people' exists. Newton et al. (2016) nicely provided an extensive overview of the different aspects of forest-dependency and indicated that, depending on the applied

Second, avoiding the use of wood prevents forestlands from generating economic rents. A vast body of literature argues that forestlands with no or low rents are more prone to conversion into other uses which generate higher rents (e.g. agriculture, plantation forests, pasture). In this context, safeguarding the long-term wood stock in sustainably managed forests can generate competitive rents and avoid land conversion (Agrawal et al. 2008, Angelsen 2010, Brandt et al. 2016, STTC 2016). Other research comes to conflicting conclusions, however, as proof cannot be found that sustainable forest management which simultaneously allows wood extraction avoids deforestation (Blackman et al. 2015, Brandt et al. 2016) or forest degradation (McDermott et al. 2015).

2.5. Initiatives to promote sustainable forest management

As mentioned, sustainable forest management and reforestation are key in the concept of forest transition. However, forest transition (recovery) cannot solely be explained by the stage of economic development or level of GDP per capita. Numerous authors describe how forest transitions in low- and middle-income countries are also influenced by institutional aspects such as the rule of law, forest policy and regulatory quality (Barbier and Tesfaw 2015), property rights, level of corruption (Wolfersberger et al. 2015), and market distortions (Barbier et al. 2017). Hence, governance quality is assumed to be crucial for forest transition. Sloan (2015) however urges caution 'in designing specific government policies to encourage the forest transition'. In Panama, he observed how forest transition might as well be the result of gradual transformation of economies (e.g. a shift in employment over several decades from agricultural to off-farm activities).

Governance is not only key in facilitating forest transitions. It also is key in developing sustainable forest management techniques. Numerous initiatives promote sustainable forest management practices. These initiatives are too different in scale and funding, scattered, and region-dependent for a comprehensive overview to be provided. Instead, this section discusses the main international strategies to promote sustainable forest management, and focuses on the strategies that are further discussed in the following chapters of this thesis. Afforestation strategies are not discussed in detail because they link less to sustainable forest management. Nevertheless, international organizations pay ample attention to afforestation projects[12].

In recent history, one of the main international initiatives is REDD+, short for 'Reducing Emissions through avoided Deforestation and Forest Degradation'. REDD+ emerged out of the UNFCCC

definition, very diverse numbers can be found for forest-dependent people. The estimate applied by the World Bank research is a rather nuanced number. Estimates mentioned by the European Sustainable Tropical Timber Coalition, for example, mention 1.6 billion forest-dependent people.

[12] E.g.: numerous afforestation and reforestation projects are covered under the clean development mechanism. However, the uptake of these projects proceeds slowly, however. UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2013). Afforestation and Reforestation Projects under the Clean Development Mechanism. Bonn, Germany.

negotiations and aims to provide financial incentives for developing countries to halt deforestation, conserve biodiversity, and mitigate climate change. The financial incentive represents remuneration for the carbon captured in trees, or avoided carbon emissions. This remuneration should be funded through the emergence of a carbon market. Ultimately, this should also encourage sustainable development and reduce poverty in the countries concerned (IIED 2017).

At its start in 2005, REDD+ was known as REDD (without plus) and mainly aimed for reducing emissions from deforestation and forest degradation. At UN COP-16, it was decided to add three new elements. A plus was added (resulting in REDD+) to stress the additional foci:

- Conservation of forest carbon stocks
- Sustainable management of forests
- Enhancement of forest carbon stocks

As such, REDD+ aims for forests which simultaneously contribute to poverty alleviation and ecological issues (climate change mitigation, biodiversity conservation and sustaining vital ecosystem services) (UN REDD 2017).

Since 2005, over 500 REDD+ projects have benefited from financial support. Those projects considerably differ in nature. Angelsen and Rudel (2013) describe how the efficiency of forest conservation strategies within the context of REDD+ depends on the phase of forest land use. In the situation of large forest cover and limited deforestation, a region should implement projects with a focus on improved forest management. Regions facing deforestation should implement projects which generate payments for reduced deforestation. If the forested area is about to recover, or in the process of forest transition, the REDD+ projects should focus on reforestation.

However, most of these projects received funding from multilateral and bilateral donors (e.g. the World Bank, UN REDD initiative). Only ten percent of these projects received funding through the carbon market, which was the initially intended source of funding (Fletcher et al. 2016, Corbera and Schroeder 2011). This indicates that the implementation of REDD+ faces problems in securing funding. In addition REDD+ faces difficulties in overcoming opposition by local communities who are suspicious of outsiders' interference (Hajjar and Kozak 2017, Sunderlin et al. 2015, Yasmi et al. 2012). Consequently, the future for REDD+ has started to look less bright. Fletcher et al. (2016) describe how the UNFCCC COP21 Paris agreement still mentions REDD+ as part of its forest conservation strategy, but that the market-based mechanism to generate carbon credits has already finished. More in particular, they claim that the required remuneration (i.e. at least the revenue they seek to offset) is too high.

McDermott et al. (2015) identify two other 'widely promoted strategies to govern tropical forests': state-based legality initiatives and non-state eco-certification. Both strategies are trade-based

governance initiatives that aim to foster explicit demand for wood which is extracted legally, out of sustainably managed forests, respectively (McDermott et al. 2015, Elliott 2000). A certificate demonstrates compliance with the legality and sustainability requirements, respectively. It is expected that a high demand for certified wood products stimulates compliance with the legality or sustainability standards on the supply side of the market. This can positively impact on sustainable forest management practices and forest conservation (Damette and Delacote 2011).

Hence, like REDD+, both initiatives adhere to the idea that sustainably managed forests should allow wood extraction. However, unlike REDD+, the legality and eco-certification initiatives require a high involvement on the demand side of the wood market. Consumers are an involved party in the final stage of the value chain and should not be considered as interfering outsiders. This approach could prevent the community-outsider conflicts which often impede the implementation of REDD+ projects (Yasmi et al. 2012). At present, no specific reference has been found that describes a lower risk for community-outsider conflicts in the case of legality-, or eco-certification. However, a Web of Science query which combines 'outsider' and 'REDD+' finds 6 relevant articles on community-outsider conflicts[13], while various queries looking for community-outsider conflicts in eco-certification or legality initiatives do not find relevant articles. This at least indicates that this problem is less topical in the latter context. Both types of certification are discussed in more detail in the following sections.

2.5.1. Eco-certification

Eco-certification of forest and wood products became an important tool to improve producers' environmental performance (Blackman and Naranjo 2012, Jaung et al. 2016). Eco-certified producers must comply with various sustainability standards which aim for more sustainable forest management (Cashore et al. 2006)[14]. Those standards include both environmental and social guidelines (Murray and Abt 2001).

The Forest Stewardship Council (FSC) and the Programme for Endorsement of Forest Certification Schemes (PEFC) dominate the international certified wood market (FAO 2014a). They reported a combined global total of 462 million hectares of certified forests in May 2016 (UNECE 2016). This includes (an estimated) 29.5 million hectares of double certified forest area. Excluding the double certified forest area, FSC and PEFC together certify 10.9% of the global forest area. According to UNECE (2016), 29% of global industrial roundwood production originates from the certified forest

[13] Including: PATEL, T., DHIAULHAQ, A., GRITTEN, D., YASMI, Y., DE BRUYN, T., PAUDEL, N. S., LUINTEL, H., KHATRI, D. B., SILORI, C. and SUZUKI, R. (2013). 'Predicting future conflict under REDD+ implementation', *Forests*, Vol. **4**, pp. 343-363, YASMI, Y., KELLEY, L., MURDIYARSO, D. and PATEL, T. (2012). 'The struggle over Asia's forests: An overview of forest conflict and potential implications for REDD+', *International Forestry Review*, Vol. **14**, pp. 99-109. MULYANI, M. and JEPSON, P. (2015). 'Social learning through a REDD+ 'village agreement': Insights from the KFCP in Indonesia', *Asia Pacific Viewpoint*, Vol. **56**, pp. 79-95.

[14] This includes protecting old growth forests, conserving natural habitats, and encouraging local employment.

area. However, the regional distribution of the certified forest area is apparent. The Northern hemisphere accounts for 87% of the global certified forest area, while the Southern hemisphere only accounts for 13% (UNECE 2016).

The geographical concentration of certified forest area in the Northern hemisphere could be explained by differences in the costs relating to certification. This cost consists of a direct and an indirect component. The direct costs are the costs of the certification process[15] and do not differ regionally. Because the direct costs are independent of the country and enterprise, they are harder for small-scale producers to bear. Consequently, small-scale and community-based enterprises face greater difficulties in obtaining certification (Nebel et al. 2005). Small-scale producers are generally found in the Southern hemisphere (Dranove and Jin 2010)[16]. The indirect costs comprise all costs required to change management practices to meet certification standards (Bass 2001)[17]. The magnitude of the indirect cost is inversely related to the quality of the current practices. This rationale is in line with research by Vedel et al. (2015) who found greater reluctance for providing eco-system services by producers with poor management practices. Poorly managed forests are mainly situated in the Southern hemisphere, resulting in higher indirect certification costs in this hemisphere. In addition, producers in developing regions also face other barriers to certification, such as a lack of information and political support (Damette and Delacote 2011, Carlsen et al. 2012). Low institutional quality in developing regions has also been identified as an obstacle to forest transitions.

Despite these difficulties in the South, forest certification is considered a useful tool for the conservation of – especially – tropical forests. Traditional conservation policies, such as international forest conservation agreements, national forest policy reform, and the creation of additional protected areas, were not able to significantly reduce unsustainable logging in tropical forests (Auld et al. 2008). This was partly because the governments responsible for the tropical forests lack the capacity to adequately manage natural resources and enforce pertinent forestry and land-use regulations (Ebeling and Yasué 2009, Kramer et al. 1997) and to provide secure land tenure (Smith et al. 2003). As a result, in the last two decades, market-based instruments involving non-state actors, such as forest certification, have been promoted as economically attractive alternatives that are less dependent on public resources and governance capacity and are, therefore, potentially more effective in tropical

[15] Audit costs, certification fees, and the costs of meeting corrective action requests (CARs). CARs might, for example, imply changes to forest management techniques following an observed infringement during an audit.
[16] Notice the discrepancy between the scale of ownership and production. Forest landownership is the Global South is highly skewed, which also implies the presence of large landowners. Large landowners might be small scale wood producers if they do not use all available forested area to produce wood. According to Brandt (2016), approximately half of the remaining global permanent tropical forest estate is used for wood production.
[17] E.g. higher investment in infrastructure and machinery in order to be able to harvest more efficiently with lower impacts, higher wage costs by paying legally specified wages and providing social benefits, and opportunity costs of reducing wood production to sustainable levels.

developing countries (Gullison 2003, Auld et al. 2008). This turns forest certification into a transnational, non-governmental approach to environmental regulation and development.

According to the assumption of competitive behavior, producers will only switch to certified production if the additional costs are compensated by a price premium (Carlsen et al. 2012). This is confirmed by the *International Tropical Timber Council* who claims that without 'tangible benefits deriving from certification in terms of profitability or competitiveness, enterprises will have little incentive to improve forest management with higher costs' (ITTC 2004)[18]. The small certified forest area in the Southern hemisphere suggests that the price premium does not cover the higher costs in this hemisphere (Carlson and Palmer 2016, Simula et al. 2004).

It is reasonable to assume that environmentally aware consumers are willing to pay a price premium in order to acquire sustainably produced wood products (Agrawal et al. 2014). While certified and conventional wood are physically homogenous, the certified products are differentiated by their credence qualities (Dulleck et al. 2011). The credence qualities relate to environmental and societal-friendly production practices that entail additional costs which require remuneration on top of the conventional wood price (Ferraro and Kiss 2002, Ferraro and Simpson 2002, Groom and Palmer 2010, Dulleck et al. 2011, Groom and Palmer 2014, Carlson and Palmer 2016, Brusselaers et al. 2017). This price premium turns certification into a market-based instrument with voluntary price signals (Pirard 2012, Veisten 2007). However, the price premium is not the result of a contingent valuation method which monetarizes the environmental and societal gains. Instead the price premium only represents the consumers' marginal utility for the credence qualities of certified wood. An increasing body of literature analyses the monetarization of ecosystem services (e.g. Schaubroeck 2016, Scarlett 2015) but this discussion falls outside the scope of this thesis.

FSC and PEFC adhere to different strategies concerning the price premium, however. On the one hand, FSC explicitly pursues a price premium. Depending on the type of operation and wood, certified products would fetch a price premium of up to 25% (FSC 2012). On the other hand, PEFC does not necessarily expect a price premium for all types of wood (PEFC 2001).

FSC and PEFC do not only differ with respect to their stance on the price premium, but also in terms of their main approaches. While FSC has designed universal principles that must be applied locally, PEFC harmonizes criteria and indicators drawn up at regional level (Levin et al. 2008). Both certification schemes are engaged in fierce competition, which occasionally results in the questioning of each other's trustworthiness (PEFC 2009). However, the competition between both certification

[18] Other authors claim intangible benefits (e.g. learning, community empowerment,…) (Carlson and Palmer 2016).

schemes is welcomed by many, since the presence of two competing global schemes ensures good protection of all stakeholders' interests (PEFC 2011).

Whether or not certification is effective in sustaining forest management and entailing a positive societal impact is an important discussion, but not part of this thesis. Multiple case studies have investigated the impact of PEFC and/or FSC. The conclusions are not homogenous. Most authors acknowledge a positive impact on forest conservation and sustainable forest management practices, and societal aspects (Damette and Delacote 2011, Miteva et al. 2015, Nebel et al. 2005, Blackman and Naranjo 2012). On the other hand, some authors stress the danger of overestimating the potential of voluntary eco-certification (Alves-Pinto et al. 2015, Lambin et al. 2014, Dauvergne and Lister 2010).

Nevertheless, within the context of forest transitions, eco-certification can in theory contribute to forest recovery. Barbier and Tesfaw (2015) describe how forest transitions can, among others, be achieved through the conservation of primary forest and plantations. Eco-certification and legality verification ultimately aim for forest conservation and sustainable forest management. In addition, the certification schemes (and subsequently the legality initiatives) more recently developed principles for certified plantation management. The emergence of plantations is identified as a second driver for forest transitions by Barbier and Tesfaw (2015).

2.5.2. Legality initiatives

An increasing number of developed countries are making it unlawful to import or trade illegal wood (products). Illegal wood in this narrative is harvested, processed, transported, bought, or sold in contravention of national and international laws (European Commission 2017d). Some examples:

- United States of America (USA): the Lacey Act was introduced in 1900 to ban the transport of illegally captured animals or wildlife products into the USA. In 2008, this Act was amended to extend its scope to include wood, paper and other forest products (Prestemon 2015).
- Australia: the Illegal Logging Prohibition Act was passed in 2012. In accordance with the US Lacey Act, the Australian act prohibits the import of illegally logged wood and wood products into Australia, and prohibits the processing of Australian-grown logs that have been illegally harvested (European Commission 2017a).
- European Union (EU): the FLEGT Action Plan was established in 2003. FLEGT is short for 'Forest Law Enforcement, Governance and Trade' and aims to reduce illegal logging by 'strengthening sustainable and legal forest management, improving governance and promoting trade in legally produced wood' (European Commission 2017d, Tegegne et al. 2017). This action plan targets tropical countries in particular (Wodschow et al. 2016, Wan and Toppinen 2016). Part of FLEGT is the EU Timber Regulation (EUTR) which bans illegal timber imports.

Both the Lacey Act (USA) and FLEGT (EU) assign the responsibility for the proof of legality to wood operators. From this point on, this section further investigates the EU-context.

In the EU, the EUTR stipulates the requirements of a Due Diligence System (DDS). The three key elements of the DDS are 1) Information: The operator must have access to information describing the wood and wood products, country of harvest, species, quantity, details of the supplier and information on compliance with national legislation. 2) Risk assessment: The operator should assess the risk of illegal wood in his supply chain, based on the information identified above and taking into account criteria set out in the regulation. 3) Risk mitigation: When the assessment shows that there is a risk of illegal wood in the supply chain that risk can be mitigated by requiring additional information and verification from the supplier (European Commission 2015b). The DDS requirements were established in 2013 (Leipold 2016).

The establishment of the DDS comes with a cost at company level, this could potentially result in a non-tariff trade barrier (Global Timber Platform 2017, Xu 2000). Therefore, FLEGT provides the possibility of negotiating a Voluntary Partnership Agreement (VPA) (Lesniewska and McDermott 2014). A VPA is a 'legally binding trade agreement between the EU and a wood-producing country outside the EU' (European Commission 2017d). The trade agreement combines legality licensing with multi-stakeholder processes[19] which aim to address underlying problems of forest governance in the country concerned (Lesniewska and McDermott 2014). Addressing the underlying problems can require both environmental and societal efforts in the wood-producing countries. In their turn, environmental- and societal-friendly production practices restrict forest management options and can increase production costs (Van Deusen et al. 2010). An alternative to a VPA in order to bypass the DDS is the use of eco-certificates, which is further discussed in the next section and chapter 5.

A country can only award FLEGT legality licenses to its operators on the precondition of an EU-approved legality assurance system. FLEGT licensed operators gain automatic access to the EU market (Carodenuto and Cerutti 2014) and bypass the DDS requirements (Wodschow et al. 2016, European Commission 2017b). Since VPAs are bilateral agreements, the processes of negotiation and implementation, and the type of wood products covered by the VPA differ for each country (European Commission 2017b, Wiersum and Elands 2013, Van Heeswijk and Turnhout 2013). Consequently, the impact of the VPAs also differs across the world. At present, only Indonesia is issuing FLEGT licences, the procedure for FLEGT licensing is briefly described below (EU FLEGT Facility 2016):

- Only FLEGT-licensed organisations (companies, state-owned organisations,…) can export FLEGT-licensed wood towards the EU;

[19] With, for example, a focus on support to civil society for independent forest monitoring, capacity building for forest ministry officials, public awareness-raising regarding the importance of reducing illegal forest activities or addressing legal issues, such as unclear or contradictory forest-related laws and weak community rights.

- Organisations applying for a FLEGT-license at company level must pass an audit by a licensing authority (e.g. in Indonesia, there are 22 recognised licensing authorities registered with the Ministry of Environment and Forestry). Wood producers can obtain a 'Valid legality or sustainable forest management certificate'. Wood operators can obtain a 'Suppliers declaration of conformity';
- The costs of the FLEGT audit at company level are borne by the company itself (i.e. the wood-based industries, wood depots, traders including exporters, and small-scale privately owned – household or cooperative – forests);
- A FLEGT-licensed organization must conform to the relevant legality standard;
- FLEGT licensed companies can obtain a FLEGT license for a specific shipment by applying in writing to the licensing authority with which it holds a contract. The following documents should be attached:
    - A summary of the transport documents for all wood/raw materials received by the factory since the last audit (up to maximum of 12 months)
    - Summaries of Wood/Raw Material Balance-Sheet Report, and Processed Wood Balance-Sheet Report since the last audit (up to maximum of 12 months)

FLEGT licenses can only be issued for products within the product scope of the VPA's annexes. Logs, sawn timber, plywood, veneer and railroad sleepers are the minimum products that are covered in all VPAs. It is possible to include other types of products, and exclude products which can never be licensed. Products out of the VPA's scope (or originating from countries without a VPA) must pass the Due Diligence check. Note that VPAs are bilateral agreements. Hence, if FLEGT-licensed wood is first processed (or mixed with other wood) in a country which does not issue FLEGT licenses, it will lose its FLEGT license. In this case, the originally FLEGT licensed would has to pass the Due Diligence check again.

At present, the EU has signed a VPA with six countries: Cameroon, Central African Republic, Ghana, Indonesia, Liberia, and Republic of the Congo. Currently, only Indonesia is issuing FLEGT licenses. Nine other countries are in the process of negotiation: Côte d'Ivoire, Democratic Republic of the Congo, Gabon, Guyana, Honduras, Laos, Malaysia, Thailand, and Vietnam. In accordance with the observation in the context of forest transition, it can be expected that the uptake of legality verification through VPAs is positively correlated to a region's institutional quality.

2.5.3. Interaction between different initiatives

Albeit presented separately, a number of the identified initiatives for sustainable forest management interact. The European Commission (2016e), for example, describes how active engagement emerged with REDD+ and FLEGT in numerous tropical countries. This allows us to build on the interactions between the two processes (they have the same goal to some extent) and make better progress on

delivering the objectives of both. Possible benefits of cooperation between REDD+ and FLEGT are: advancement of forest governance reforms, clarification of land tenure, strengthening stakeholder engagement and balancing competing interests.

FLEGT (and its EUTR) also closely interacts with the 'demand-led, market-based' initiatives such as FSC and PEFC (Lambin et al. 2014). Both eco-certification schemes are in full compliance with the EUTR requirements (Trishkin et al. 2015, PEFC 2016). For this reason, both eco-certificates are accepted, and explicitly mentioned as sufficient proof of legality within the EUTR (UNECE 2015), and eco-certified wood can pass a 'due diligence light' which entails lower costs. This has also resulted in increased investment in eco-certification schemes by wood importers who want to ensure sufficient supply of legal and sustainable wood (European Commission 2014).

In addition, the European Commission (2014) rightfully refers to policies at national level in support of legal and sustainable wood which partially depend upon eco-certification. These national policies focus on 'areas outside the responsibility of the European Commission, such as government procurement'. At present, government procurement is gaining momentum as a tool to foster the production and consumption of environmentally-sustainable goods and services (Schaltegger et al. 2014). Once governments take environmental and societal criteria into account, in addition to purely economic criteria, when procuring goods and services, this is referred to as Green Public Procurement (GPP). On the supply side of the market, GPP must spur the introduction of innovations involving sustainable techniques and practices. On the demand side of the market, GPP must reduce the transaction costs for adapting to new products and stimulate the uptake of innovations (Edler et al. 2015).

An increasing number of governments at national[20], European[21], and international[22] level, explicitly refer to the two main certification schemes: FSC and PEFC. Those governments recognize certificates as sufficient proof of compliance with the green criteria for wood. More details on GPP and its link with eco-certification are provided in chapter two.

According to Gulbrandsen (2014), governments must not only support (non-governmental) eco-certification schemes by purchasing eco-certified wood themselves. In addition, they can also support

[20] E.g. Belgium, Denmark, Germany, the UK, and the Netherlands use their own adapted criteria and processes to determine whether certification schemes provide sufficient assurance for GPP. The current consensus of these Member States is that, in general, FSC and PEFC provide sufficient levels of assurance based on their national criteria. EUROPEAN COMMISSION (2012). Green Public Procurement a collection of good practices. Luxembourg.

[21] E.g. FSC and PEFC are explicitly recognized as sector specific labels in the EC's handbook on GPP EUROPEAN COMMISSION (2016b) *Buying green! A handbook on green public procurement. 3rd Edition*, Brussels.

[22] FSC and PEFC comply with the internationally agreed reference point ISO/IEC 17065 EUROPEAN COMMISSION (2016c). 'Green Public Procurement Criteria for Office Building Design, Construction and Management', in JRC (ed.), Seville, pp. 140.

eco-certification by providing additional services to the producers (e.g. expertise and technical advice, as well administrative or financial support).

3. Objective, scope and methodology

The second section of this chapter described the contribution of forests to climate change mitigation and biodiversity conservation, and how three challenges must be addressed in order to safeguard forests' ecosystem services: combat deforestation, combat forest degradation, promote afforestation. Different types of initiatives and policies aim to address these challenges, but this thesis specifically on the analysis of policy options which aim to impose sustainability standards to wood production through signaling preferences at the demand side of the market. Figure 1-2 provides a visual summary of this rationale as it describes how eco-certification and legality verification can formalize the sustainability standards.

The following sections provide a more thorough overview of the objective, scope and outline of this thesis. This overview demonstrates how three of the four chapters are situated at the crossroads of Environmental and Resource Economics at the one hand and International Economics at the other hand. Chapter 3 is situated in Consumer Economics.

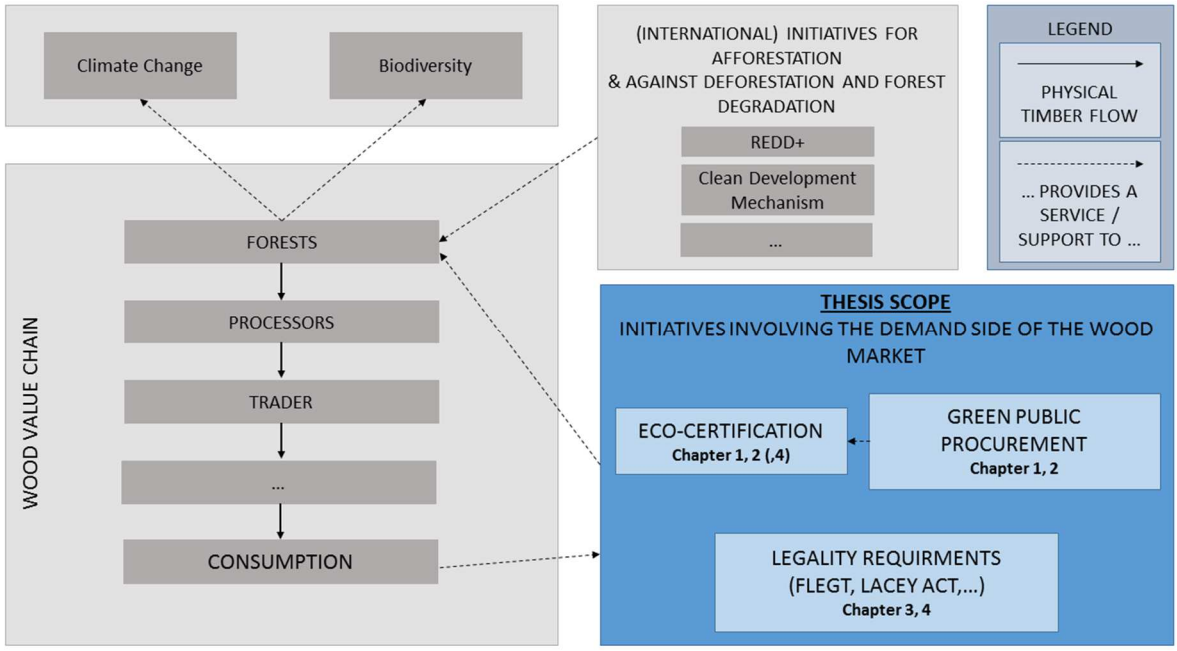

Figure 1-2: Scope of the thesis.

3.1. Thesis objective

This thesis focuses on the economic analysis of policies which aim to sustain forest management and wood extraction from forests by signaling preferences for sustainable wood at the demand side of the

market. This should impose sustainability standards to the production of wood (products). Only policies which (can) originate in the EU are considered.

By setting criteria, the demand side of the market can influence the value chain in order to sustain forest management. This is visualized in Figure 1-2 as it positions the (theoretical) potential role of the wood value chain and the sustainability initiatives in order to safeguard forest ecosystem services in the context of climate change and bio-diversity conservation. As indicated in the lower right building block in Figure 1-2, the initiatives that emerge out of the demand side of the market encompass both non-governmental eco-certification and state-based legality initiatives (McDermott et al. 2015). However, governmental and non-governmental initiatives can closely interact. Governments can for example design policies such as GPP in support of non-governmental eco-certification.

3.2. Policies out of scope

All policies which do not imply consumer involvement and the setting of (legality or environmental) standards through signaling preferences at the demand side of the market are outside the scope of this thesis. The policies out of scope are visualized in the upper right building block in Figure 1-2 ('(International) Initiatives for afforestation & against deforestation and forest degradation') and for example include REDD+ [23].

In addition, it should be noted that the concerned policies and initiatives specifically focus on wood extraction, as wood is the product bought by consumers. Consequently, the initiatives focus more on sustainable management of existing forest than on pure afforestation projects. Note that FSC and PEFC do not specifically identify afforestation as a goal, although FSC does indicate that its principles can be applied to afforestation projects (FSC 2016).

3.3. International impact assessment of EU-initiated policies

Albeit this thesis focuses on policies that are initiated in the EU, there is a need to conduct an impact assessment of these policies at international level. This is motivated by the observation that regional wood markets are 'increasingly linked through international trade and global environmental policies' (Raunikar et al. 2010). These linkages, allow a pass-through effect of demand and supply shocks in one region to other regions' wood markets. Accordingly, one region's forest conservation policy can lead to deforestation in other regions (Gan and McCarl 2007, Sedjo and Sohngen 2013). As such, the interlinkages through trade can become an 'important driver of environmental degradation' (Heilmayr and Lambin 2016).

[23] In addition to all other international forest conservation agreements, national forest policy reform, and the creation of additional protected areas.

These observations and statements validate the assumption that policies that are originally initiated in the EU can entail a global impact. Furthermore, this assumption is strengthened by the observation that the EU is responsible for 20 to 40 % of global purchases of wood products (depending on type) (FAO 2015b). Also, eco-certification could potentially contribute towards addressing these international issues, as eco-certification is a transnational approach towards forest conservation (Auld et al. 2008).

The need for a global assessment of policies calls for techniques applied in international economics, such as spatial equilibrium modelling of international trade flows and time series analysis of historical trade flows. The methods applied are briefly explained in the following section.

3.4. Thesis outline: research questions and methods

This section provides a brief overview of the remaining chapters of this thesis. Each chapter addresses (aspects of) a policy that aims to support initiatives which aim to sustain wood production and forest management through the signaling of preferences at the demand side of the market. Chapter 2 and Chapter 3 further analyze aspects of Green Public Procurement (GPP) of eco-certified wood by governments. This policy aims to promote the uptake of the sustainability standards set by non-governmental eco-certification schemes. Chapter 4 and Chapter 5 analyze FLEGT as a state-based legality initiative. The following sections discusses this in more detail per chapter.

3.4.1. Modelling green public procurement of eco-certified wood (Chapter 2)

The first chapter analyses to what extent Green Public Procurement (GPP) of wood in Europe succeeds in stimulating the uptake of sustainable wood production and consumption at global level. Sustainable wood in this narrative, as in many examples in reality (see section 2.5.3), is defined as eco-certified wood.

This chapter modifies the standard spatial equilibrium model (SEM) by Takayama and Judge (1971) in order to analyze the aspired pass-through effect of GPP in the EU on sustainable wood production and consumption around the world. The novelty of the SEM is found in the introduction of certified next to conventional products. Albeit both types of wood are substitutes, the traditional multi-product models cannot be used. The price mechanisms between both products are not based on substitutability, but on the price premium. A second modification allows analysis of the impact of government spending by distinguishing the governments' share of final consumption from the households' share. The price mechanism uncovered enables better policy recommendations.

3.4.2. Measuring private consumers' support for green public procurement (Chapter 3)

GPP is designed to stimulate both the production and consumption of sustainable (eco-certified) wood (Edler et al. 2015). Therefore, this chapter for the first time analyses to what extent private consumers support GPP.

This chapter uses cross-sectional survey data through questionnaires. This allows us to establish distinct consumer profiles in terms of demographics, attitudinal and behavioral characteristics. The distinct profiles are formed using a two-step segmentation process that combines K-means and hierarchical segmentation. Attitudes are compared between these distinct profiles in different scenarios in order to uncover unconscious (self-centered) drivers for purchasing eco-certified wood. This chapter's conclusions provide new insights with regard to some commonly accepted drivers for sustainable purchases (e.g. environmental concern, perceived consumer effectiveness, and the subjective norm).

3.4.3. Historical analysis of legality requirements to wood imports in the EU (Chapter 4)

This chapter, for the first time, investigates the impact of a Voluntary Partnership Agreement (VPA) during the implementation process, and its entry into force, by using historical trade data at macro-economic level. A VPA must eventually offer the possibility of issuing FLEGT licenses which grant automatic access to the EU's wood market. In this context, the FLEGT license serves as proof of legality. This chapter's analysis uses a Vector Autoregression, in combination with the identification of a structural change point. This allows us to benchmark Cameroon's wood exports against its regional counterfactual.

The case of Cameroon is selected because of the importance of Cameroon as a wood exporter, and because Cameroon was one of the first to negotiate and conclude a VPA (2007 and 2010 respectively). The VPA finally came into force in 2011 (Tegegne et al. 2017). This chapter finds an unusual pattern of anticipative and rent-seeking behavior prior to the VPA coming into force. This implies that the VPA implementation process can significantly impact on trade flows. In addition, the VPA coming into force appears to negatively impact on trade flows. This chapter's conclusions provide valuable insights for current and future VPA negotiations. At present, the EU is negotiating a VPA with nine different wood producing countries.

3.4.4. Modelling legality requirements to wood imports in the EU (Chapter 5)

The modified SEM which has been developed in Chapter 2 is modified in order to analyze the impact of the legality requirements on the EU's wood market. Two instruments can release wood operators from the burden of providing sufficient proof of legality: eco-certification and FLEGT-licensing. Both instruments imply a type of labelling (albeit they are respectively non-governmental and governmental in nature). Hence the modified SEM's structure, which allows the introduction of labelled (eco-

certified in Chapter 2) next to conventional products, also allows analysis of the impact of the EUTR's legality requirements on the international trade of wood.

This analysis' output describes underlying price mechanisms which can explain the negative impact of Cameroon's VPA coming into force, as observed in reality (Chapter 4). Understanding this price mechanism is essential for policy recommendations in the context of the promotion of sustainable and legal wood production (and consumption) by setting minimum standards on the demand side of the wood market.

Chapter 2. Green Public Procurement of Certified Wood: Spatial Leverage Effect and Welfare Implications

Abstract. This chapter presents a novel spatial equilibrium model to analyze the leverage effect of green public procurement (GPP) in Europe on demand and supply of sustainable wood. This leverage effect is an argument in favor of GPP but it has never been investigated thoroughly, or simultaneously for demand and supply. Our research finds that GPP provides an incentive for certification at global level. By tapping into previously unused potential consumer and producer surplus, the policy also increases global welfare. Unfortunately, these are not Pareto improvements. A trade barrier emerges due to the home-effect of domestic consumption patterns. This trade barrier reduces the importance of certification and/or welfare in some regions.

Context: Modified Spatial Equilibrium Model in order to investigate the impact of Green Public Procurement on global consumption and production of eco-certified wood

Based on:

Brusselaers, J., Van Huylenbroeck, G., Buysse, J. (2017). 'Green Public Procurement of Certified Wood: Spatial Leverage Effect and Welfare Implication', *Ecological Economics*, Vol. 135, pp. 91-102.

1. Introduction

This chapter analyses the impact of Green Public Procurement (GPP) of wood in Europe. GPP implies that governments take environmental and sustainability criteria into account in addition to purely economic (i.e. price) criteria when procuring goods and services. This can result in a considerable demand shock since government procurement accounts for a substantial proportion of final wood consumption. Within the EU, this share is estimated at 26.88% (EUROSTAT 2015).

GPP is gaining momentum as a tool to foster the production and consumption of environmentally-sustainable goods and services (Schaltegger et al. 2014)[24]. On the supply side of the market, GPP must spur the introduction of innovations involving sustainable techniques and practices. On the demand side of the market, GPP must reduce the transaction costs for adapting to new products and stimulate the uptake of innovations (Edler et al. 2015).

The EU formally introduced the possibility for GPP in 2004. Since 2014, two EU Directives (Directive 2014/24/EU and Directive 2015/25/EU) define the legal framework for public procurement. These directives seek to ensure greater inclusion of social and environmental considerations (European Union 2014). The EU initially set an indicative target that, by 2010, 50% of all public tendering should be green (European Commission 2016d). 'Green' means that the purchased goods and services comply with the EU's core GPP criteria[25]. The uptake of GPP at EU-level has been estimated once in 2011, but is not systematically monitored by the EU[26]. This study indicates that 26% of the contracts in the sample included all core criteria, while 55% included at least one core criterion[27]. On the downside,

[24] GPP is especially applied by developed countries such as Austria, Belgium, Denmark, Finland, France, Germany, Japan, Mexico, the Netherlands, New Zealand, Norway, Switzerland, and the United Kingdom. FAO (2014b). 'State of the world's forests, enhancing the socio-economic benefits from forests', FAO, Rome.

[25] The European Commission has core and comprehensive criteria for GPP of a number of product groups. Core criteria are suitable for use by any contracting authority across the Member States and address the key environmental impacts. The comprehensive criteria are for those who wish to purchase the best environmental products available on the market. Both types of criteria remain voluntary however. The EU publishes extensive guidelines for public procurers on the core criteria per product group. Consequently, the core criteria differ per product group.

[26] Some decentralized, non-standardized, monitoring is organized by (local) governments as the EC encourages all governments to quantitatively monitor the uptake of GPP and qualitatively review its GPP activities. 'Several EU Member States have introduced, or are in the process of introducing, schemes to monitor national GPP implementation, which may set specific procedures to be followed for the gathering of information. EUROPEAN COMMISSION (2016b) *Buying green! A handbook on green public procurement. 3rd Edition*, Brussels. This decentralized monitoring must enable the improvement of their GPP activities. First of all because different aspects of GPP are monitored. Second because this overview would be biased: governments which do not apply GPP also do not monitor GPP activities. Unfortunately this decentralized monitoring does not allow for a general overview at EU-level.

[27] The study conducted a survey in which over 850 authorities from 26 Member States participated. This created a sample of more than 230.000 contracts, signed by public authorities in 2009, 2010, and 2011 for a value of approximately 117.5 billion euro CENTRE FOR EUROPEAN POLICY STUDIES, C. O. E. (2012). The uptake of Green Public Procurement in the EU27. Brussels.

the 'lowest price criterion' remained decisive for 64% of the respondents (Centre for European Policy Studies 2012).

The 50% target has not been adapted since 2010, but a Member State can set more ambitious targets in its National Action Plan (NAP)[28]. The European Commission (EC) encourages the Member States to develop a publicly available NAP which describes how they will green public purchases. Hence, the Member States are free to apply GPP differently according to their preferences/needs (European Commission 2016b), despite the EC's handbook on GPP. So far, 23 Member States have established a NAP.

Besides the lack of proper monitoring of the uptake of GPP, there is currently no theoretical or empirical basis for the impact of GPP (Georghiou et al. 2014). To our knowledge, no quantitative study has measured the spillover effect of GPP on private consumption. In addition, the existing qualitative literature comes to conflicting conclusions. Akenji (2014) finds no proof for the spillover effect of GPP on private consumption while other authors stress the importance of GPP for stimulating private green purchases (Pacheco-Blanco and Bastante-Ceca 2016, Tarantini et al. 2011). On the supply side of the market, only anecdotal evidence points to the leverage effect of GPP (Georghiou et al. 2014). The existing qualitative studies have a descriptive focus. The few quantitative studies focus on good practices, not on the uptake and leverage effect (Zhu et al. 2013). No study analyses the impact of GPP at both sides of the market simultaneously. This is an important flaw in literature since it is the objective of GPP to motivate suppliers to innovate towards sustainability and simultaneously encourage consumers to buy sustainable products and services. Unfortunately, these flaws in literature negatively affect the design of current GPP policies (Georghiou et al. 2014).

This chapter for the first time quantifies the leverage effect of GPP in Europe on the consumption and production of green wood. The case of wood is selected for two reasons. First, governments within the EU are important wood consumers. They account for 26.88% of the final wood consumption[29]. This surpasses the governments' share in overall final consumption within the EU (approximately 19%) (EUROSTAT 2015, European Commission 2016b). Second, wood is important in a government's spending. At EU level, three of the ten priority groups for GPP at least partially exist out of wood: Furniture, Copying & Graphic Paper, and Construction[30]. At Member State level, an increasing

[28] For example: the Dutch government set a 100 % Sustainable Procurement target to be reached by 2015 and the Flemish government in Belgium targets 100% sustainable procurement by 2020 EUROPEAN COMMISSION (2011). Buying green! A handbook on environmental public procurement. Brussels.

[29] To our knowledge, no comparative data exists which list the governments' market shares per product per country. However, some individual case studies relate to the wood sector. The UK government, for example, purchases 30 – 50 % of office furniture EFECA (2010). 'An assessment of the impacts of the UK Government's timber procurement policy', London, UK.

[30] The EC selected priority product groups based upon two criteria. First, the environmental impact of the product group, and the accompanying need for green criteria. Second, the importance of the product group in total public procurement.

number of NAPs stipulate mandatory rules for the use of wood in specific product groups[31], despite the voluntary nature of a NAP (European Commission 2015a). Due to the prominent role of wood in public procurement, this case can set an example for other product groups which are frequently purchased by governments.

If all European governments implement GPP, this chapter assumes they exclusively buy (eco-) certified wood. Certified wood in this narrative is the green alternative to conventional wood. This assumption is further explained and justified in section 2. The FSC- and PEFC-certificate dominate the certified wood market (FAO 2014a). In May 2015, 10.9% of the total global forest area was FSC or PEFC certified. The regional distribution of the certified area is, however, apparent: The Northern hemisphere accounts for 89% of the globally certified area while the Southern hemisphere only accounts for 11% (UNECE 2015).

Certified and conventional wood are physically homogenous but the certificate indicates that their production processes differ. Consequently, certified wood becomes a credence good which is vertically differentiated by process attributes (Dulleck et al. 2011). Those process attributes entail additional costs for which the producers request remuneration in the form of a price premium on top of the conventional wood price.

It would be incorrect to analyze the impact GPP in Europe in an autarky situation. Our research needs to take into account the international dimension of wood markets. Forest industries in different regions are 'increasingly linked through international trade and global environmental policies' (Buongiorno 2003). Consequently, demand and supply shocks in one region can impact on other regions' wood markets. In addition, forest conservation policies – such as certification – in one region can lead to deforestation in other regions (Gan and McCarl 2007, Sedjo and Sohngen 2013).

For this reason, this research presents a novel Spatial and temporal price allocation Equilibrium Model (SEM) to analyze the impact of GPP in Europe. This implies that we adhere a strictly economic approach in this chapter, based on perfect competition. A SEM will allow interaction between spatially separated regional wood markets. The novelty of this research is found in the modifications made to the standard SEMs maximization framework. A first modification distinguishes conventional products from certified products in each regions' production and consumption. Albeit both types of wood are substitutes, the traditional multi-product models cannot be used. The price mechanisms between both products is not based upon substitutability, but on the price premium. A second modification permits the analysis of the impact of government spending by distinguishing the governments' share of final consumption from the households' share.

[31] Seven Member States stipulate mandatory rules for construction tenders, 6 Member States have mandatory rules for paper and furniture, and 3 Member States mandatorily request a proof of legality for the wood used in the products they purchase.

The modified SEM's objective function maximizes global quasi-welfare[32] (Swoboda 1972) through the simultaneous solution of all regions' equilibria under the assumption of bilateral trade costs. The equilibrium state of the model will however also provide in-depth information on each region's welfare level, equilibrium price and equilibrium quantity. Due to the modifications, the model also determines an equilibrium price premium and the equilibrium share of certified wood within a region's total wood consumption and production.

The remainder of this chapter is structured as follows: section 2 describes the link between certification and GPP. Section 3 describes the theoretical model. Section 4 explains the main outcomes of the model in detail. The remaining section 5 interprets the particular phenomena following the GPP for wood, and discusses the limitation of the modified SEM. Section 6 provides a brief conclusion to this chapter.

2. Certification and GPP

If all European governments implement GPP, this chapter assumes they exclusively buy (eco-) certified wood. This is a valid claim for a number of reasons:

- Certified wood production is expected to positively impact forest conservation and sustainable forest management practices (Damette and Delacote 2011).
- An increasing number of governments at national[33], European[34], and international[35] level, explicitly refer to the two main certification schemes: FSC and PEFC. Those governments recognize certificates as sufficient proof of compliance with the green criteria for wood (e.g. certification became a comprehensive criteria for paper products in the EC's handbook on GPP).

[32] The difference between 'quasi-welfare' and 'welfare' relates to the solution of the applied equilibrium model. 'Welfare' is used when a full equilibrium is attained. This requires an equilibrium in each separate market in the economy. In a full equilibrium, excess demand in one economy is compensated by excess supply in another economy. Swoboda (1972) describe how in stable economic systems, 'forces that will eliminate any disequilibrium and return the system to its equilibrium position are automatically set in motion'. 'Quasi-welfare' relates to a quasi-equilibrium position in which a disequilibrium in (at least) one market is consistently prevented from spreading to other markets and from returning the system (assumed to be stable) to equilibrium.

[33] E.g. Belgium, Denmark, Germany, the UK, and the Netherlands use their own adapted criteria and processes to determine whether certification schemes provide sufficient assurance for GPP. The current consensus of these Member States is that, in general, FSC and PEFC provide sufficient levels of assurance based on their national criteria. EUROPEAN COMMISSION (2012). Green Public Procurement a collection of good practices. Luxembourg. and EUROPEAN COMMISSION (2016c). 'Green Public Procurement Criteria for Office Building Design, Construction and Management', in JRC (ed.), Seville, pp. 140.

[34] E.g. FSC and PEFC are explicitly recognized as sector specific labels in the EC's handbook on GPP (European Commission 2016b)

[35] FSC and PEFC comply to the internationally agreed reference point ISO/IEC 17065 EUROPEAN COMMISSION (2016c). 'Green Public Procurement Criteria for Office Building Design, Construction and Management', in JRC (ed.), Seville, pp. 140.

- The legality of wood[36] is a core criteria within the EU's handbook on GPP. A certificate is accepted as sufficient proof of legality by the EC for product groups Furniture, Copying & Graphic paper, and Construction. Additional requirements for GPP exist per product groups (e.g. hazardous substance requirements for furniture, environmental friendly materials in construction, double printing) but the minimum requirement of legality remains valid in any case.
- The use of certification in GPP can tackle the issue of limited availability of environmental criteria for products/services which hinders the uptake of GPP (European Commission 2016a).
- The use of certification can make public procurement decisions more consistent (Parikka-Alhola 2008). Consistency across the EU avoids the use of different environmental criteria in different geographical markets. Consistency increases the incentive for suppliers to invest in eco-innovation and comply with high environmental standards as it will simultaneously increase his/her chances of competing in multiple national procurement markets (European Commission 2008).
- Testa et al. (2012) identify certification as one of the three key factors in successful GPP implementation within the EU[37].
- Governments increasingly are interested in socially responsive forestry administration, next to transparency in trade. Eco-certification complies to these concerns (Atyi et al. 2013) .

3. Theoretical model

3.1. Theoretical background

Takayama and Judge (1971) developed a multi-product SEM which distinguishes substitute goods. Since certified and conventional wood are substitutes, it appears to be more straightforward to use this multi-product SEM. Unfortunately, the price mechanism in the multi-product SEM is not appropriate for markets characterized by the presence of certified products alongside conventional ones. The standard price mechanism for substitute products assumes a positive (negative) cross-price elasticity for demand (supply) for substitute goods (Takayama and Judge 1970, O'Sullivan et al. 2011). A price increase of one substitute good makes the substitute relatively cheaper.

[36] The legality of wood is further defined in the EU's Timber Regulation. Both FSC and PEFC are in full compliance with, and accepted by the EU's Timber Regulation. UNECE (2013). 'Forest Products Annual Market Review 2012-2013', Geneva, Switzerland, pp. 155.

[37] The two other elements are a) 'a strong political push through (for instance) national guidelines and action plans' and b) the use of 'innovative tools in procurement procedures such as *life cycle assessment* and green *contract variants.* (Testa et al. 2012)

However, the certified and conventional wood prices are directly linked to each other. The certified wood price ($P_{d,i}^{cer}$ and $P_{s,i}^{cer}$ for demand and supply) consists of the conventional wood price ($P_{d,i}$ and $P_{s,i}$) with the addition of a price premium ($Pprem_{d,i}$ and $Pprem_{s,i}$). $Pprem_{d,i}$ and $Pprem_{s,i}$ are expressed as a percentage increase to the conventional price:

$$P_{d,i}^{cer} = P_{d,i} * (1 + Pprem_{d,i}) \quad (2\text{-}1)$$

$$P_{s,i}^{cer} = P_{s,i} * (1 + Pprem_{s,i}) \quad (2\text{-}2)$$

Hence, a price increase for conventional wood increases the certified wood price by the same percentage and both wood types remain equally expensive in relative terms. As a consequence, the multi-product SEM's price mechanisms does not hold in this situation: the demanded (supplied) quantity of the certified good is not positively (negatively) related to the conventional wood price per se. Instead, the new price mechanism is built into the single-product SEM.

The novel price mechanism deserves some explanation. On the demand side of the market, consumers of certified wood are willing to pay a price premium on top of the conventional wood price (Michaud et al. 2012). This price premium constitutes remuneration for the credence qualities attributed to the certified products. The credence qualities relate to the environmental and societal-friendly production practices applied in the certified production process. Hence, the credence good is vertically differentiated by process attributes (Ferraro and Kiss 2002, Ferraro and Simpson 2002, Groom and Palmer 2010, Dulleck et al. 2011, Groom and Palmer 2014, Carlson and Palmer 2016). As such, the Willingness to Pay (WTP) is a measure of the consumers' marginal utility, it is not the result of a contingent valuation method which perfectly monetarizes the environmental and societal gains. This turns certification into a market-based instrument with voluntary price signals (Pirard 2012). The boundaries of market-based instruments as provider of a remuneration for eco-system services are numerous, complex (Gómez-Baggethun and Muradian 2015), and not part of this research. The WTP for certified wood differs regionally for many reasons[38]. Our research builds upon the logic by Greenstone and Jack (2015) who link the WTP to income. They claim that "for the very poor, the marginal utility of consumption dominates utility gains from improved environmental quality".

The reason to exclude non-monetary measures for (improved) human welfare related to forest certification is twofold. First, the impact of sustainable forestry initiatives on deforestation remains ambiguous (Brandt et al. 2016). Hence, it is impossible to estimate welfare effects in terms of benefits

[38] E.g.: (1) the longer presence of certification in North America and Europe, (2) market failures including both the classic market failures of public goods and externalities, and the market imperfections more common to developed countries (missing land, capital, and labor markets), although missing credit markets lead to revealed preference measures that reflect liquidity constraints, rather than WTP. (Cai and Aguilar 2013, and Greenstone and Jack 2015).

from cleaner production related to deforestation. Second, also directly related social benefits of forest certification are controversial (Burivalova et al. 2017) and are likely to differ regionally.

On the supply side, environmental and societal-friendly production practices restrict forest management options. Consequently, the production costs for certified wood are higher than for conventional wood (Van Deusen et al. 2010). The certification costs comprise direct and indirect costs. The direct costs are the costs of the certification process[39] and do not differ regionally. Hence, these costs are harder to bear for small-scale producers. Small-scale producers are generally found in the Southern hemisphere (Dranove and Jin 2010). The indirect costs comprise all costs required to change management practices to meet certification standards (Bass 2001) [40]. The magnitude of the indirect cost is inversely related to the quality of the current practices. This approach is in line with research by Vedel et al. (2015) who found a high Willingness To Accept (WTA) for providing eco-system services by producers with poor management practices. Poorly managed forests are mainly situated in the Southern hemisphere, resulting in higher indirect certification costs in this hemisphere. In addition, producers in developing regions also face other barriers to certification like a lack of information and political support (Damette and Delacote 2011, Carlsen et al. 2012). According to the assumption of competitive behavior, producers will only produce certified wood if those additional costs are compensated by a price premium $Pprem_{s,i}$ (Carlsen et al. 2012). The WTA measures the minimum price premium requested by a producer. The arguments above explain why the WTA will be higher in the Southern hemisphere.

The regional WTP and WTA is introduced in the standard single-product SEM by Takayama and Judge (1971) in order to distinguish certified from conventional wood. The following parts explain the three modifications to the standard SEM and the modelled demand shock.

3.2. Modification I: supply and demand function

The SEM endogenously determines the equilibrium demand quantity of wood $Q^*_{d,i}$ and the equilibrium demand price $P^*_{d,i}$ in region *I* by making use of the demand function:

$$Q^*_{d,i} = Q^0_{d,i} * \left(1 + e_{d,i} * \frac{\Delta P_{d,i}}{P^0_{d,i}}\right) \qquad (2\text{-}3)$$

The demand function in our research does not distinguish between certified and conventional wood. $Q^*_{d,i}$ and $P^*_{d,i}$ are calculated from the baseline demand quantity $Q^0_{d,i}$ and the baseline demand price $P^0_{d,i}$

[39] Audit costs, certification fees, and the costs of meeting corrective action requests (CARs). CARs might for example imply changes to forest management techniques following an observed infringement during an audit.
[40] E.g. higher investment in infrastructure and machinery in order to be able to harvest more efficiently with lower impacts, higher wage costs by paying legally specified wages and providing social benefits, and opportunity costs of reducing wood production to sustainable levels.

as a function of the response to a price change ($\Delta P_{d,i} = P^*_{d,i} - P^0_{d,i}$). As such, the first modification directly introduces the price difference $\Delta P_{d,i}$ in the demand functions. The extent to which the demand quantity responds to price changes is determined by each region's price elasticity for demand $e_{d,i}$.

The supply function is constructed accordingly and endogenously determines the equilibrium supply quantity and equilibrium supply price:

$$Q^*_{s,i} = Q^0_{s,i} * \left(1 + e_{s,i} * \frac{\Delta P_{s,i}}{P^0_{s,i}}\right) \qquad (2\text{-}4)$$

The value of each regions's $Q^0_{d,i}$, $Q^0_{s,i}$, $P^0_{d,i}$, $P^0_{s,i}$, $e_{d,i}$, and $e_{s,i}$ is based on Buongiorno and Shushuai (2014). The data by Buongiorno (2014) provides information at country level. This chapter calculates regional weighted means (based on volume) out of their data. This is necessary since country level information is missing for other parameters (e.g. the WTP and WTA). Five regions are taken into account: Latin America, North America, Europe (including Russia), Africa, and Asia (including Oceania).

Figure 2-1 to Figure 2-3 present some stylized facts for parameters $Q^0_{d,i}$, $Q^0_{s,i}$, $P^0_{d,i}$, and $P^0_{s,i}$. Price elasticities $e_{d,i}$, and $e_{s,i}$ result out of a meta-analysis. Buongiorno (2014) found a price elasticity in demand for (industrial round-) wood which varies between -0.05 and -0.37, inversely related to the income level. The price elasticity for supply varies between 0.11 and 2.84. To tighten the range, Buongiorno and Shushuai (2014) set the price elasticities at 0.8.

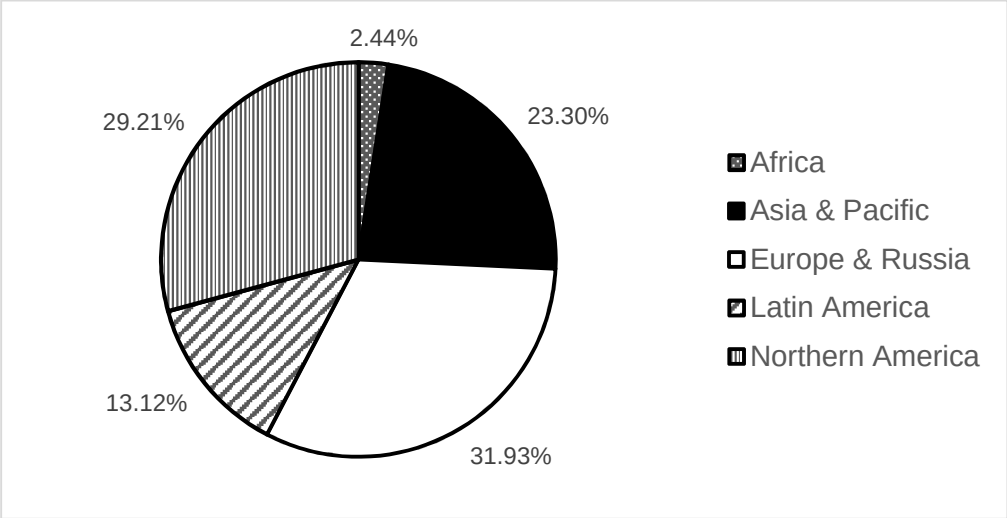

Figure 2-1: Regional share (%) in global industrial roundwood production.
NOTE.-Each reginal share is found by $Q^0_{s,i}/\sum_i Q^0_{s,i}$. Asia encompasses Oceania and Europe encompasses Russia.

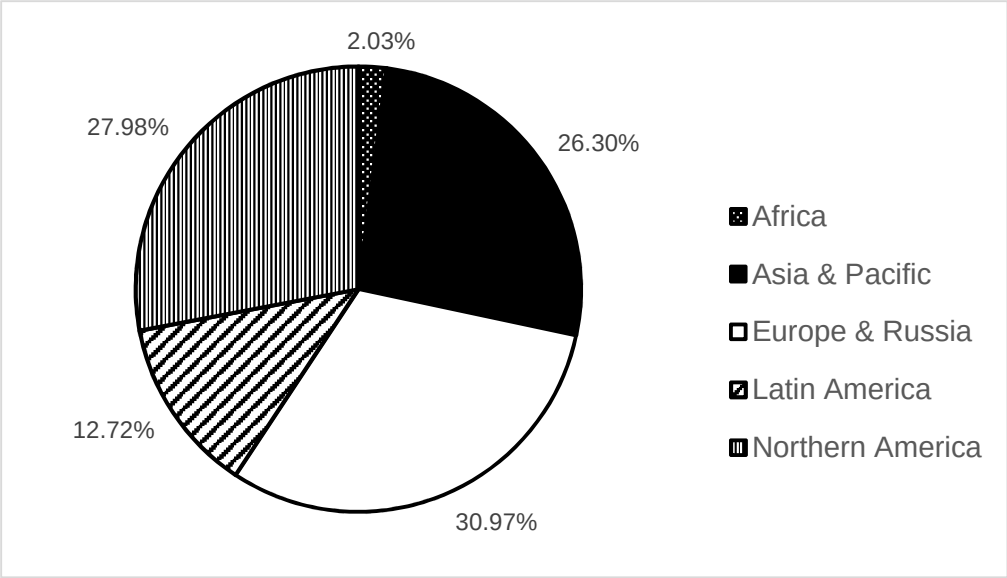

Figure 2-2: Regional share (%) in global industrial roundwood consumption.
NOTE.-Each reginal share is found by $Q^0_{d,i}/\sum_i Q^0_{d,i}$. Asia encompasses Oceania and Europe encompasses Russia.

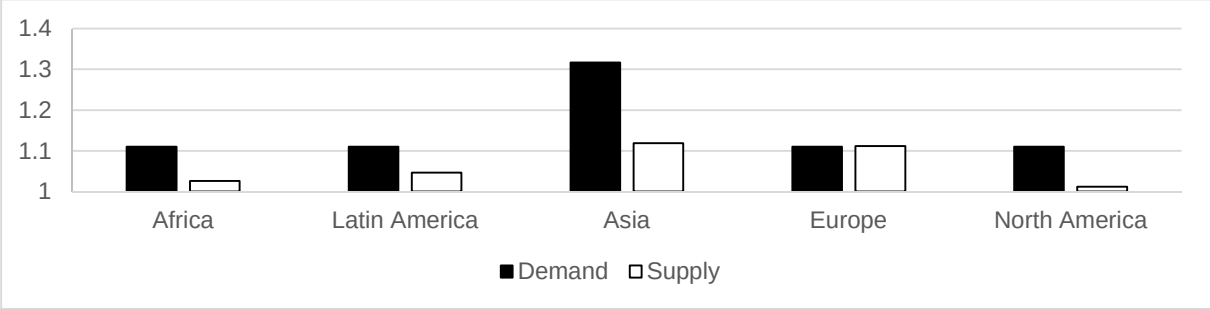

Figure 2-3: Demand and supply prices per region (100 USD per m^3).
NOTE.-The regional prices are the volume weighted prices out of the country-level GFPM data.

3.3. Modification II: distinguish certified from conventional wood

A second modification to the single-product SEM distinguishes certified from conventional wood. Key to the new price mechanism is the introduction of the price premiums $Pprem_{d,i}$ and $Pprem_{s,i}$ as endogenous regional variables, using equations 2-1 and 2-2. Based upon the regional price premiums, the SEM endogenously determines the proportion of total consumption and production which is certified: respectively $Share^{cer}_{d,i}$ and $Share^{cer}_{s,i}$. The WTP and WTA functions for each region describe the relationship between the price premium and the certified share. The model uses a logistical distribution function for WTA and WTP because the function can be analytically integrated, which is not possible for the normal distribution.

The WTP in region *i* is symmetrically distributed around a known mean ($\mu_{WTP,i}$) following a logistic distribution with variance $\pi^2\sigma^2_{WTP,i}/3$. The cumulative distribution function for this logistical distribution links the certified share of total consumption to the price premium level:

$$Share_{d,i}^{cer} = 1 - \frac{1}{1+e^{-(Pprem_{d,i}-\mu_{WTP,i})/\sigma_{WTP,i}}} \quad (2\text{-}5)$$

For each price premium level, the cumulative distribution function determines the certified share of the total wood consumption in region *i*. Figure 2-4 demonstrates how a low price premium $Pprem^{low}$ on top of the conventional equilibrium wood price $P_{d,i}^{*}$ results in a high proportion of certified consumption ($Share_{d,i}^{cer}\ hi$) in the total equilibrium wood consumption $Q_{d,i}^{*}$. A high price premium $Pprem^{high}$ results in a small share $Share_{d,i}^{cer}\ low$. This reasoning is in accordance with the overview of literature on the relation between price premiums and certified market shares by Aguilar and Cai (2010).

The regional parameters $\mu_{WTP,i}$ and $\sigma_{WTP,i}$ are retrieved from the meta-analysis on consumers' WTP for certified wood by Cai and Aguilar (2013). At global level, they found a mean WTP of 12.2% with a standard deviation of 8%. The logistic regression model by Jacobsen and Hanley (2009) is used to determine each region's mean WTP based on the regional differences in the GDP per capita (Appendix A). The GDP-based approach by Jacobsen and Hanley (2009) provides a unilateral macro-economic estimate for the regional WTP which possibly neglects other explanatory variables for WTP. However, this is a suitable approach given this research's geographic aggregation at continent level. The aggregation would complicate the determination and estimation of other explanatory variables' values, as they are person-bound.

In accordance with the WTP approach, a cumulative distribution function of certified production is constructed out of a region *i*'s logistically distributed WTA (equation 2-6). This allows the SEM to determine the certified share of a region's production and the price premium on the supply side of the market endogenously:

$$Share_{s,i}^{cer} = \frac{1}{1+e^{-(Pprem_{s,i}-\mu_{WTA,i})/\sigma_{WTA,i}}} \quad (2\text{-}6)$$

Figure 2-4 visualizes how a high price premium stimulates certified wood production ($Share_{s,i}^{cer}\ hi$) and a low price premium discourages certified production ($Share_{s,i}^{cer}\ low$).

The regional parameters μWTA_i and σWTA_i are determined from the combination of the price premiums reported by the certification bodies and the actual certified percentage of forest area per region (Appendix B). This WTA is highest for Africa and Asia which have the lowest percentage of certified area. In Europe and North America the WTA is lower, in contrast to their percentage of certified area (Appendix B - Table B1). This research adheres a strictly economic approach towards certification, based on the assumption of perfect competition. Hence, the SEM only allows producers to switch to certified production if the cost of producing certified wood (WTA on top of production costs) is compensated by the received certified wood price. Experts of the ITTC (2004) confirm this

rationale: without 'tangible benefits deriving from certification in terms of profitability or competitiveness, enterprises will have little incentive to improve forest management with higher costs'. This problem is found to be particularly serious in the case of tropical wood-producing countries (Simula et al. 2004). Also Greaker (2006) described how an insufficient willingness to pay for green (certified) products can endanger foreign producers' profits. Carlson and Palmer (2016), on the other hand, stress the importance of less tangible benefits for eco-certified wood producers (e.g. community empowerment). This type of benefit is hard to capture in a monetary value.

The outcome of these modifications is an equilibrium state for the market which is no longer two-dimensional (price and quantity). Instead, the equilibrium consists of four dimensions: price, quantity, price premium, and certified share of total consumption/production.

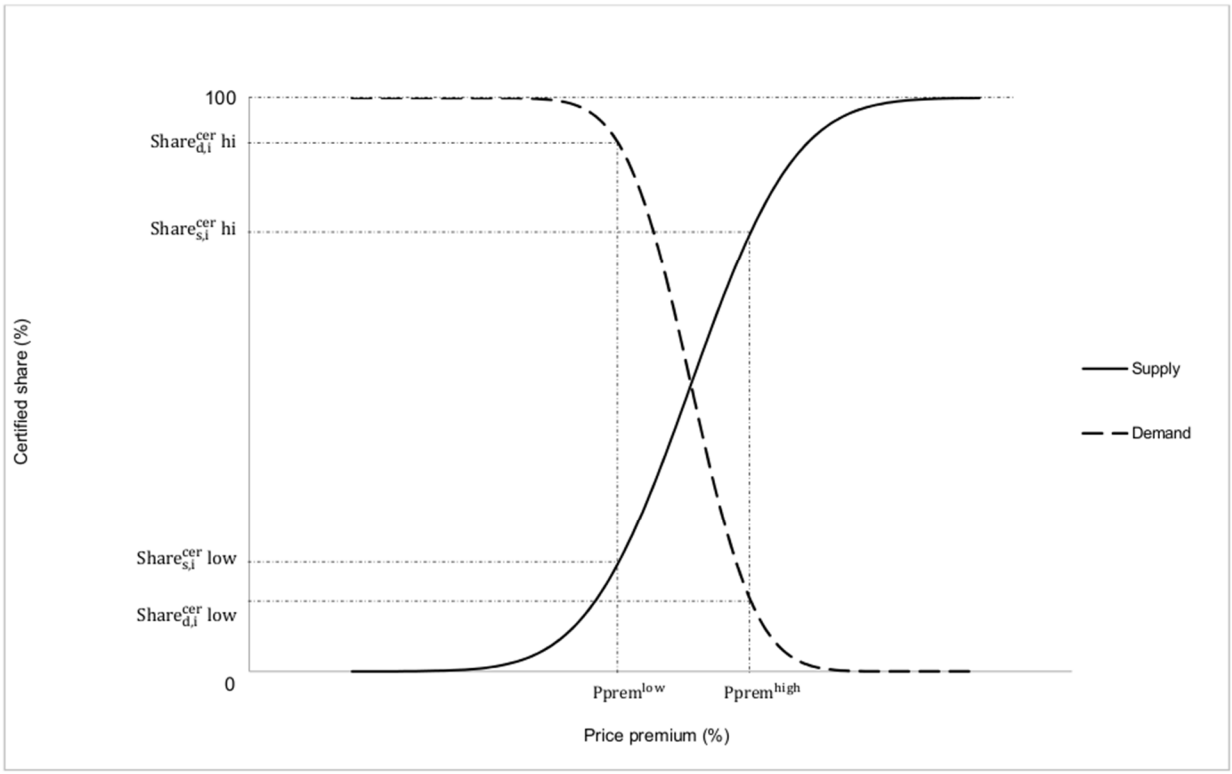

Figure 2-4: Cumulative distribution function of certified wood in total demand and supply for region *i*.
NOTE.-The low and high price premium are determined arbitrarily.

3.4. Modification III: additional welfare calculation

The introduction of certified alongside conventional wood adds an additional welfare element to the objective function of the standard SEM. This standard objective function maximizes the global quasi-welfare under the assumption of transport costs. This is done by taking the integral of the demand and supply function (equation 2-3 and equation 2-4) over the equilibrium quantity and price (Appendix C). Hence, in the modified SEM, this quasi-welfare is calculated for the consumption and production of both certified and conventional wood.

The introduction of the price premium for certified wood creates some additional consumer and producer value. Figure 2-4 demonstrates how a low price premium $Pprem^{low}$ encourages a high percentage of a region *i*'s consumers ($Share_{d,i}^{cer}hi$) to acquire certified wood. But this $Pprem^{low}$ is lower than most of the certified wood consumers are willing to pay for certified wood. For those certified wood consumers willing to pay a higher price premium, an equilibrium price premium equal to $Pprem^{low}$ creates additional consumer value. This additional consumer value is quantified by integrating the cumulative logistic distribution function (equation 2-5) over the right hand side of the equilibrium price premium. A maximum price premium of 100% is assumed[41]:

$$CS_i^{cer} = \int_0^1 Share_{d,i}^{cer}\, dPprem_{d,i} - \int_0^{Pprem_{d,i}} Share_{d,i}^{cer}\, dPprem_{d,i} \qquad (2\text{-}7)$$

This additional consumer surplus is added to the traditional consumer surplus (Appendix C).

The same logic is applied at the supply side of the market: an equilibrium price premium ($Pprem^{high}$) creates additional producer surplus for the producers who are willing to supply certified wood at a lower price premium. This additional producer surplus is quantified by integrating the cumulative logistic distribution function of the certified share of wood production (equation 2-6) over the left hand side of the equilibrium price premium. This additional producer surplus is added to the standard producer surplus in order to construct a new objective function (Appendix C).

$$PS_i^{cer} = \int_0^{Pprem_{s,i}} Share_{d,i}^{cer}\; dShare_{d,i}^{cer} \qquad (2\text{-}8)$$

The non-negativity constraints on prices ($P_{d,i}^*$, $P_{s,i}^*$) and physical quantities ($Q_{d,i}^*$, $Q_{s,i}^*$) placed remain valid and is extended to the price premiums $Pprem_{d,i}$ and $Pprem_{s,i}$. This implies that the conventional wood price is below or equal to the certified wood price.

Both the additional consumer and producer surplus (equation 2-7 and 2-8, respectively) are multiplied with the regional equilibrium conventional wood price ($P_{d,i}^*$ and $P_{s,i}^*$) and the regional equilibrium wood quantity ($Q_{d,i}^*$ and $Q_{s,i}^*$). This multiplication is added to the traditional SEM's objective function in order to construct the modified SEM's objective function (Appendix C). The traditional SEM's price condition for trade and the trade balances remain valid in the modified SEM. However, the balances do account for the certified share of demand and production, and the price premiums, if necessary.

The modified SEM simultaneously solves each region's equilibrium under the assumption of bilateral trade costs (Appendix C). Hence, the transport costs separate, but do not isolate different regions' markets. The outcome of the modifications is an equilibrium state for the market which is no longer

[41] This is not a stringent assumption. It relaxes earlier findings who describe maximum price premiums of 50%. (Aguilar and Cai 2010).

two-dimensional (price and quantity). Instead, the equilibrium consists of four dimensions: price ($P^*_{d,i}$ and $P^*_{s,i}$), quantity ($Q^*_{d,i}$ and $Q^*_{s,i}$), price premium ($Pprem_{d,i}$ and $Pprem_{s,i}$), and the certified share of a region's total consumption and production ($Share^{cer}_{d,i}$ and $Share^{cer}_{s,i}$). This finally allows us to determine each region's quasi-welfare.

3.5. Modification IV: the trade balances

The distinction between conventional and certified wood in the modified SEM requires the modification of other constraints. First, the consumption of certified (conventional) wood in region *i* cannot exceed the sum of each region *j*'s transported quantities of certified (conventional) wood to region *i*: $TQ^{cer}_{j,i}$ ($TQ^{con}_{j,i}$). This includes region *i*'s production which is destined for the domestic market.

$$Share^{cer}_{d,i} * Q^*_{d,i} \leq \sum_j TQ^{cer}_{r,j} \quad (2\text{-}9)$$

$$(1 - Share^{cer}_{d,i}) * Q^*_{d,i} \leq \sum_j TQ^{con}_{j,i} \quad (2\text{-}10)$$

Accordingly, region *i* cannot transport more certified (conventional) wood to other regions $TQ^{cer}_{i,j}$ ($TQ^{con}_{i,j}$) than it produces itself. This includes production for the domestic market:

$$Share^{cer}_{s,i} * Q^*_{s,i} \leq \sum_j TQ^{cer}_{i,j} \quad (2\text{-}11)$$

$$(1 - Share^{cer}_{s,i}) * Q^*_{s,i} \leq \sum_j TQ^{con}_{i,j} \quad (2\text{-}12)$$

The standard SEM's price condition still determines whether trade of conventional wood occurs between two regions *i* and *j* (equation 2-13). A comparable price condition is introduced to determine whether trade of certified wood occurs (equation 2-14):

$$P^*_{s,i} + TC_{i,j} \leq P^*_{d,j} \rightarrow TQ^{con}_{i,j} > 0 \quad (2\text{-}13)$$

$$P^*_{s,i} * \left(1 + Pprem_{s,i}\right) + TC^{cer}_{i,j} \leq P^*_{d,j} * (1 + Pprem_{d,j}) \rightarrow TQ^{cer}_{i,j} > 0 \quad (2\text{-}14)$$

These price conditions imply that the demand price in the importing region must compensate the supply price in the exporting region plus the per unit transport costs between both regions ($TC_{i,j}$). In the case of certified wood, also the price premium is taken into account ($TC^{cer}_{i,j}$) (Appendix C). The non-negativity constraint for the transported quantities implies that $TQ^{con}_{i,j} = 0$ and $TQ^{cer}_{i,j} = 0$ if the price condition of respectively conventional and certified wood is not met.

In this setting, the transport costs separate, but do not isolate, markets in different regions. The parameters' value for the bilateral transport costs are based on Buongiorno and Shushuai (2014). The unit costs of shipping wood between two regions comprise two parts. The first component is a fixed

cost of shipping one unit from one region to another (USD 20.2). The second component is a region-dependent ad valorem percentage. This ad valorem percentage varies from 7.197% for Africa to 0% for Europe and North America. The transport costs are not just taken into account to determine whether bilateral trade flows will occur. The transport costs are also taken into account in the global quasi-welfare calculation (Appendix C).

3.6. Modelled shocks

This chapter assumes that if governments do not implement GPP, they only make use of economic criteria to evaluate different bids. This implies that the price is the main criterion to select one out of two physically homogenous products: certified versus conventional wood. Due to the non-negative price premium for certified products, governments will opt for the less-expensive conventional product if they exclusively make use of the price criteria.

This requires a modification of equation 2-5 which determines the percentage of certified wood within a region's total wood demand. In the baseline scenario, the government's share of final consumption is exclusively devoted to the purchase of conventional wood. Consequently, the maximum percentage of certified wood equals 100 % minus the government share in final consumption (G_i):

$$Share_{d,i}^{cer} = 1 - G_i - \frac{1-G_i}{1+e^{-(Pprem_{d,i}-\mu_{WTP,i})/\sigma_{WTP,i}}} \quad (2\text{-}15)$$

In the GPP scenario, the European governments limit themselves to buying only certified wood. In equation 2-16, the government's share in the total final consumption exclusively comprises certified wood. Hence, the quantity of wood purchased by governments varies according a region's total consumption. This corresponds to the so-called procyclical spending where spending is cut during recessions and increased during expansions (Galinato and Galinato 2016). The preferences of the other European wood consumers remain unchanged:

$$Share_{d,EU}^{cer} = 1 - \frac{1-G_{EU}}{1+e^{-(Pprem_{d,EU}-\mu_{WTP,EU})/\sigma_{WTP,EU}}} \quad (2\text{-}16)$$

4. Results

4.1. Certified consumption

Table 2-2 describes the impact of GPP on the consumed quantities of conventional and certified wood, and on the demand prices of conventional and certified wood. The results are presented both at regional and global level. In the baseline scenario, certified wood consumption is especially important in North America and Europe (62.62% and 61.19% of final consumption respectively). The

explanation for these high proportions is twofold. First, the WTP for certified wood is high in these regions. Second, these regions' producers produce both conventional and certified wood efficiently. This leads to competitive prices. There is a low demand for certified wood in Africa, Latin America, and Asia (0.96%, 5.93%, and 2.92% respectively). The model's baseline scenario reports high price premiums for certified wood in these regions. This does not encourage the consumers of these poorer regions (low WTP) to purchase large quantities of certified wood.

The impact of GPP in Europe on the certified share of consumption is remarkable. The share of certified wood in the total global wood consumption increases by 15.53%. Consequently, certified wood now accounts for 43.99% of the global wood consumption. But the consumption of certified wood is not boosted in each region. The increased relative certified wood price discourages some consumers in North America and Asia.
In Europe, the certified share increases from 61.19% to 95.67%. Certified wood gains 34.48% of market share, which is above the government share of final consumption (26.88%). Hence, GPP also stimulates other European consumers to switch from conventional to certified wood consumption. This sounds counterintuitive since the increased demand by European governments has resulted in a certified wood price increase of 15.71% in real terms. However, this increased certified wood price is entirely due to the increase in the conventional wood price. In fact, certified wood consumption has become the standard in the GPP scenario in Europe. Following the rationale of the price premium function (Figure 2-4), high shares of certified consumption link to non-existing price premiums. Nevertheless, the price paid for certified wood must compensate the producers' production and certification costs. Due to the disappearance of the price premium, the European conventional wood price therefore increased to the level at which it simultaneously compensates the conventional production costs and the additional certification costs. This explains the considerably higher conventional demand price in the Europe (1.52) compared to the other regional conventional demand prices. This makes certified and conventional wood equally expensive in Europe. Or put differently, certified wood has become relatively cheaper compared to conventional wood. In addition, the European conventional wood price is influenced by the Asian conventional wood price since European producers are shipping conventional wood towards Asia. A high conventional price in Asia stimulates the conventional wood price in Europe.

The relative price evolutions also explain the increased certified consumption in Africa (+65.63%) and Latin America (+71.03%). Also in these regions, certified wood became relatively cheaper than conventional wood. The explanation for the steep increase in the conventional wood price is twofold. First, the skyrocketing conventional wood price in the dominant European market (due to the disappearance of the price premium) boosted the conventional wood price in Africa and Latin America. Second, these two regions are exporting conventional wood to Asia, which also positively impact the price. Note, however, that in Africa, the market share for certified wood in total wood

demand is still marginal: 1.62%. In Latin America, certified wood accounts for 10.32% of the total demand.

The trend of growing importance of certified consumption is not observed in North America and Asia. In those two regions, certified wood has become relatively more expensive than conventional wood. This has driven a number of consumers out of the certified segment of the market. In North America, the conventional wood price increased by 4.05% in the GPP scenario. As in many other regions, this is explained by increased exports to Asia and the increased conventional wood price in Europe. However, in North America, the certified price increase is proportionally higher: 15.74%. This is because less certified wood is available for consumption in North America. The situation in Asia is even more distinct. In the GPP scenario, other regions' producers gained interest in supplying conventional wood to the Asian market. This influx results in a collapsing conventional wood price in Asia. Simultaneously, the certified wood price increases in Asia due to the growing interest in certified wood at global level. This drives consumers towards conventional wood products.

4.2. Certified production

Table 2-1 describes the impact of GPP on the produced quantities of conventional and certified wood, on the supply prices of conventional and certified wood, and on the price premium. The results are presented both at regional and global level. In addition, the table presents the production cost ($Pcost_{s,i}$). The production can be lower than the received price because of the properties of the spatial model which prevent an infinite increase of wood production and consumption and the separation of the wood markets by transport costs. This allows producers to generate additional producer surplus.

In the baseline scenario, Europe and North America are producing most certified wood. Respectively 64.03% and 62.62% of their wood production is certified. This is much less in the other regions. The third biggest wood producer – Asia – is not producing certified wood. In both Africa and Latin America, 4.25% of the wood production is certified in the baseline situation. This corresponds to these regions certified wood consumption and illustrates the home-effect of consumption. Due to the transport costs, producers have a strong position on their domestic market and will first of all target domestic consumers.

The increased demand for certified wood at global level (+14.70%) in the GPP scenario requires an equivalent production increase. But only Europe, Asia, and Latin America increase their certified wood production. In Europe and Latin America, the certified wood production follows the increased certified domestic demand (home-effect). The increased certified production in Asia is more peculiar. This region is characterized by a decreasing demand for certified wood. However, Asia is no longer importing certified wood in the GPP scenario while it was importing all of its certified wood

requirements from North America and Africa in the baseline scenario. The disappearance of certified wood imports is compensated for by domestic certified wood production in Asia.

In fact, the GPP for wood in Europe creates a trade barrier for certified wood. In the GPP scenario, not a single bilateral trade flow for certified wood is identified (Table 2-4). However, international trade in conventional wood still exists in the GPP scenario. Hence, it is the price premiums, not the transport costs, which isolate the different regions' certified markets. The disappearance of international trade also explains why the production of certified wood plummets in Africa (-70.18%) despite an increased demand for certified wood in the region. Africa was shipping certified wood to Latin America and Asia in the baseline scenario. Africa loses these export markets because it cannot produce certified wood efficiently enough to set a competitive price which allows trade at transport costs. Unfortunately, the increased demand for certified wood in Africa does not fully compensate for the decrease in exported volumes of certified wood. African producers are not only producing less certified wood in real terms. They are also expanding their conventional wood production (+7.18%). This additional conventional wood production is not destined for the domestic market. In the GPP scenario, Africa is exporting 24.88% of its conventional wood production to Asia.

The producers in North America are facing a reduction in domestic consumption of certified wood in combination with the disappearance of export opportunities to Latin America and Asia. This explains the decreased certified wood production in this region. The production of conventional wood in North America skyrocketed however (+64.06%). This increased production of conventional wood is destined for the domestic market and export to Asia.

Whether a region's certified wood production increases or decreases depends upon the relative price change of wood again. The certified wood price increase was smaller than the conventional wood price increase in Africa and North America. This explains why producers in those regions are switching to conventional production. The opposite is true for the regions which experience increased certified wood production: Europe, Latin America, and Asia. Hence, the GPP for wood production does stimulate the production of certified wood at global level, but not in every single region.

4.3. Welfare implications

Equation 2-15 and 2-16 only differ in terms of their intercept with the y-axis. In the baseline scenario (equation 2-15), the intercept equals 100% minus the government share in final consumption. In the GPP scenario (equation 2-16), the intercept equals 100%. Consequently, the integral of equation 2-15 is smaller than the integral of equation 2-16 for any value of the price premium. Or put differently, in the baseline scenario, not all potential quasi-welfare is tapped into because governments opted for the lowest priced bid. This does not allow for other dimensions of quality related to for example

certification (Lewis and Bajari 2011). However, the introduction of the price premium captures these other dimensions of quality and consequently allows quasi-welfare to increase.

The comparison of the global quasi-welfare for both scenarios confirms this reasoning. The global quasi-welfare increases by 0.37% in the GPP scenario because the modified SEM's objective function can tap into the previously unused potential quasi-welfare (Table 2-3). However, this is not a Pareto efficient improvement, since not every region's quasi-welfare increases. Whether a region gains or loses wealth depends on the evolution of its consumption of certified wood. Due to the shape of the demand and supply functions, the importance of the consumer surplus surpasses the importance of the producer surplus in all regions' quasi-welfare. Consequently, only the three regions that are consuming more certified wood became wealthier: Europe (+3.06%), Africa (+0.41%), and Latin America (+0.53%). North America (-0.78%) and Asia (-5.46%) lose quasi-welfare due to a decreased certified wood consumption.

The SEM's outcome allows the determination of the multiplier effect for Europe. If the European governments exclusively opt for certified wood, they face a price premium. Consequently, their expenses on wood purchases will augment. The SEM's outcome indicates that their wood expenses increase by 0.36 welfare units (=price baseline scenario * government share in final consumption baseline scenario – certified price GPP scenario * government share in final consumption GPP scenario). Those additional expenses led to a welfare increase in Europe of 1.68 welfare units (Table 2-3). Hence, the additional European government expenses for wood due to the GPP is the equivalent of 21.85% of the European welfare increase. Put differently, the tax payer's return on investment in terms of wealth increase equals 4.58 (= additional government expenses / European welfare gain).

Table 2-1: Production of wood, production of certified wood, supply prices (conventional), certified supply price, and supply price premiums (baseline scenario and GPP scenario)

	Africa		Latin America		Asia		Europe		North America		World	
	Baseline	GPP	Baseline	GPP	Baseline	GPP	Baseline	GPP	Baseline	GPP	Baseline	GPP
Quantities:												
$Q_{s,i}$	.36	.38	1.88	1.95	3.88	3.34	4.44	4.61	4.41	4.58	14.97	14.87
$Q_{s,i}$change (%)		+3.89		+3.86		-13.83		+3.82		+3.89		-.72
$Q_{s,i}^{cer}$	.02	.01	.08	.19	.00	.09	2.84	4.38	2.76	1.88	5.70	6.55
$Q_{s,i}^{cer}$ change (%)		-70.18		+134.12		+∞		+54.11		-32.03		+14.69
$Share_{s,i}^{cer}$ (%)	4.25	1.22	4.25	9.58	.00	2.69	64.03	95.05	62.62	40.97	38.08	43.99
$Share_{s,i}^{cer}$ change (%)		-71.29		+125.41		+∞		+48.45		-34.57		+15.53
(Cost) Prices:												
$P_{s,i}$	1.28	1.33	1.22	1.27	1.27	1.26	1.21	1.52	1.21	1.26	1.23	1.34
$P_{s,i}$ change (%)		+4.10		+4.06		-.53		+26.18		+4.05		+9.50
$Pcost_{s,i}$	1.00	1.05	1.00	1.05	1.27	1.05	1.00	1.05	1.00	1.05	1.07	1.05
$Pcost_{s,i}$ change (%)		+4.87		+4.87		-16.89		+4.87		+4.05		-1.79
$Pprem_{s,i}$ (%)	30.98	25.34	30.98	34.82	0.00	25.34	30.98	41.47	30.96	27.07	22.95	32.12
$Pprem_{s,i}$ change (%)		-18.21		+12.40		+∞		+33.86		-12.56		+39.95
$P_{s,i}^{cer}$	1.56	1.60	1.54	1.56	1.52	1.53	1.32	1.52	1.32	1.52	1.40	1.54
$P_{s,i}^{cer}$ change (%)		+2.69		+1.51		+.31		+15.71		+15.74		+10.00
$Pcost_{s,i}^{cer}$	1.32	1.32	1.32	1.42	1.27	1.32	1.32	1.49	1.32	1.34	1.32	1.39
$P_{s,i}^{cer}$cost change (%)		+0.35		+7.94		+4.18		+13.27		+1.76		+5.54

NOTE.-Prices are in 100 USD per m³. Quantities are standardized. Asia encompasses Oceania and Europe encompasses Russia. The world prices are calculated as the volume weighted average of each region's prices. The percentage changes represent the change of the variable's value in the GPP scenario compared to the baseline scenario. The displayed price premiums $Pprem_{s,i}$ are the percentage increase on top of the conventional wood price $P_{s,i}$.

Table 2-2: Consumption of wood, consumption of certified wood, demand prices (conventional), certified prices, and demand price premiums (baseline scenario and GPP scenario)

	Africa		Latin America		Asia		Europe		North America		World	
	Baseline	GPP	Baseline	GPP	Baseline	GPP	Baseline	GPP	Baseline	GPP	Baseline	GPP
Quantities:												
$Q_{d,i}$	.29	.28	1.85	1.81	3.99	3.99	4.65	4.58	4.20	4.19	14.97	14.87
$Q_{d,i}$ change (%)		-1.85		-1.72		+.11		-1.43		-.22		-.72
$Q_{d,i}^{cer}$	.00	.01	.11	.19	.12	.09	2.84	4.38	2.63	1.88	5.70	6.55
$Q_{d,i}^{cer}$ change (%)		+65.63		+71.04		-24.92		+54.11		-28.85		+14.69
$Share_{d,i}^{cer}$ (%)	.96	1.62	5.93	10.32	2.92	2.19	61.19	95.67	62.63	44.83	38.08	43.99
$Share_{d,i}^{cer}$ change (%)		+68.75		+74.03		-25.00		+56.35		-28.42		+15.53
Prices:												
$P_{d,i}$	1.28	1.33	1.22	1.27	1.27	1.26	1.21	1.52	1.21	1.26	1.23	1.34
$P_{d,i}$ change (%)		+4.10		+4.06		-.53		+26.18		+4.05		+9.50
$Pprem_{d,i}$ (%)	22.04	20.39	25.85	22.76	20.27	21.28	9.05	0.00	9.03	21.27	14.36	14.88
$Pprem_{d,i}$ change (%)		-7.49		-11.95		+4.98		-100.00		+135.55		+3.65
$P_{d,i}^{cer}$	1.56	1.60	1.54	1.56	1.52	1.53	1.32	1.52	1.32	1.52	1.40	1.54
$P_{d,i}^{cer}$ change (%)		+2.69		+1.51		+.31		+15.71		+15.74		+10.00

NOTE.-Prices are in 100 USD per m³. Quantities are standardized. Asia encompasses Oceania and Europe encompasses Russia. The world prices are calculated as the volume weighted average of each region's prices. The percentage changes represent the change of the variable's value in the GPP scenario compared to the baseline scenario. The displayed price premiums $Pprem_{d,i}$ are the percentage increase on top of the conventional wood price $P_{d,i}$.

Table 2-3: Percentage change of the regional welfare

	Welfare baseline	Welfare GPP	Change in welfare (in %)
Africa	0.63	0.64	+0.41
Latin America	3.86	3.89	+0.53
Asia	15.60	14.75	-5.46
Europe	54.96	56.64	+3.06
North America	50.05	49.65	-0.78
World	125.11	125.57	+0.37

NOTE.- Asia encompasses Oceania and Europe encompasses Russia. The welfare is based upon the standardized quantities and prices in 100 USD per m^3 and The percentage changes represent the change to the variable's value in the GPP scenario compared to the baseline scenario and are displayed in 100%.

Table 2-4: internationally traded quantities of wood, per wood type, per scenario

Destination / **Origin**	**Wood type** / **Scenario**	Africa		Latin America		Asia		Europe		North America	
		Conv	Cert	Conv	Cert	Conv	Cert	Conv	Cert	Conv	Cert
Africa	Baseline	0.2863	0.0028		0.0058		0.0068	0.0604			
	GPP	0.2791	0.0046			0.0924					
Latin America	Baseline			1.7368	0.0799			0.0648			
	GPP			1.6274	0.1873	0.1395					
Asia	Baseline					3.8769	0.0003				
	GPP					3.2532	0.0877				
Europe	Baseline							1.5977	2.8436		
	GPP					0.0300		0.1984	4.3823		
North America	Baseline				0.0239		0.1094	0.0806		1.5686	2.6294
	GPP					0.3948				2.3110	1.8777

NOTE.- Quantities are standardized. Asia encompasses Oceania and Europe encompasses Russia.

5. Discussion

5.1. Trade barrier

As indicated, no international trade in certified wood occurs in the GPP scenario (Table 2-4). The existence of transport costs cannot be held responsible for this evolution for two reasons. First, the international trade in conventional wood increased considerably (+219.06%) in the GPP scenario despite the transport costs. Asia, in particular, imports conventional wood in the GPP scenario. The Asian imports mainly originate from North and Latin America. They respectively account for 60.11% and 21.25% of the Asian imports. Those regions are able to export conventional wood to Asia due to the efficiency of their conventional wood producers and their low bilateral transport costs to Asia. This results in a comparative cost advantage for North and Latin America. Second, certified wood trade is possible in the baseline scenario: Africa and North America are exporting certified wood to Latin America and Asia. Hence, the transport costs separate, but do not isolate, the different regions' (certified) markets.

However, in the GPP scenario, all regions' demand for certified wood is fulfilled by domestic production. This is due to consumers' limited WTP for certified wood. This WTP is sufficiently high to account for the increased price premium demanded by certified wood producers. However, the WTP is not sufficiently great to account for the combination of the transport costs and the increased price premium. This provides a competitive advantage for domestic producers over foreign producers. Hence, this situation is in accordance with the findings of Atkeson and Burstein (2010) who describe how transport costs determine to what extent producers implement innovation (i.e. the switch from conventional to certified production).

The situation is especially problematic in Africa. Despite an increased African demand for certified wood, this region's certified wood producers are outcompeted in the other regions' certified wood markets. This leads to reduced certified wood production in Africa in the GPP scenario. Instead, Africa is producing more conventional wood. Also North American producers are producing more conventional wood instead of certified wood. This decrease is explained by the combination of the trade barrier and the reduced demand for certified wood in North America itself. This is seemingly contradictory to the initial goal of GPP which aims to encourage sustainable forest management and conservation worldwide through the purchase of certified wood. This finding provides a justification for the dominance of the home-effect applied by Fajgelbaum et al. (2011)[42].

[42] In the research by Fajgelbaum, the richer countries also export the high-quality goods. This is not the case in this research, the home-effect makes trade impossible. As a consequence however, the richer countries need to fulfil the higher demand for high-quality products themselves.

Hence, the grounds for exclusion out of the certified segment of export markets are purely economic: the importers' demand prices do not compensate the exporters' supply prices plus the transport costs. This approach – which is based on the assumption of perfect competition – is valid: experts of the *International Tropical Timber Council* already described that without 'tangible benefits deriving from certification in terms of profitability or competitiveness, enterprises will have little incentive to improve forest management with higher costs. Although other authors claim that the intangible benefits (e.g. learning, community empowerment,…) might also justify the additional certification costs (Carlson and Palmer 2016). The problem is particularly serious in the case of tropical wood producing countries' (Simula et al. 2004). This kind of trade barrier endangers the future of certification. If 'producers are forced to drop out from traditional markets, as has already happened in some cases, product prices are driven down'. In some regions, this can lead to a reduction in the value of the resource, encouraging its conversion into other uses. Hence, the trade barrier created by GPP stimulates forest degradation due to the slow progress of certification in tropical countries.

Finally, it is worth mentioning that this chapter's trade barrier are most likely an underestimation of real life's trade barriers since consumers tend to have a preference for locally produced wood (Aguilar and Cai 2010).

5.2. Leverage effect of GPP for certification

GPP stimulates certification at global level, but whether or not GPP stimulates certification at regional level depends on the regional consumption and production functions. Next to Europe, certification only gained importance on both the demand and supply side of the market in Latin America. All other regions experience decreasing importance in production (Africa), consumption (Asia) or on both sides of the market (North America).

The analysis of the evolution of the certified shares is important for analyzing the leverage effect of GPP, but the real certified market share in consumption and production is also important. In both scenarios, the certified share of wood consumption and production in the Southern hemisphere (Africa, Asia, Latin America) is equal to or below 10%. Concerning consumption, the positive relationship between the WTP, the GDP, and the certified share in a region's consumption indicates that 'Willingness to Pay' is probably the wrong choice of words. It rather reflects the capacity to pay for certified products. A considerable local certified demand is crucial for the uptake of certified production in a region (Carlsen et al. 2012). Therefore, it is crucial to encourage certified consumption as well.

Concerning production, the limited importance of certification is also observed in reality (Table B1). Certification is a market-based instrument which relies on the price premium to encourage sustainable forest management. This suggests that, also in reality, the price premium insufficiently compensates

the costs of certification of the producers in the Southern hemisphere. This is also observed by Carlson and Palmer (2016). In addition, the SEM demonstrates that the European governments' market power as a substantial consumer does not sufficiently increase the price premium to make certification more inclusive at global level.

Instead of working on the price premium, government policies can aim to reduce the costs of certification. A cost reduction can be effectuated by improving: the legislative framework in support of certification (Putz et al. 2000), the distance and convenience of the transport of wood (Gullison 2003), the available financial means (ITTC 2004), and the bureaucratic requirements. The later especially poses a problem for illiterate producers (Nussbaum and Simula 2013).

Cooperative initiatives can also decrease the direct costs of certification for small-scale producers (who are typically more located in the Southern hemisphere). Small-scale producers are disadvantaged for two reasons. First, the direct costs are not dependent on the size of a forest/company (Ebeling and Yasué 2009). Consequently, the costs are relatively low for large-scale producers and relatively high for small-scale producers (Gullison 2003). Second, the demand for certified wood is mainly driven by retail, which demands large volumes, consistent quality, and low prices. Large-scale wood producers in the Northern hemisphere are better able to meet these requirements (Molnar and Trends 2003, Rametsteiner and Simula 2003, Klooster 2005, Taylor 2005, Meijaard et al. 2014). In the Southern hemisphere, Atyi et al. (2013) describe how large scale industrial forest concession holders, instead of small-scale concession holders, benefit from increased exports towards the North.

However, a phased approach is needed for this kind of policy (Simula et al. 2004). In addition, a comprehensive strategy must be developed in which certification plays a complementary role in sustainable forest management. Other points of attention of the comprehensive strategy can focus at other aspects which disadvantage sustainable forestry in the tropics (e.g. weak land tenure rights), as they are numerous (Wang et al. 2016, Faria and Almeida 2016).

5.3. Limitations

The SEM's design does not allow exact forecasting of the leverage effect of GPP on each region's certified wood consumption and production for a number of reasons. First, the SEM applies regional aggregation. This is a mere simplification of reality, since those regions encompass a set of heterogeneous countries. Therefore, this research does not claim that, for example, certified production will decrease in every African country due to GPP in Europe. Instead, the model's mechanisms reveal what the impact will be for a country with a country profile which is comparable to one of the 5 regions' profiles.

Second, the SEM neglects a number of alternative explanatory variables for the consumption and production of (certified) wood. The SEM is a partial model, so one important neglected factor are the prices and availability of substitutes for industrial roundwood. In addition, the SEM also neglects the origin of the wood. Industrial roundwood from one region might have better characteristics than wood from other regions. In reality, this might entail a higher WTP for this higher-quality industrial roundwood. Also the type of forest ownership (public versus private) is neglected. Publically owned forest are able to bear higher opportunity costs of forest and biodiversity conservation (Hily et al. 2015).

Third, this is a comparative static equilibrium model. The evolution from the baseline scenario's equilibrium to the GPP scenario's equilibrium will require time. More in particular, it requires the time for consumers and producers to reallocate their consumption and production factors from conventional to certified wood production and consumption (or vice versa). In addition, governments need time to implement GPP perfectly (Testa et al. 2012). In order to successfully implement GPP, governments first need to train their staff, develop practical tools and information, and acquire expertise in applying environmental criteria (European Commission 2016a). In addition, governments should pursue a more systematic implementation and integration of GPP into management systems, and co-operation between authorities to foster the uptake of GPP (European Commission 2016a). In addition, a static model might not capture the increased trustworthiness of eco-certification schemes due to GPP. According to Gulbrandsen (2014), governments which approve certification schemes can signal that those 'schemes are credible governance systems on which private producers and buyers can rely'. This can increase the long run WTP, and indirectly increase GPP's effects on the wood market.

As such, this chapter's findings remain indicative for the impact of GPP. In this context, note that it is not common to calibrate this type of research's results due to a lack of experimental data to which they can be validated. The model runs under the ceteris paribus assumption which can never be observed in reality. Suitable data for a proper validation does not exist. Nevertheless, the different parts of the model have been calibrated, as real data is used in order to provide the input data for the SEM (e.g. the trade data by Buongiorno). The interaction between the different parts of the model is new, and is not calibrated. Another element which impedes validation is the fact that GPP implementation cannot happen overnight. Hence, it is difficult to filter the effect of GPP out of historical data.

6. Conclusion

According to the modified SEM presented in this chapter, the GPP for wood in Europe stimulates the consumption and production of certified wood at global level. However, this leverage effect is not transposed into each region's consumption. In some regions, conventional wood became less expensive than certified wood. Those regions' consumers increased their conventional wood

consumption at the expense of certified wood. Notable is the disappearance of the price premium in the region where certified wood became the standard: Europe. The European conventional wood price increased demand to the extent that it also compensated for the costs of certification.

The leverage effect for certification is also not realized on the supply side for all regions' markets. The increased certified wood price created an impenetrable trade barrier for certified wood. The disappearance of international certified wood trade, in combination with the home-effect of decreasing domestic demand for certified wood in some regions, resulted in reduced certified wood production in specific cases. All these findings are in line with what is currently observed in reality, suggesting that more attention must be devoted to the costs of certification.

The innovative features added to traditional Spatial Equilibrium Modelling allow us to analyze the impact of the policy for each regions' quasi-welfare. At global level, the quasi-welfare increased because GPP taps into previously unused potential consumer and producer surplus. Unfortunately, this is not a Pareto efficient improvement. Due to the considerable weight of the consumer surplus in quasi-welfare, the regions that experienced reduced consumption of certified wood also faced a decrease in their quasi-welfare: North America and Asia.

Chapter 3. Drivers for intention to buy eco-certified wood and support for Green Public Procurement with negative consequences

Abstract. This chapter empirically investigates to what extent consumers of eco-certified wood are driven by self-interest instead of environmental or altruistic concerns. This is done by making use of a questionnaire. The questionnaire allows to establish distinct consumer profiles in terms of demographics, attitudinal and behavioral characteristics. The profiles are formed using a two-step segmentation process combining hierarchical and K-means segmentation. The perceived consumer effectiveness does not drive eco-certified consumption. This is explained by the low frequency of wood purchases, which results in a low Perceived Consumer Effectiveness for wood. In addition, this chapter observes decreasing support for Green Public Procurement with negative consequences, especially among consumers with a high environmental concern. The high level of involvement implies that consumers want to perform sustainable purchases themselves, instead of transferring this responsibility to governments. This suggests that the traditional methods to probe for a consumer's environmental (altruistic) concern capture an element of self-interest, which appears to be an important driver for eco-certification.

Context: Chapter 2 describes a crowding-out effect of GPP on private consumption. This chapter further investigates the private consumers' position towards crowding out of GPP, or increased prices due to GPP.

1. Introduction

This chapter empirically investigates to what extent consumers of eco-certified wood are driven by self-interest, environmental, or altruistic concerns. This is done by making use of a questionnaire, which allows to establish distinct consumer profiles in terms of demographics, attitudinal and behavioral characteristics. Attitudes are compared between these distinct profiles in different scenarios in order to uncover unconscious (self-centered) drivers for purchasing eco-certified wood.

On the supply-side of the market, eco-certification of forest and wood products has become an important tool to improve the producers' environmental performance (Blackman and Naranjo 2012, Jaung et al. 2016). Eco-certified producers must comply with various sustainability guidelines which are aimed towards more sustainable forest management (Cashore et al. 2006)[43]. As such, eco-certification tackles deforestation and forest degradation while enhancing forest carbon stocks (FSC 2015). Deforestation and carbon stocks are two essential elements in current discussions about climate change. The human exploitation of forest area accounts for 9.51% of the global environmental footprint in 2016. This is more than the footprint of built-up land, fisheries or grazing land. The carbon footprint, for which deforestation and forest degradation are also partially responsible, even accounts for 59.51% of the global environmental footprint (Lin et al. 2016).

On the demand-side of the market, eco-certification schemes assume that environmentally aware consumers purchase sustainably produced goods (Agrawal et al. 2014) which are differentiated from conventional products by their credence quality. The credence quality relates to the application of environmental and socially responsible production practices throughout the production process. Hence, credence goods are vertically differentiated by process attributes, and not by physical characteristics (Ferraro and Kiss 2002, Ferraro and Simpson 2002, Groom and Palmer 2010, Dulleck et al. 2011, Groom and Palmer 2014, Carlson and Palmer 2016, Brusselaers et al. 2017). Depending on the species and circumstances (e.g. income), consumers are even willing to pay a price premium over the conventional wood price as remuneration for the credence qualities (Shoji et al. 2014). Producers who aim to supply the environmentally aware consumer segment therefore have an interest in achieving certification and meeting the sustainability standards (Agrawal et al. 2014).

Earlier research analyzed the impact of several (psychological) consumer characteristics[44] on attitude towards, and intention to buy, certified products. In particular, the emotional component of consumer decision-making can increase certified consumption (Vermeir and Verbeke 2006, Kang et al. 2013,

[43] This includes protecting old growth forests, conserving natural habitats, and encouraging local employment.
[44] Characteristics taken into account by earlier research: environmental knowledge, familiarity with eco-labels, subjective knowledge, pro-environmental self-identification, sense of personal responsibility, concern for negative environmental impacts of production, perceived consumer effectiveness, gender, and education (Vermeir and Verbeke 2006, Kang et al. 2013, Jonell et al. 2016)

Jonell et al. 2016). Some of these drivers have an individual-oriented focus. Examples are the subjective norm[45] and the consumer's attitude towards eco-certified consumption. Other drivers have an altruistic, environment-oriented focus. Examples are the respondents' Perceived Consumer Effectiveness[46] (PCE), adherence to the Dominant Social Paradigm[47] or the New Environmental Paradigm (NEP) (Dunlap et al. 2000, Dunlap and Van Liere 1984). The PCE measures to what extent a person believes that his/her personal choices contribute to a reduction in the environmental impact of consumption. The Dominant Social Paradigm adheres the view that humans are superior to other species, mankind can unlimited extract resources, and (technological) progress provides solutions for environmental problems. In contrast, the NEP serves as a measure of 'endorsement of a "pro-ecological" world view'. In addition to these attitudes towards sustainable consumption, Aguilar and Vlosky (2007) specifically linked trust in the certificate's positive impact and income level to eco-certified wood consumption (Aguilar and Vlosky 2007).

This chapter acknowledges the usefulness of these concepts as explanatory variables for the intention to buy eco-certified wood and measures them through the questionnaire. In addition, generic information (gender, education, financial position,…) is gathered. Subsequently, the collected data is used to establish distinct consumer segments. Each segment consists of consumers who are similar to each other, and dissimilar to consumers in other segments (Vanhonacker et al. 2013). The segments are formed using a two-step process combining hierarchical and K-means segmentation.

Unlike previous research, the consumer profiles are not solely used to investigate the uptake of certified consumption. In addition, the questionnaire probes for the respondents' support for government purchases of eco-certified wood in different scenarios. This policy is also known as Green Public Procurement (GPP) (Edler et al. 2015). Depending on the scenario, the GPP entails negative consequences, such as increased prices or crowding-out of private consumers (i.e. eco-certified wood becomes unavailable for private consumption). The design of the different scenarios depends on earlier research by Vermeir and Verbeke (2006) and Annunziata and Scarpato (2014). They described how sustainable purchases might be hindered by high prices or low perceived availability of the sustainable products.

As such, this chapter investigates, for the first time, to what extent altruistic, environment-oriented concerns are genuine drivers for eco-certified consumption. If genuine, a high environmental concern should not induce a preference for own consumption of sustainable products instead of other consumers' consumption of sustainable products. Theoretically, the environmental impact of

[45] The subjective norm indicates to what extent people feel pressured by other people in their social environment to perform or not perform a specific behavior (Fishbein and Ajzen 1977).
[46] To what extent a person believes that his/her personal choices contribute to a reduction in the environmental impact of consumption (Ellen et al. 1991).
[47] The view that humans are superior to other species, mankind can unlimited extract resources, and (technological) progress provides solutions for environmental problems

sustainable consumption is independent from the identity of the consumer. Hence, a consumer with high environmental concerns who purchases sustainable products will achieve exactly the same environmental benefit compared to other consumers' (e.g. governments) consumption of sustainable products. However, it is not unimaginable that self-interest and individual concerns play a role when it comes to eco-certified consumption. A number of authors described how self-interest and individual concerns act as obstacles to environmental behavior (Follows and Jobber 2000, Kim 2011). In contrast, this chapter checks whether self-interest can positively impact on consumer environmental behavior (i.e. sustainable consumption to satisfy a personal need).

It is a valid and relevant assumption to consider the government as a consumer who creates scarcity in the certified wood market for three reasons. First, governments account for a considerable share in the final consumption of wood products. In the EU, governments, for example, account for 26.88% of final wood consumption (EUROSTAT 2015). Second, governments are increasingly taking "environmental and sustainability criteria into account in addition to purely economic (i.e. price) criteria when procuring goods and services" (Brusselaers et al. 2017). Third, expert consultation confirms that the certified wood supply would not immediately be able to meet the increased certified demand if governments decide to solely purchase eco-certified wood products (FSC International 2015). Recently, Brusselaers et al. (2017) also described how GPP can increase the price of certified wood and subsequently reduce private certified wood consumption.

This chapter shows that support for GPP decreases significantly once the policy entails negative consequences. The loss of support appears to be positively correlated to environmental concern (measured as a score on the NEP). This contests the sincerity of the ecological concern and suggests self-interest might be more important than previously expected. These insights are important for all stakeholders who aim to promote the private consumption of eco-certified wood. These stakeholders include governments, since GPP aims to foster the private consumption of environmentally-sustainable goods by reducing the transaction costs for adapting to new products and stimulating the uptake of innovations[48] (Edler et al. 2015, Schaltegger et al. 2014).

The remainder of this chapter is structured as follows. The second part describes the applied methods. Part three presents some descriptive statistics prior to analyzing the impact of consumer involvement, PCE, the consumers' subjective norms, knowledge of the labels and demographic characteristics. Subsequently, the different scenarios are compared in order to check the impact of a perceived decreasing availability due to government purchases. Part four discusses the results, while part five ends with a conclusion.

[48] E.g.: Once the consumption of sustainable products becomes more common, this will decrease the required effort and cost related to the information search.

2. Data collection and methods

2.1. Study design and subjects

This research uses cross-sectional survey data collected through questionnaires in May 2016 and January 2017 in Belgium (Appendix J). The study sample consists of 274 young Belgian adults following higher education. The selection of this specific population is based on the threefold rationale by Vermeir and Verbeke (2006). First, the selection of a uniform group rules out possible interference from classical socio-demographic variables (e.g. age, income, social class) which are proven to impact on attitude and behavioral intentions with regards to sustainable consumption. Second, young adults are the most important consumers for the next half century. According to Vermeir and Verbeke (2006) it is likely that they will take their habits into their older age, which provides policy makers with "ample possibilities to create sustainable consumption habits within this population" in the future. Third, this chapter assumes that higher educated young adults have an awareness of the concept of sustainability. The respondents' environmental awareness is a prerequisite for this research, as unaware respondents are likely to have non-existent attitudes and behavioral intentions. This would not allow the segmentation of the respondents.

The awareness among the respondents is not explicitly checked. However two elements ensure sufficient compliance to the precondition. First, all of the respondents are enrolled in a Bachelor program at Ghent University. They either attended a combination of courses in 'Ecology' and 'Ethics', or they attended a combination of courses in 'Ecology', 'Economics', and 'Sustainable production processes'. All of those courses address the concept of sustainability. In addition, Ghent University annually gauges for the perceived quality of its educational services through a questionnaire. At this occasion, over 80% of the responding students indicate that the concept of sustainability is sufficiently present in the University's educational program.

On the downside of this sampling approach, this chapter's findings mainly apply to the sample's characteristics and generalization remains speculative. Therefore, this research's results remain speculative and must not be used for extrapolation of consumption in the long run. This limitation is further discussed in section '5. Limitations'. Table 3-1 presents some overall socio-demographic characteristics of the sample.

Table 3-1: Socio-demographic characteristics of the sample (n=274)

Socio-demographic characteristics	% of total
Gender	
Male	51
Female	49
Age Group 18 – 22, higher educated	100
Financial situation	
Below average & Average	39
Above average	48
Wealthy	13
Living environment	
Rural	33
Urban	67
Purchasing responsibility in family	
Main responsibility	9
Shared responsibility	33
Someone else has more responsibility	58

2.2. Questionnaire and scales

The questionnaire comprises three parts (Appendix J). The first part measures the respondents' environmental attitudes using the 15-item version of the NEP scale by Hawcroft and Milfont (2010). In addition, the final four questions of this first part gauges to what extent the respondents' believe that their personal choices contribute to a reduction in the environmental impact of consumption. This is done by applying the 4-item Perceived Consumer Effectiveness (PCE) measurement, as described by Ellen et al. (1991) and Lee and Holden (1999). As such, the Both the NEP and PCE are considered as altruistic, environment-oriented drivers of sustainable consumption.

The second part questions knowledge on, and attitude towards forests, sustainable forest management, and sustainable wood production. The questionnaire first presents some information on the contribution of deforestation and forest management to global CO_2 emissions. Subsequently, the questionnaire checks whether the respondents are aware of the existence of the FSC and PEFC[49] certification schemes (the accompanying logos were also presented). FSC and PEFC are the most important certification schemes in terms of volume and certified forest area, both in Belgium and at global level (Yamamoto et al. 2014). Further questions probed the respondents' attitudes towards the purchase of certified wood. This is done by combining components of both experimental and instrumental nature, as described by Ajzen (1991). Each component is measured on a 5-point semantic differential scale. The antonyms used were 'harmful versus beneficial, 'advantageous versus disadvantageous', 'good versus bad', 'worthless versus valuable', 'enjoyable versus unenjoyable'. In

[49] FSC = Forest Stewardship Council, PEFC = Programme for Endorsement of Forest Certification Schemes. However, the abbreviations are most often used in marketing campaigns for both certification schemes, and in the visible certificate.

line with the stipulations by Ajzen (1991), part two probes for the subjective norm to purchase eco-certified wood products. This analyses to what extent the respondents' social environment is likely to influence them to opt for eco-certified products. The likelihood is measured on a 5-point interval scale varying from 'not likely' to 'very likely'. The social groups taken into account were 'people who are important to me', 'people whose opinion I value', 'friends', 'family', 'people who affect my purchasing decisions'. This indicates to what extent people feel pressured to perform, or not perform, a specific behavior (Ajzen 1991, Fishbein and Ajzen 1977).

Subsequently, respondents had to indicate to what extent they intend to buy eco-certified wood products in the future (5-point scale from 'completely disagree' to 'completely agree') and to what extent they believe the eco-certificates indeed sustain forest management and wood production (5-point scale from 'not sure at all' to 'very sure'). Trust in the eco-certification scheme's impact is probed twice for each separate aspect (social, economic, and environmental) upon which the eco-certificates aim to impact. Pappila (2013) and Van Kooten et al. (2005) described the importance of trust when it comes to eco-certification of wood. In fact, wood operators often opt for eco-certification because this is an indicator of trustworthiness (Owari et al. 2006). The followed procedure to transform the questions' results into scales is further explained in Appendix K.

At the end of part two, the respondents had to indicate to what extent they support their government purchasing eco-certified wood, instead of conventional wood, in different scenarios. This type of government policy is called Green Public Procurement (GPP). The level of support is measured on a 5-point scale ranging from a non-supportive position to a very supportive position, with a neutral position in between. In the first scenario, the respondents had to indicate whether they support GPP when this policy had no consequence for their private wood consumption. In the second and third scenario, GPP entailed negative consequences: respectively the unavailability of eco-certified wood (crowding-out of private consumers) and increased price for eco-certified wood.

The third part of the questionnaire collected information on the socio-demographic characteristics of the respondents. This included gender, age, education, financial situation, living environment, and purchasing responsibility in the family. A summary of these characteristics is presented in Table 3-1.

2.3. Consumer segmentation

This research applies segmentation analysis in order to separate the respondents into different groups based on their characteristics. The segmentation process aims for a high degree of similarity among respondents within a segment, and a high degree of dissimilarity between the segments.

The reason to apply segmentation analysis is twofold. First, this research aims to check whether the identified determinants of sustainable consumption also apply to wood consumption. Those

explanatory variables are the respondents' environmental concern, PCE, subjective norm, and attitude towards eco-certified purchases. In addition, this chapter also takes explanatory variables into account which specifically link to eco-certified wood consumption: trust in the certificate's positive impact and income level (Aguilar and Vlosky 2007) in addition to the socio-demographic variables. The segmentation analysis is conducted by making use of the respondents' score for these explanatory variables, on the condition that these variables significantly impact on the intention to buy eco-certified wood. The latter is checked using Ordinary Least Squares (OLS) regression analysis and analysis of the Pearson correlation coefficient. This allows us to check for the presence of segments with a significantly different intention to buy eco-certified wood. Second, the consumer segmentation provides a solid framework for the comparison of attitudes by different consumer types towards government purchases of eco-certified wood (given specific scenarios).

Segmentation analysis is only useful if the segmentation process is sufficiently efficient to result in stable segment solutions. This chapter applies the two-step procedure, as described by Yedla et al. (2010). The first step consists of hierarchical segmentation in order to determine the optimal number of segments, and the position of each segment's centroid. The second step introduces those centroids as the initial points for a K-means segmentation. The quality of this solution is double-checked by analysis of the within group sum of squares for the resulting number of segments. Finally, ANOVA must indicate significantly different attitudes or characteristics between the segments.

3. Results

3.1. Descriptive statistics and construct validity

Table 3-2 presents information on the reliability of the constructs applied in this research. Each construct appears to be sufficiently reliable with Cronbach's Alpha above 0.60. The high mean score (3.75) for the 'environmental concern' construct indicates that this research's sample inclines to the NEP. The sample displays a high environmental concern. Hence, they are more inclined towards the NEP instead of the Dominant Social Paradigm. Hence, the sample does not believe that humans are superior to other species, the Earth provides unlimited resources for humans, and that progress is an inherent part of human history (Allaby and Park 2013).

The score on the PCE is close to the neutral position 3 on the 5-point scale. The higher standard deviation for the PCE indicates that both consumers who believe, and consumers who do not believe that their individual behavior contributes to the solution of the environmental problem are present in this study sample. The sample also displays a positive 'attitude towards the consumption of eco-certified wood'. Hence they value, and enjoy this type of purchase. The mean score for the subjective norm is slightly lower, but nevertheless remains – significantly – above the neutral score 3 (according

to an ANOVA test). Hence, people in the respondents' environment are inclined to purchase eco-certified wood or believe that this type of consumption is the right thing to do. This could pressure the respondents into copying their behavior. Finally, the mean score for confidence in the eco-certification schemes is significantly lower than 3 (according to an ANOVA test). The respondents tend not to believe the claims that the eco-certification schemes ensure social, economic, and environmental sustainability in forest management and wood production.

Table 3-2: Construct reliability test: Cronbach's Alpha

Construct	Number of items	Cronbach's Alpha	Mean	Standard Deviation
Environmental concern	12	0.68	3.75^{A}	0.39
Perceived consumer effectiveness	3	0.67	3.03^{B}	0.84
Attitude towards eco-certified purchases	5	0.79	3.98^{C}	0.54
Subjective norm	5	0.75	3.17^{D}	0.53
Confidence in eco-certification schemes	6	0.70	2.88^{B}	0.61

NOTE.- All constructs are measured on a 5-point scale with a maximum score of 5 and minimum score of 1.
[a,b,c,d] Scores in a column with different superscripts are significantly different ($p<0.05$), tested using ANOVA with Tukey post hoc tests.

Table 3-3 presents the respondents' intentions to buy eco-certified wood in future. The mean of 3.58 is significantly higher than the neutral score of 3. This indicates that a considerable proportion of the respondents are interested in purchasing eco-certified wood. Even more respondents believe that governments should solely purchase eco-certified wood (mean 3.79). However, this preference for governments purchasing eco-certified wood decreases significantly when this makes eco-certified wood unavailable or more expensive (respective mean score of 3.27 and 3.18).

Table 3-3: Intention to buy eco-certified wood and attitude towards government purchases of eco-certified wood

Agreement with statement	Mean	Standard deviation
"In the future, I will buy eco-certified wood products"	3.58^{A}	0.79
"Governments should solely purchase eco-certified wood"	3.79^{B}	0.80
"Governments should solely purchase eco-certified wood, even if this implies that no eco-certified wood is available for my personal consumption"	3.27^{C}	0.89
"Governments should solely purchase eco-certified wood, even if this implies that the price of eco-certified wood increases"	3.18^{C}	0.85

NOTE.- All constructs are measured on a 5-point scale ranging from 'completely disagree' to 'completely agree'. 'completely disagree' obtains a score of 1, 'completely agree' obtains the maximum score of 5, while 'neutral' obtains the center score 3.
[a,b,c,d] Scores in a column with different superscripts are significantly different ($p<0.05$), tested using ANOVA with Tukey post hoc tests.

3.2. Consumer segmentation

This chapter's literature review identified environmental concern, PCE, subjective norm, and attitude towards eco-certified purchases as drivers for sustainable consumption. This chapter first applies OLS regression in order to check whether the variables indeed determine the intention to buy eco-certified

wood[50] (Table 3-4). Note that also the significance of the socio-demographic variables was first checked. However, this test did not reveal any significant impact on the intention to buy eco-certified wood (full output is presented in Appendix D).

In theory, it is more appropriate to apply ordinal logistic regression on an ordered discrete dependent variable. However, in consumer research, it is common practice to consider a 5-point scale as continuous. For this reason, and reason of comprehensibility of the model's coefficients, this paper adheres the OLS approach. The results are cross-checked however by (the statistically more appropriate) ordinal logistic regression (Appendix D). The results for the ordinal logistic regression are in line with the initial OLS's findings which provides additional justification for the applied OLS approach.

Table 3-4: Estimation results of OLS regression (dependent variable is the intention to buy eco-certified wood)

Variable	Estimated coefficient	p-value
Intercept	-0.99	0.076
Perceived consumer effectiveness	-0.01	0.90
Environmental concern	0.46 ***	3.54 e^{-5}
Subjective norm	0.40 ***	1.81 e^{-6}
Attitude towards eco-certified purchases	0.40 ***	2.01 e^{-6}

NOTE.- * Statistical significance at $p < 0.05$, ** Statistical significance at $p < 0.01$, *** Statistical significance at $p < 0.001$.

The regression analysis demonstrates a significant and positive impact for environmental concern, subjective norm, and attitude towards eco-certified purchases. The explanatory variables can potentially be correlated with each other. To avoid multicollinearity problems, this chapter calculated the Pearson correlation coefficients for each combination of explanatory variables in the model. No correlation above 0.3 is observed. In addition, the model is rerun with the exclusion of previously significant explanatory variables. In none of the cases, does PCE turn into a significant explanatory variable. Finally, the Variance Inflation Factor is also calculated for each explanatory variable, but those scores do not exceed 10. This indicates that no multicollinearity problems endanger the efficiency of the OLS regression model and that the PCE does not seem to impact on the intention to buy. For this reason, PCE is excluded as an input variable in the subsequent segmentation analysis.

During the first step of the segmentation procedure, hierarchical segmentation of the respondents is based on the three remaining input variables. This results in an optimal number of four segments. The segments are acceptable as they are different to the input variables and have a meaningful size (Malhotra and Birks 2007).

Subsequently, K-means segmentation is applied to four segments while the initial points of the K-means segments are set at the centroids of the hierarchically determined segments. Table 3-5 presents

[50] The questionnaire only gauged for the intention to buy eco-certified wood, it does not measure an attempt or adaption of eco-certified wood purchases. Those are the two remaining possible attitudes towards sustainable consumption, as identified by Fishbein and Ajzen (1977).

the mean scores for each segment on the input variables, and other variables for which significant differences between the segments are detected using ANOVA and Tukey post hoc.

Concerning the input variables, segment A has a significantly higher mean score than all other segments. The only exception is segment B's score for 'environmental concern', but the means for both segments do not differ significantly. Hence, segment A's members face the strongest incentives for sustainable consumption. As a consequence, segment A is the most voluntaristic and demonstrates a significantly higher intention to buy eco-certified wood than all the other segments. Noteworthy is segment A's fairly high mean PCE (significantly higher than segments C and D, and significantly above the neutral score 3). The PCE was not significant in the OLS regression, but the most voluntaristic segment's members do believe that their personal choices and actions can help to address the sustainability problems in forest management and wood production. In addition, they are the least pessimistic when it comes to confidence in the eco-certification schemes' sustainability impact (mean score does not significantly differ from the neutral position 3). Finally, 57.33% of segment A's members are female.

Segment B is most similar to segment A. It has a comparable mean score for 'environmental concern' and also the mean score for 'attitude towards eco-certified purchases' is high (albeit significantly below segment A's mean score). However, compared to segment A, segment B's mean score for the subjective norm is much lower. This results in a mean intention to buy which ranks second. No other significant differences can be found between segments A and B.

Segments C and D are also comparable for a number of input variables. No significant differences are detected for their mean scores for 'environmental concern' and 'attitude towards eco-certified purchases'. Both segments significantly score lower for these variables compared to segments A and B. The main difference between segments C and D is their mean score for the 'subjective norm'. While segment C is characterized by the, overall, second highest subjective norm, segment D has the lowest subjective norm. Consequently, the intention to buy for segment C ranks third, while segment D's intention to buy ranks fourth. For both segments C and D, the PCE and confidence in the eco-certification schemes is significantly lower than for the two other segments and below the neutral position 3. This implies that members of those segments do not believe their personal choices and actions, nor the certification schemes, contribute to addressing the sustainability problems in forest management and wood production. Finally, the segments with the lowest scores for the input variables, segments C and D, consist of more male than female members, although no significant differences are observed for the gender ratio.

Table 3-5: Mean score for the input variables per segment after K-means segmentation (initial point based upon hierarchical segmentation)

	Segment A: Voluntaristic & Subjective norm	Segment B: Voluntaristic	Segment C: Poor drivers & Subjective norm	Segment D: Poor drivers
Segment size	75	87	72	38
Input variables				
Environmental concern (mean)	3.89 ^{A}	3.95 ^{A}	3.46 ^{B}	3.55 ^{B}
Subjective norm (mean)	3.60 ^{A}	3.03 ^{C}	3.33 ^{B}	2.36 ^{D}
Attitude towards eco-certified purchases (mean)	4.65 ^{A}	3.93 ^{B}	3.55 ^{C}	3.61 ^{C}
Intentional behavior				
Intention to buy eco-certified wood in future (mean)	4.00 ^{A}	3.69 ^{B}	3.35 ^{C}	2.92 ^{D}
Other scales				
Perceived Consumer Effectiveness (mean)	3.30 ^{A}	3.21 ^{A}	2.75 ^{B}	2.64 ^{B}
Confidence in eco-certification impact (mean)	3.02 ^{A}	2.93 ^{A}	2.78 ^{A}	2.65 ^{B}
Socio-demographic variables				
Gender (percentage of female respondents)	57.33%	50.57%	44.44%	36.84 %

NOTE.- All variables except Gender are measured on a five-point scale: 1=low score, 5=high score.
^{a,b,c,d} Scores in a row with different superscripts are significantly different ($p<0.05$), tested using ANOVA with Tukey post hoc tests. Variables which do not significantly differ between segments are financial status, living environment, purchasing responsibility, knowledge of the certification schemes, and age.

3.3. Scenarios

This part investigates support by the different segments for government purchases of eco-certified wood – GPP – in different scenarios. The results are presented in Table 3-6. In the first scenario, GPP entails no consequences for private consumption. In this case, support for GPP appears to be correlated to the intention to buy eco-certified wood. The two segments with the highest intention to buy eco-certified wood (segments A and B) are also significantly more supportive towards GPP compared to the two segments with the lowest intention to buy eco-certified wood (C and D). Note that the level of support for GPP in this scenario is above, or equal to, the intention to buy eco-certified wood for all segments. For segments B and D, the level of support for GPP is even significantly higher than their own intention to buy eco-certified wood.

The segments with a high intention to buy eco-certified wood are more supportive towards GPP. Therefore, this analysis applies OLS regression in order to check whether the segmentation's input variables, again including PCE, are useful explanatory variables for the level of support. The results of this analysis are presented in Appendix E. The level of support for GPP is positively related to environmental concern and attitude towards eco-certified wood. A high level of environmental concern and a positive attitude towards eco-certified purchases also provide a basis for supporting

GPP. The PCE does not impact on the level of support for GPP. This is apparent since a person might consider his personal consumption decisions as irrelevant, but in contrast perceive government purchases more considerable in volume. Nor does the subjective norm impact on the level of support. This is more straightforward since the subjective norm represents a perceived pressure to perform, or not perform, a specific behavior. In this context, the behavior by the government is irrelevant and does not impact a person's individual situation.

The support for GPP significantly decreases when this policy reduces the availability of eco-certified wood, or increases the eco-certified wood price. In scenario 2 (crowding-out private consumers), each segment's support for GPP decreased compared to scenario 1. As a consequence, no segment has a significantly different mean score for GPP support. Hence, the positive stance of the most supportive segments A and B disappears when eco-certified wood becomes unavailable for their private consumption. This suggests that the decrease in support between the first and second scenario was greater for the segments that were initially most in favor of GPP (segments A and B). ANOVA with Tukey post hoc tests confirm this observation when the decrease in support by segments A and B is compared to the loss of support by D, but not compared to segment C (Table 3-6). Finally, the level of support by segments C and D no longer differs significantly from the neutral score 3. Hence, these segments do not have a distinctive positive stance towards GPP in scenario 2.

Table 3-6: support for GPP, per segment and scenario

	Segment A: Voluntaristic & Subjective norm	Segment B: Voluntaristic	Segment C: Poor drivers & Subjective norm	Segment D: Poor drivers
Scenarios				
Scenario 1: "governments should solely purchase eco-certified wood"	4.00 ^{A}	3.94 ^{A}	3.58 ^{B}	3.39 ^{B}
Scenario 2: "Idem – no eco-certified wood available for private consumption"	3.4	3.26	3.19	3.13
Scenario 3: "Idem – price of eco-certified wood increases"	3.29	3.15	3.20	2.94
Decrease of support				
Scenario 2	0.60 ^{A}	0.68 ^{A}	0.39 ^{A}	0.26 ^{B}
Scenario 3	0.71 ^{A}	0.79 ^{A}	0.38 ^{B}	0.48 ^{A}

NOTE.- All variables except are measured on a five-point scale: 1=no support, 5=high support.

The findings for scenario 3 (the price of eco-certified wood increases due to GPP) are exactly the same except for the significant differences in the decrease in support among the segments. The only significant difference is observed between segments B and C. Nevertheless, the segments that were most supportive towards GPP in scenario 1 again experience the biggest decrease in support. OLS regression is also applied to analyze whether some of the segments' characteristics impact on the decrease in support for GPP. Only environmental concern is significantly and positively related to the size of the decrease in support.

4. Discussion

4.1. Perceived Consumer Effectiveness does not drive intentional behavior

Although the segment with the highest intention to buy eco-certified wood also has a high PCE, the OLS regression analysis demonstrated that the respondents' PCE does not significantly drive their intention to buy eco-certified wood. This is an apparent outcome as earlier research unambiguously identifies PCE as motivation for sustainable consumption of other commodities (Vermeir and Verbeke 2006, Kang et al. 2013).

This chapter claims that the absence of PCE as a driver for sustainable wood consumption stems from the low frequency of wood purchases. The wood consumption frequency is not measured in the questionnaire, but it is reasonable to assume that private consumers only rarely purchase wood. For this reason, the perceived environmental impact of private wood consumption might be rather small. A low PCE obviously results in a low attitude-behavior correlation (Berger and Corbin 1992). However, the standard PCE estimation technique by Ellen et al. (1991) and Lee and Holden (1999) is applied in this research, without specific reference to wood. This technique does not refer to any particular product or commodity. Hence, this research might be hindered by a discrepancy between the respondents' general PCE and their PCE specifically in relation to wood consumption. This finding advocates for commodity- or product-specific estimation of a respondent's PCE.

Finally, it must be noted that the low frequency of wood purchases in this specific sample can be linked to the young age of respondents and the accompanying low purchasing responsibilities. Nevertheless, 42% of the respondents have main or shared purchasing responsibilities in their family, and this responsibility was not found significant as explanatory variable for the intention to buy sustainable wood.

4.2. Public support for GPP

Public support is essential for any type of government policy. The segmentation analysis demonstrated that the support for GPP without negative consequences (scenario 1) appears to be higher for the segments with a high intention to buy eco-certified wood. Subsequent analysis of the Pearson correlation coefficient and OLS regression analysis demonstrates that the subjective norm does not significantly explain the level of support for GPP, while it does drive the intention to buy eco-certified wood. This insight directly links to the conceptualization of the subjective norm itself. The subjective norm indicates to what extent people feel pressured by people in their social environment to perform, or not perform, a specific behavior (Ajzen 1991). Consumption of eco-certified wood relieves the

private consumer from this pressure. In this context, the behavior of the government is irrelevant. A high score for the subjective norm does not translate into increased support for GPP.

In contrast, environmental concern (measured by the score on the NEP) and attitude towards eco-certification are positively related to support for GPP. Hence, these attitudes are a motivation to sustain individual consumption patterns, and simultaneously create the expectancy for other consumers (and governments) to sustain their consumption. Building support for GPP policy can focus on the environmental concern of private consumers, by for example increasing awareness of the environmental benefits of eco-certified wood consumption. This claim especially holds since the segments with a higher intention to buy also demonstrated a higher trust in the impact of eco-certification.

4.3. Decreasing support for GPP as an indicator for self-interest

GPP without negative consequences receives ample support by private consumers. Once negative consequences arise, this support decreases significantly. At present, the risk of these negative consequences is limited. However, expert consultation confirms that the supply of eco-certified wood would not be able to meet demand if governments decide to purchase solely eco-certified wood products (FSC International 2015). In addition, Chapter 2 described how GPP can increase the demand for, and consequently the price of certified wood. Hence, the negative consequences are not unrealistic.

The segments with the highest intention to buy eco-certified wood are more averse towards GPP if it entails negative consequences. At first sight, this is a straightforward conclusion as those segments probably attribute most utility to eco-certified purchases and hence would lose the most due to negative consequences. However, this contradicts one of the main drivers of eco-certified wood consumption: environmental concern. Furthermore, OLS regression analysis even finds that environmental concern is the only significant explanatory variable for the loss of support. Respondents with a high environmental concern demonstrate a higher loss of support for GPP when negative consequences occur. Theoretically, from an environmental point of view, the identity of the consumer (government or private consumer) does not change the environmental benefit of eco-certification. Hence, consumers with purely environmental drivers for the choice of eco-certified wood should not be disappointed when governments purchase the remaining eco-certified wood instead of them.

The opposite is observed however. This can be explained by the concept of involvement, or perceived personal importance. Involvement occurs when an object “is important to the self because it addresses important values and goals in peoples’ life” (Vermeir and Verbeke 2006). In this case, people with a high environmental concern are highly involved and invest cognitive effort in the decision-making process which leads to the consumption of eco-certified wood. The cognitive effort results in lengthier

decision making processes, extensive information search, formation of beliefs, attitudes and intentions and, most importantly, the behavioral outcome of purchasing a product which meets their values (Beharrell and Denison 1995, Jager 2000, Vermeir and Verbeke 2006). Not being able to purchase the eco-certified wood in this case is a deception. This suggests that the distinction between internal, person-oriented drivers (e.g. subjective norm), and environment-oriented drivers (e.g. environmental concern) for eco-certified wood consumption might not hold. The NEP probes for the respondent's altruistic concern for an external factor (i.e. the environment) but it also captures an element of self-interest. The respondents with a high environmental concern favor their personal consumption over government purchases. Hence, personal interest might be a more important driver for eco-certified consumption than previously assumed.

The importance of self-interest as driver for eco-certified consumption is also suggested by the observation that albeit confidence in forest eco-certification is low, consumers tend to have a positive attitude towards, and intention to buy eco-certified wood products. Table 3-2 displays a mean level of confidence of 2.88. This represents a negative stance as it is significantly below the neutral score of 3 according to a one sample t-test. However, the attitude towards eco-certified purchases is highly positive (3.98, not significantly different from the explicitly positive score of 4). Albeit the perceived limited effect of eco-certification, consumers appear highly interested in eco-certified purchases. This does not provide irrefutable evidence for, but instead suggests the presence of self-interest as driver for eco-certified purchases. Alternatively, consumers can have a positive attitude towards eco-certified purchases because they believe they support the idea of eco-certification. As such, they might improve the functioning of the eco-certification schemes in the long run.

Note that this research opts for segmentation analysis because its results are interesting tools for stakeholders that aim to reach out to the consumers. However, also MANOVA would have been an appropriate type of analysis to investigate the impact of the different variables on the intention to buy and changes in the level of support for GPP. Appendix F presents the results of the MANOVA test for the impact on loss of support and intention to buy. The MANOVA's results confirm the results of the segmentation analysis.

4.4. Leverage effect of GPP

GPP aims to foster the consumption of environmentally-sustainable goods by reducing the transaction costs for adapting to new products and stimulating the uptake of innovations (Edler et al. 2015, Schaltegger et al. 2014). This chapter's segmentation analysis contributes by making this a realistic ambition. The findings provide a better understanding of consumers' attitudes and behavior towards eco-certified wood consumption. These insights can be used in the development of a communication

strategy for the different segments in order to encourage them to opt for eco-certified wood consumption.

The intention to buy eco-certified wood is explained by the consumer's attitude towards eco-certified purchases, subjective norm, and environmental concern. Hence, comparable to building support for GPP, governments should pay adequate attention to the environmental concern of private consumers. Higher environmental concern encourages consumers to invest cognitive effort and to undertake extensive information search (Jager 2000). Under this rationale, reducing the transaction costs for seeking information, for example, could stimulate private consumption of eco-certified wood. Related to this issue, the lack of trust in the eco-certification schemes probably also obstructs the uptake of eco-certified wood consumption. As described by Pappila (2013), trust is essential in wood eco-certification.

Together with the subjective norm, this could create a self-reinforcing upward cycle. More environmentally concerned consumers in an individual's environment could increase this person's subjective norm and again encourage eco-certified purchases, etc. This leverage effect can only manifest itself when there is sufficient eco-certified wood supply. GPP's negative consequences, such as reduced availability and increasing prices could prevent the uptake of eco-certified wood consumption and reduce support for GPP.

5. Limitations

This research probes for the intention to buy eco-certified wood in future, but does not explicitly mentions a specific price. In theory, this is not necessary because it is not this chapter's intention to estimate a demand function. A demand function describes a consumer's actual behavior, while this research probes for the intention. The theory of planned behavior by Ajzen (1991) clearly distinguishes between intention and behavior and acknowledges that, in future, discrepancy can arise between measured intention and performed behavior. The possible explanations for this discrepancy are numerous, and include for example the respondent's future income. It is a deliberate choice to probe for intention instead of behavior. Research on the respondents' actual behavior requires a more extensive questionnaire, including for example choice experiments leading to – for example – Structural Equation Models. However, this approach is more demanding and time-consuming for the respondents and can result in high drop-out rates among the respondents. In case of high drop-out rates, it is likely that the less interested consumers (with the lowest intention to buy eco-certified wood) drop-out first. This creates the risk of a selection bias, as data would be missing for the group of non-motivated consumers.

A second limitation relates to the sampling approach. This approach results in an interesting and relevant sample, but on the downside the sample also has very specific characteristics. A number of

issues impede generalization of the research's findings. First, all respondents are following higher education. So, they are more likely to end up in the higher income categories. This creates a bias but simultaneously also adds an interesting feature to the study sample since income level is positively linked to owning a house (instead of renting) (Kain and Quigley 1972). This assumption also holds in the Flemish region in Belgium (Vlaamse woonraad 2011). Households owning a house are in charge of investments in their house and property, and thus need to decide more frequently on wood purchases compared to households which rent a house.

Second, the sample's young age impedes generalization. Due to the young average age, only 42% of the respondents has main or shared purchasing responsibility in their respective families. This creates a hypothetical bias, as the remaining 58% of the respondents is not considerably involved in consumption decisions and thus provided hypothetical answers to the questionnaire's questions. Nevertheless this study advocates that the selected sample remains sufficiently interesting due to the importance of the sample in future.

Finally, one could also argue whether the respondents have sufficient insights in the functioning of the wood market in order to correctly assess the different scenario's. The respondents received some brief information on the concept of eco-certification, but it is for example possible that they cannot link the increased demand by governments to increased prices. Nor has it been explicitly explained that eco-certified consumption could stimulate eco-certified production.

6. Conclusion

Traditionally, the intention to buy sustainable products is explained by a consumer's level of environmental concern, PCE, subjective norm, and attitude towards eco-certified purchases. This chapter uses these drivers as input variables in a combined hierarchical and K-means segmentation analysis in order to investigate two main issues. First of all, this analysis allows us to check whether these drivers also apply to the case of eco-certified wood consumption. The PCE turned out to be the only standard driver for sustainable consumption which does not significantly impact on eco-certified wood consumption. This is explained by the low frequency of wood purchases, which potentially results in a low PCE for wood, compared to the measured general PCE (unrelated to a type of commodity).

Second, the segmentation analysis allows a thorough investigation of the support for GPP in different scenarios. GPP without negative consequences enjoys support by consumers with high environmental concern and a positive attitude towards eco-certified consumption. However, support for GPP decreases significantly when GPP entails negative consequences. It is particularly consumers with high environmental concern who demonstrate a large drop in support. This stems from the high level of involvement for these consumers. The high level of involvement results in the investment of

cognitive effort in the decision process towards sustainable consumption. If this type of consumer cannot acquire eco-certified wood, this results in high levels of disappointment (and explains the considerable loss of support). As such, this analysis uses the measured loss of support as a proxy indicator for the self-centered driver for eco-certified consumption. In contrast to earlier findings, this indicates that self-interest might be a more important driver for eco-certification compared to more altruistic drivers.

Finally, this research describes a potential pathway from GPP to increased eco-certified private consumption. Highly involved consumers invest time and cognitive effort in the decision process for consumption. This entails some transaction costs. Lowering the transaction costs relating to this decision process, for example, for information seeking, could facilitate eco-certified wood consumption. In relation to these issues, this chapter observed a lack of trust in the positive impact of eco-certification. A higher involvement, trust and environmental concern, in combination with subjective norms, could result in a self-reinforcing upward cycle of increased eco-certified consumption.

Chapter 4. Implementation of the EU-Cameroon Voluntary Partnership Agreement: trade distortion, rent-seeking and anticipative behavior

Abstract. This chapter empirically investigates the impact of the implementation process for the Voluntary Partnership Agreement (VPA) in Cameroon on the volume of exported wood from Cameroon to the European Union (EU). This is achieved by applying time series analysis, change point detection, and vector autoregression with exogenous variables. No previous research has quantitatively analyzed the long-term impact of VPAs on traded wood. Two major conclusions are drawn. First, the VPA, and accompanying improved forest governance, negatively impacted on the wood volume exported from Cameroon when it came into force (December 2011). However, wood extraction in Cameroon's neighboring countries increased as operators can still economically benefit from less stringent environmental standards in these countries. Second, this chapter observes anticipative behavior before the VPA came into effect. During the negotiations, exports decreased due to redirection of the trade flows, and uncertainty concerning the outcome of the negotiations. However, during the months before the VPA came into force, wood exports sharply increased. This is explained by rent-seeking behavior by operators who wished to benefit from the less stringent trade conditions, whilst they lasted.

Context: In addition to signaling preferences as a consumer (Chapter 2 and Chapter 3), governments can formalize sustainability standards to production in legislation. This chapter empirically investigates the impact of the mandatory legality verification through Voluntary Partnership Agreements.

Based on:

Brusselaers, J., Buysse, J. (2017). 'Implementation of the EU-Cameroon Voluntary Partnership Agreement: trade distortion, rent-seeking and anticipative behavior'. Submitted in March and currently in review process in *Review of Environmental Economics & Policy*.

1. Introduction

This chapter empirically investigates the impact of the implementation process for the Voluntary Partnership Agreement (VPA) in Cameroon on the volume of wood exported from Cameroon to the European Union (EU) using time series analysis, change point detection, and vector autoregression with exogenous variables.

VPAs, together with the EU's Timber Regulation (EUTR) are the two main elements in the EU's Forest Law Enforcement, Governance and Trade Action Plan (FLEGT) (Lesniewska and McDermott 2014). This action plan 'focuses on the wood trade and enforcement of forest laws and regulation as a way to combat illegal logging' and improve forest governance at global level (Tegegne et al. 2017). Since 2013, the EUTR has required a due diligence system (DDS) for the legality of imported wood and wood products (Leipold 2016). This is intended to prevent the placement of illegal wood (products) on the EU-market. Since the wood operators bear the cost of this DDS, these more stringent requirements could create a trade barrier (Xu 2000).

While the EUTR prohibits the placement of illegal wood on the EU-market, VPAs help wood-producing countries to ensure that the wood products they export to the EU are legal. A VPA is a 'legally binding trade agreement between the EU and a wood-producing country outside the EU' (European Commission 2017d). These agreements combine legality licensing with multi-stakeholder processes[51] that address underlying problems of forest governance (Lesniewska and McDermott 2014). A country can only award FLEGT legality licenses to its operators on the precondition of an EU-approved legality assurance system. FLEGT licensed operators gain automatic access to the EU market (Carodenuto and Cerutti 2014) and avoid the costs relating to DDS. By granting automatic access to the EU market, a VPA has elements in common with, but is not completely similar to a Free Trade Agreement (FTA). This can potentially be beneficial for the wood producing countries as renewable resources can positively impact economic growth, on the precondition of an open economy and well-functioning institutions (Tajibaeva 2012).

This chapter is the first to present an analysis of the VPA's impact on Cameroon's wood exports to the EU. This is useful for two reasons. First, it is interesting to investigate the impact of any FTA, as FTAs do not necessarily increase trade flows and thus specific conclusions can be derived from this case. According to Burfisher et al. (2001), "whether or not a regional trade agreement benefits its members will depend on parameter values and initial economic structure — it is essentially an empirical issue that must be settled by data analysis". In addition, the nature of the FTA also

[51] With, for example, a focus on support to civil society for independent forest monitoring, capacity building for forest ministry officials, public awareness-raising regarding the importance of reducing illegal forest activities or addressing legal issues, such as unclear or contradictory forest-related laws and weak community rights.

determines the extent of its impact (Lake and Yildiz 2016) and when FTAs involve natural resources, there is an additional risk for overexploitation (Ferreira 2007). Second, Carodenuto and Cerutti (2014) identify the lack of research which specifically focusses on VPAs' potential and their actual impact: "existing research regarding long-term impacts is speculative or relates to the processes preceding legality verification". To date, no such research has been conducted (either for Cameroon or for other VPA countries).

FTAs do not necessarily increase trade, and this is no different for the VPA in Cameroon, especially since the VPA comes with other responsibilities. Wood operators can only obtain a FLEGT license if they meet the stipulated legality criteria. This often requires considerable changes in forest management practices. Those changes, and the accompanying costs, might exclude some of Cameroon's operators from participation in trade with the EU. Cameroon is currently reviewing the first round of applications for FLEGT licenses (European Union 2016), but has, so far, not awarded any license. Nevertheless, the VPA is expected to have an impact, since a VPA implies governance reforms, legislative and policy reforms and impact monitoring (European Commission 2017d, Carodenuto and Cerutti 2014). Van Heeswijk and Turnhout (2013) describe the specific focus on law enforcement, and how this neglects sustainability issues. These changes affect every wood operator in Cameroon.

This chapter does not focus solely on the point in time when the EU-Cameroon VPA was agreed or came into force (May 2010 and December 2011 respectively). In addition, the analysis takes into account the whole negotiation period (November 2007 – May 2010). This is necessary since multiple authors have observed increased trade volumes during the negotiation period which precedes an FTA coming into force (Mölders and Volz 2011, Freund and Ornelas 2010, Coulibaly 2007, Croce et al. 2004). Magee (2008) quantifies the anticipation effect of regional trading agreements – in general – as about 25% throughout the four years prior to an FTA coming into force. Baier et al. (2014) even described how some authors reverse the causality. In this reasoning FTAs emerge as a consequence of intense trade.

According to Eichengreen and Irwin (1998), the explanation for this anticipation effect is twofold. First, suppliers begin to redirect 'their exports in anticipation of future market openings'. Second, less formal arrangements often precede the conclusion of an FTA. This stimulates trade between the negotiating countries and reinforces the anticipation effect. Alternatively, Csilla and Nilsson (2015) stress the importance of reduced trade policy uncertainty as the negotiation process proceeds. An uncertain trade environment does not stimulate trade (Fontagné et al. 2015).

In the European context, the anticipation effect is observed for numerous intra- and extra-EU agreements. At intra-EU level, the anticipation effect first occurred prior to the formation of the European Coal and Steel Community in 1951 (Eichengreen and Irwin 1998). Subsequently, increased

trade flows were observed prior to the different EU expansions, for example when Portugal joined in 1986 (Handley and Limao 2015, Csilla and Nilsson 2015). At extra-EU level, the anticipation effect occurred prior to agreement on the EU-Korea FTA (Csilla and Nilsson 2015).

Also, this chapter finds (significant) effects during the period which preceded the VPA coming into force. Depending on the conditions, Cameroon's exports to the EU were positively or negatively affected by the VPA's implementation process.

The remainder of this chapter is structured as follows. The second part describes the context of the EU-Cameroon VPA. Part three describes the data and methods applied in order to investigate the impact on trade flows. Part four presents the results of the analysis, while part five discusses these results prior to ending with a conclusion.

2. FLEGT and the VPA in Cameroon

The entire VPA implementation process in Cameroon consists of 3 phases. The first phase encompasses the VPA negotiations (November 2007 – May 2010). The second phase starts with the VPA agreement in May 2010 and ends with the VPA coming into force (December 2011). Hence, at this stage the negotiations are finalized, and the outcome of the negotiations is known. However, the bilateral binding agreement did not enter into force yet. The third period runs from the VPA's entry into force up to the present.

Tegegne et al. (2017) describe how this entire process has been managed by the Cameroon Ministry of Forests and Wildlife. The ministry created two agencies to negotiate and implement the VPA process: the Joint Implementation Council to oversee the VPA implementation, and a National Monitoring Committee to guide and assess the VPA implementation. At least one of the two agencies includes representatives of the Prime Minister's office and five government ministries, the National Assembly, the private sector, civil society, indigenous people and community forests. The high number of stakeholders involved is one of the reasons why this process is often perceived as a "good" process (Tegegne et al. 2014, Dooley and Ozinga 2011).

Since 2011, Cameroon has been developing its 'Timber Legality Assurance System and methods of impact monitoring, and implementing transparency commitments' (Tegegne et al. 2017). Barriers to VPA implementation in Cameroon are corruption, the informal nature of the domestic sector, non-sensitive wood demand, technicalities of the legality assurance system, the high cost of legality and lack of awareness on the part of the private sector (Carodenuto and Ramcilovic-Suominen 2014).

3. Methodology

3.1. Case selection

This chapter claims that it is relevant and necessary to individually investigate the Cameroonian case because each VPA is unique. A VPA is a bilateral agreement between the EU and a wood-producing country, hence both the process of negotiation and implementation of a VPA differ for each country (European Commission 2017b, Wiersum and Elands 2013, Van Heeswijk and Turnhout 2013). Also, the type of wood products covered by each VPA differs. Hence, different VPAs will generate heterogeneous impacts across the world[52]. Therefore this chapter does not consider VPAs simultaneously.

The reason for selecting the case of Cameroon is threefold. First, the EU-Cameroon VPA came into force on 1st December 2011. The negotiations started in November 2007. Sufficient time has therefore passed to be able to assess the impact of it coming into force and the preceding implementation period. At global level, only the VPA with Ghana came into force earlier (December 2009), but throughout the period 2000 – 2015 Ghana exported 5 times less wood to the EU (EUROSTAT 2017). This is the second reason to opt for Cameroon: it is the most important African exporter of tropical hardwood to the EU (Tegegne et al. 2014) and therefore a relevant case to investigate. Third, Cameroon is surrounded by countries which also export wood to the EU. This creates the opportunity to compare Cameroon's exports with its regional counterfactual.

This research opts for a regional instead of a global counterfactual in order to ensure that homogenous trade flows are compared. Comparing Cameroon's exports to the export by, for example, Argentina or Indonesia could cause some problems because those countries grow different species. Consequently, they produce and export different types of wood as well, and their export flows are too heterogeneous to compare.

3.2. Data

Monthly trade data for the period January 2000 – December 2015 was retrieved from the EUROSTAT (2017) 'International Trade in goods – detailed data by HS2-HS4' database. We used detailed trade data on the volume (not value) at the 2 digit breakdown level for product category 44; 'Wood and articles of wood'. This broad category encompasses a number of product categories which are not

[52] At present, the EU has signed 6 VPAs with the following wood-producing countries: Cameroon, Central African Republic, Ghana, Indonesia, Liberia, and the Republic of the Congo. Nine other countries are in the process of negotiation: Côte d'Ivoire, Democratic Republic of the Congo, Gabon, Guyana, Honduras, Laos, Malaysia, Thailand, Vietnam

subject to the EU-Cameroon VPA[53]. However, all of Cameroon's exports of wood products to the EU are covered by the VPA except for charcoal, but charcoal only represents a negligible 0.018% of the wood exports to the EU. Hence, 99.982% of the exported volume represented by product classification 44 is subject to the VPA. For this reason, we can make use of this aggregated number to analyze the impact of the VPA implementation process. The monthly volumes exported to the EU are indexed. The observation for January 2000 was set at 100.

The counterfactual was calculated by taking the mean of the indexed monthly volumes exported to the EU by Cameroon's neighbors. By making use of the indexed values, it is more straightforward to compare the evolution of Cameroon's exports to the exports from its regional counterfactual. This chapter opted for the aggregate counterfactual in order to level out the impact of country-specific events in the neighboring countries. Some of the neighboring countries are, for example, also implementing a VPA (European Commission 2017d). Applying the mean of the indexed export volumes levels-out the impact of different countries entering different VPA implementation phases or implementing the VPA at a different speed.

The neighboring countries taken into account include Equatorial Guinea, the Central African Republic, Republic of the Congo, Nigeria, and Gabon. Chad is the only neighboring country which is not incorporated in the analysis. This is explained by the low level of wood (products) exports by Chad. Ghana is also an important wood producer in the West-African region, but nevertheless it is not incorporated in the counterfactual because its exports are too erratic (i.e. not stationary).

3.3. Empirical specification

This chapter starts with some general descriptive statistics on the exported volumes of wood by both Cameroon and its counterfactual to the EU. The descriptive statistics include a decomposition of the observed trade flows into a trend, seasonal and random component, and the general likelihood ratio method, as introduced by Hinkley (1970), in order to check for the presence of a single change point in the mean exported wood volumes[54]. This allows the detection of a change in the statistical properties of the sequence of observations for the exported volumes from Cameroon to the EU changed, on the precondition this kind of change is present.

The change point detection does not provide irrefutable evidence for the impact of the VPA implementation phases. Therefore, this chapter presents a Vector Autoregression (VAR) for a more thorough analysis of the impact of the VPA implementation. This research uses a Seemingly Unrelated Model such as VAR because its autoregression part allows that a time series' current value partially

[53] The EU-Cameroon VPA covers logs, sawn wood, veneers, plywood, railway sleepers, sleepers, furniture, fuel wood and wooden tools
[54] This analysis made use of the AMOC algorithm.

depends upon its previous levels. In addition, its vector part can capture linear interdependence between the lagged values of different time series. As such, the VAR accounts for correlated errors, but does not assume that the current levels of the two endogenous trade flows can impact each other (Chan and Chung 1995). Our time series represent the physical wood flows from different countries to the EU. Hence, this kind of interdependence can be expected. This chapter assumes that the current level of exports from both Cameroon and its counterfactual in month *t* (respectively $Y_{cam,t}$ and $Y_{reg,t}$) depend on the previous levels of exports ($Y_{cam,t-p}$ and $Y_{reg,t-p}$, in which p stands for the lag order). This results in the following VAR specification:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \qquad (4\text{-}1)$$

In which y_t is a 2x1 matrix constructed out of the two endogenous variables $Y_{cam,t}$ and $Y_{reg,t}$. A_i is the time-invariant 2xp coefficient-matrix and u_t is a 2x1 matrix which represents the error term. The Bayesian Information Criterion is used in order to determine lag order p.

As indicated, this chapter aims to investigate the impact of the VPA implementation process on Cameroon's wood exports to the EU. Three phases are distinguished: the negotiation period, the period in which the VPA was agreed but had not come into force, and the period in which the VPA came into force. Three dummy variables are created in order to identify the respective phases: $x_{neg,t}$, $x_{agr,t}$, and $x_{eif,t}$. The use of dummy variables to measure the impact of the VPA is in line with earlier research (Baier et al. 2014, Foster et al. 2011). The exogenous dummy variables are separately introduced in the initial VAR in order to assess the impact of the separate phases. Introducing exogenous variables in a VAR transforms it into a VARX model. For the negotiation phase this would result in the following specification:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B x_{neg,t} + u_t \qquad (4\text{-}2)$$

In which B is a time-invariant 2x1 matrix which represents the impact of the dummy variable $x_{neg,t}$ on the exports to the EU by Cameroon ($Y_{cam,t}$) and its counterfactual ($Y_{reg,t}$) respectively. The choice for the VARX approach is based on the assumption that the trade flow from Cameroon is likely to be affected, but not determined, by the VPA implementation. The VARX model allows the distinction between endogenous variables which mutually determine each other (i.e. the export variables for Cameroon and its counterfactual) and exogenous variables which have an influence on the endogenous variables (i.e. the dummy variables per VPA implementation phase).

The possibility to include the VPA implementation phases as exogenous variable is another argument in favor of the Seemingly Unrelated Models such as VARX models. In Simultaneous Equation Models, our analysis could falsely conclude that the export flows by Cameroon and its counterfactual are contemporaneously correlated (even if there is no instantaneous feedback between both markets) if

both time series react simultaneously to the exogenous variable. This would imply that the effect of the exogenous variable cannot be isolated from that of common trends in the two time series. According to us, no instantaneous feedback should be expected between the trade flows of Cameroon and its counterfactual. In addition, our model does not directly capture unobservable shocks (e.g. political unrest). In the case exogenous shocks are unobservable, a Simultaneous Equation Model can yield unreliable inferences on the causal relationship between the two trade flows. Instead, Chan and Chung (1995) describe how VAR models can reveal the underlying process better than Simultaneous Equation Models when no actual contemporaneous interaction occurs between the two markets / trade flows. In this research's VARX model, the counterfactual is composed as the mean of the neighboring countries' trade flows. This approach dilutes the impact of country-specific disturbing factors (e.g. political unrest).

In theory, it is possible to introduce a matrix of exogenous variables (vectors) in a VAR at the same time. In this specific case, however, introducing the three dummy variables simultaneously is not feasible. Once the VPA negotiations start, the different VPA implementation phases follow each other without delay. The end of the negotiation period coincides with the agreement of the VPA. Accordingly, the VPA will lose its "agreed but not in force" status at the point it does come into force. A VARX which includes the three dummies simultaneously confuses the observations for the dummy variables with the process of time. If both the time series for Cameroon and its counterfactual experience a comparable trend throughout 2000 – 2015, the VARX might falsely attribute an explanatory value to the dummy variables for this overall trend. Instead, this chapter investigates divergence from the general trend relating to one of the dummy variables.

The reason to prefer a VARX model over the more conventional gravity trade models is twofold. First, the geographical focus on Cameroon and its neighboring countries limits the variability among the exporting countries. Traditional variables such as 'distance to receiving market' will not differ considerably due to the proximity of the exporting countries. Second, our research could only make use of data on trade flows towards the EU. This prevents the introduction of variables such as GDP of the different importing countries, which traditionally introduces variability in gravity trade models. In addition, the exclusive focus on the EU as importing country implies that it is hard to identify alternative explanatory variables for traditional gravity models: the diversity among the EU Member States (e.g. different languages, colonial ties,…) impedes the identification of variables which could indicate bilateral connections (e.g. common language) between a West-African country and the EU as a whole.

4. Analysis

4.1. Descriptive statistics

The upper graph in Figure 4-1 displays the observed evolution of the wood exports from Cameroon to the EU for the period 2000 – 2015. The second to fourth graph in Figure 4-1 decomposes this observed time series into a general trend for the 2000 – 2015 period, a seasonal component and a random term.

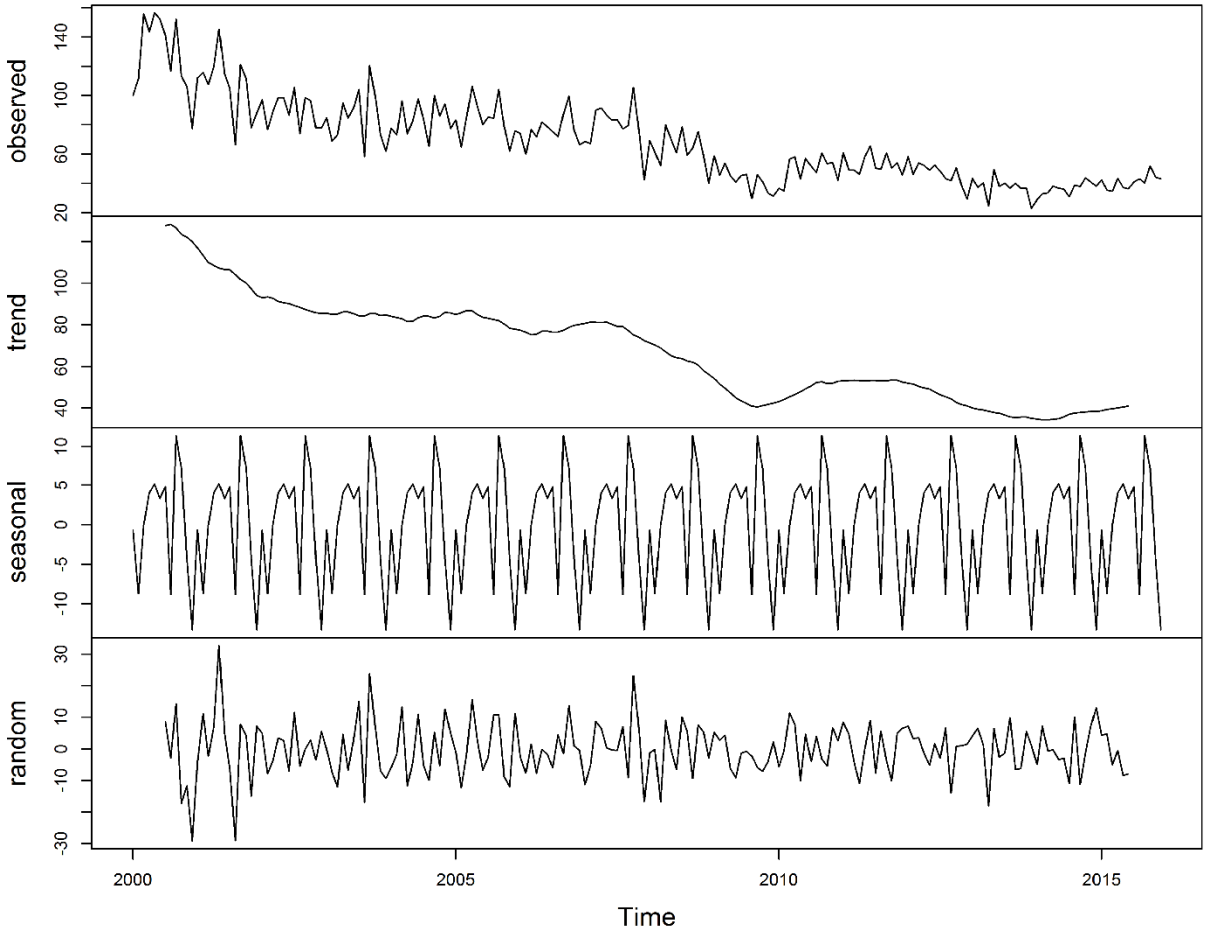

Figure 4-1: decomposition of additive time series: Cameroon's wood export to the EU, indexed (2000 = 100), period 2000 – 2015

The decomposition uncovered a decreasing trend throughout the period under consideration. This suggests that the volumes of wood (products) exported from Cameroon to the EU have been decreasing. The augmented Dickey-Fuller test shows that the trend component of the traded volume time series is stationary.

A seasonal component was also observed (third graph, Figure 4-1). This is due to Cameroon's rainy season which prevents the transport of the wood. Finally, the random component of the time series is itself stationary (tested by making use of the augmented Dickey-Fuller test).

Figure 4-2 displays the indexed volume of exported wood (products) from Cameroon's neighbors to the EU for the period 2000 – 2015. The first graph displays the time series observed. A downward sloping trend was observed, although this was less clear than for the Cameroonian time series. This is also demonstrated in the second graph in Figure 4-2. Note, however, that this general trend experienced a revival in both 2010 and 2012. The augmented Dickey-Fuller test indicates that the general trend is only stationary at 10% CI, while the overall (non-decomposed) wood exports by the counterfactual are stationary at 5% CI.

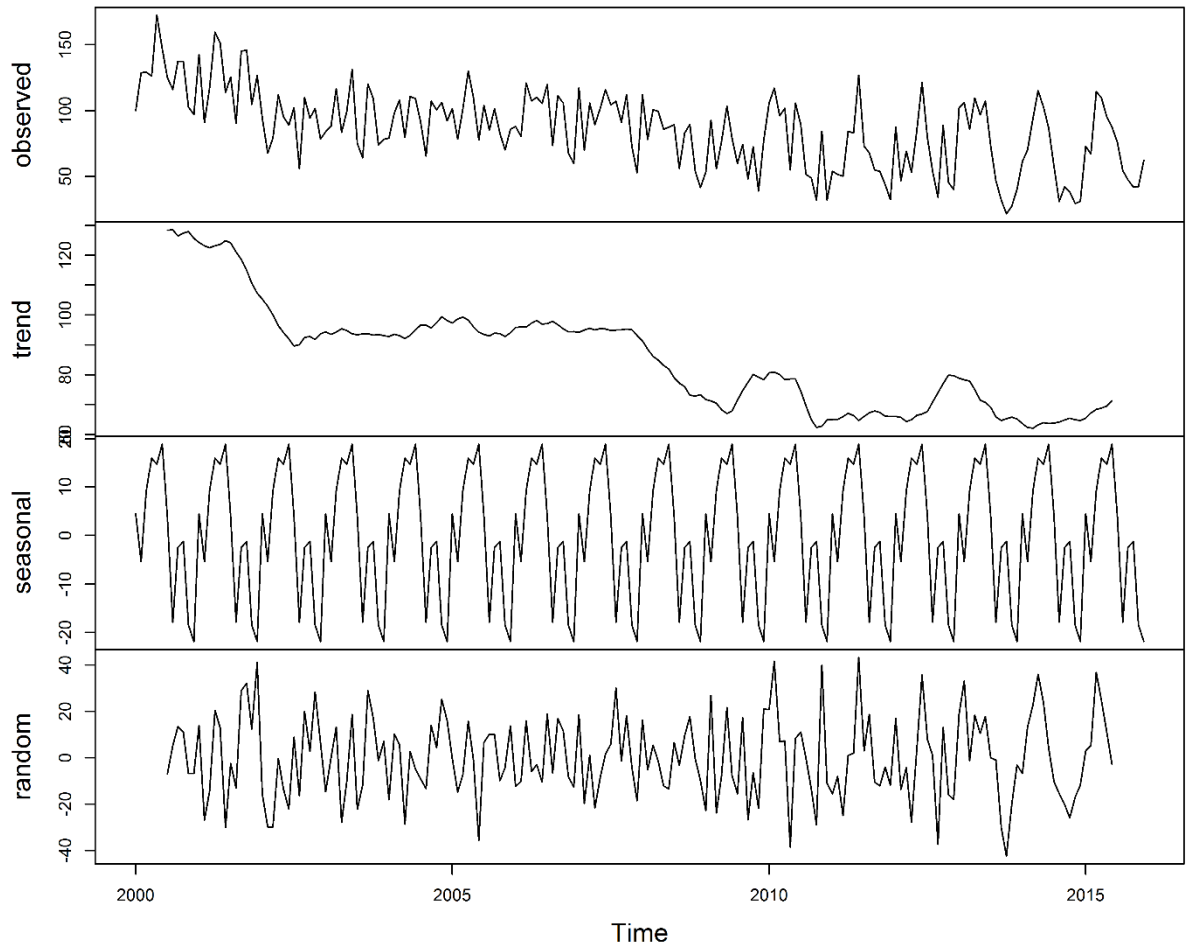

Figure 4-2: decomposition of additive time series: regional counterfactual's wood export to the EU, indexed (2000 = 100), period 2000 – 2015

The seasonal component of the overall time series is again determined by the rainy season in Central and West Africa and shows a comparable pattern compared to the seasonal component in Cameroon's wood exports to the EU. The correlation coefficient for the seasonal component in Cameroon's and the counterfactual's exports is 0.66 (Appendix G). Note that this finding confirms the homogeneity of the demarcated region. Finally, the random component of the regional counterfactual's exports to the EU also deserves some attention. The mean of this random component does not differ significantly from the random component of Cameroon's exported volume to the EU (tested by making use of a T-test) and by default equals zero. The variance of both random components, however, does differ. An F-test indicates that the variance in the counterfactual's random component is significantly higher than the

variance for Cameroon's random component. This suggests a more stable trade relationship between the EU and Cameroon compared to the trade relationship between the EU and the counterfactual.

4.2. Change point detection

The previous analysis revealed a decreasing trend throughout the 2000 – 2015 period. This chapter applies the Binary Segmentation technique, as introduced by Scott and Knott (1974), to check for the presence of change points. The Binary Segmentation technique is the most widely used change point search method (Killick et al. 2012). In this research's rationale, a change point represents the point at which the long-run mean of the wood volume exported by Cameroon to the EU significantly changed. The result of the change point detection is presented in Figure 4-3.

The outcome of the analysis is interesting for two reasons. First, three main change point are detected. Hence, the exported wood volume from Cameroon to the EU has indeed decreased significantly over time. Second, one of the change points for the mean was found to be in November 2007. Therefore, the change point coincided with the start of the VPA negotiations in Cameroon. The mean of the (indexed) exported wood volume from Cameroon to the EU was 85.3 before the start of the VPA negotiations. After November 2007, the long run-mean of Cameroon's exported wood value decreased to 53.0 A drop of 32.3 index points, from which Cameroon's exports have never recovered.

This type of analysis does not provide irrefutable proof of the impact of the start of the VPA negotiations. The downward sloping trend for exported wood volumes by Cameroon to the EU implies that it is likely that a change point was detected in this period. It could be a coincidence that the change point was detected at the start of the VPA negotiations.

Nevertheless, this analysis does suggest a negative impact of the VPA negotiations on the volume of wood exported by Cameroon to the EU. Moreover, it suggests that the exports did not recover from this setback. The suggestion is strengthened by the observation that the counterfactual's second change point was only found in July 2008. Hence, the VPA negotiations could have accelerated the downward trend in Cameroon in comparison to the situation in its neighboring countries. In addition, the decline in mean exported value before and after the change point was smaller for the counterfactual. The mean decreased from 95.2 to 73.5, a drop of 21.7 index points (compared to 32.3 for Cameroon). We cannot conclude anything based on suggestive analysis, but at least this analysis indicates that our subsequent analysis should devote some attention to the point at which the VPA negotiations started, alongside the VPA agreement and it coming into force. This is in line with the literature review in section 1.

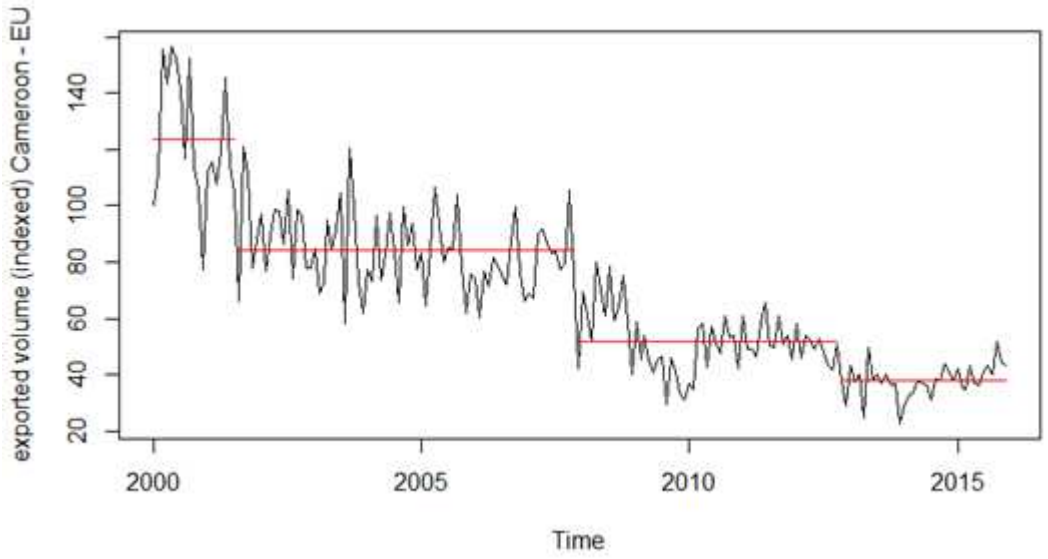

Figure 4-3: Change point detection for the mean exported volume of wood from Cameroon to the EU, indexed (2000 = 100), period 2000 – 2015.
NOTE.- Change points detected in July 2001, November 2007, and October 2012.

4.3. VARX Model

The presence of a change point which coincides with the start of the VPA negotiations suggests an impact of the negotiation period on exports. In addition, Cameroon's trade flow did not recover from this setback once the VPA was agreed or came into force. This chapter presents three VARX models in order to check this more thoroughly. One unique model was created for each VPA implementation phase (negotiation, agreement, entry into force), as specified in equation 4-2. The exogenous identifier variable was a dummy variable which had the value of one during a specific implementation phase.

Prior to the construction of the VARX model, the Augmented Dickey-Fuller test and the Ljung-Box Test were applied in order to check the stationary conditions for the time series on Cameroon's and the counterfactual's exports. Both tests had a satisfactory outcome, which enables the use of the VARX approach.

In addition to the model's variables, two parameters of the VARX model must be specified: the order of the autoregressive part of the model and the number of lags of the exogenous variable. This chapter determines both parameters by computing the Bayesian Information Criterion for the VARX process. The order of the autoregression was set at 3. Hence the current trade flow was partially determined by the last three months' trade flows. Accordingly, the lag for the exogenous variable was set at 0. Hence, no lagged impact was assumed for this variable[55].

[55] The Akaike Information Criterion suggested a lag order of 12. This relates to the observed seasonality in the trade flows. However, applying a 12-period lag results in numerous non-significant coefficients in the VARX output in combination with significant and positive coefficients for lag 11 and 12. This could be expected since we observed seasonality, and therefore increasing the lag order does not add value to the original analysis. For

Figure 4-1 displays the estimated coefficients per model (Appendix H presents the full output per model). The constant term and the coefficients for the autoregressive part of the VARX models do not differ drastically from each other. Hence, the vector autoregression manages to consistently capture the overall trend throughout the 2000 – 2015 period.

Both the exports by Cameroon and its counterfactual are characterized by positive autocorrelation (third-order for Cameroon, first-order for the counterfactual). Noteworthy are the two negative, significant, coefficients for cross-correlations (at first order for Cameroon and second order for the counterfactual). This suggests a substitution effect between Cameroon and its counterfactual as the EU's wood suppliers. Or put differently, if the EU increases its imports from the counterfactual, this occurs at the expense of the Cameroonian exports with a lag of one month. Note that Cameroon's exports reversely respond earlier to changes in the counterfactual's export. The substitution effect appears to be less important (smaller estimated coefficient) for the counterfactual and only manifests itself at order two, hence after two months.

The analysis of the coefficients of the exogenous variables provides insights into the effect of the VPA implementation phases on trade flows. Figure 4-1 displays comparable coefficients for both the VPA negotiations and for the VPA coming into force. On the one hand, both periods impacted negatively on Cameroonian exports. Hence, the downward trend which was observed previously (Figure 4-1) was aggravated during the VPA negotiations, as well as by the VPA coming into force. On the other hand, the counterfactual's exports were not impacted by either VPA implementation phase. Finally, the analysis includes a satisfactory check for stationarity of the VARX' error terms (Appendix H).

These findings are double checked by investigating what type of trend, if any, occurred during the periods concerned (i.e. VPA negotiation period, and VPA coming into force). This requires the construction of a new vector. The vector compares, for each region and each month *t* in the period concerned, whether the exports ($Y_{cam,t}$ and $Y_{reg,t}$) differ from those from a year ago ($Y_{cam,t-12}$ and $Y_{reg,t-12}$). This results in a 30-item vector for the 30-month VPA negotiation period, and one of 49 items for the period following the VPA coming into force. Subsequently, a t-test is applied to check whether the mean of these new vectors significantly differed from zero. For Cameroon, the t-test indicates that the mean of this vector is indeed significantly negative for the negotiation period (-15.86) and after the VPA came into force (-2.93). Hence, exports to the EU from Cameroon are decreasing. The trend for the counterfactual's exports has not been significantly affected by the external change of the VPA negotiation and the VPA coming into force.

The 19 month period between negotiation and the VPA coming into force (May 2010 – November 2011) has had an opposite impact on trade flows. The exogenous variable did not have a significant

this reason, this research adheres the suggestion by the Bayesian Information Criterion and applies a lag order of 3.

impact on the Cameroonian exports. Instead, the exports by the counterfactual were negatively distorted (coefficient -8.55). The t-test approach was again applied to check this more thoroughly. A new vector was composed which compared the differences between each month's export level and the export level from a year ago. For Cameroon, this reveals that the exports consistently increased throughout this 19 month period (with a significant positive mean of 7.16). Between 2000 and 2015, this is the longest period during which each consecutive month's export level was higher than the export level from a year ago. In contrast, the mean vector for the counterfactual's exports does not significantly differ from zero. Put differently, during the period between negotiation and the VPA coming into force, the counterfactual's exports did not significantly change compared to the previous period. This appears to be in conflict with the earlier findings in the VARX model (Table 4-1). However, the VARX coefficients describe the impact of the concerned period on the overall trend of the counterfactual's exports to the EU. Taking the differences between exported volumes over the period of a year is a more suggestive approach.

Table 4-1: Coefficients per VARX model, significant at 5% confidence interval level

	Model 1: VPA negotiations November 2007 – April 2010		Model 2: VPA agreement, but not in force May 2010 – November 2011		Model 3: VPA in force December 2011 - present	
	Cameroon	Counter factual	Cameroon	Counter factual	Cameroon	Counter factual
Constant term	4.89	26.00	N.S.	28.74	7.69	26.00
Autoregression coefficients matrix - order 1						
Cameroon	0.32	0.11	0.32	0.13	0.32	0.11
Counterfactual	-0.22	0.46	-0.21	0.45	-0.22	0.46
Autoregression coefficients matrix - order 2						
Cameroon	0.27	-0.07	0.27	-0.06	0.26	-0.07
Counterfactual	0.22	N.S.	0.21	N.S.	0.22	N.S.
Autoregression coefficients matrix - order 3						
Cameroon	0.29	N.S.	0.31	N.S.	0.27	N.S.
Counterfactual	0.30	N.S.	0.28	N.S.	0.30	N.S.
Coefficient of exogenous variable	-3.62	N.S.	N.S.	-8.55	-4.18	N.S.

NOTE.- Only the significant coefficients (at 5% confidence interval) are displayed, 'N.S.' indicates non-significant coefficient estimates. Each model's quality is checked by calculating the multivariate Ljung-Box statistics for cross-correlation matrices, and analysis of the residual plots. "N.S." stands for a non-significant coefficient estimate.

5. Discussion

This section discusses the impact of the three different phases of the implementation process. The periods are not discussed in chronological order.

5.1. Impact of the VPA into force

The VARX model reveals a negative impact of the VPA on Cameroonian wood exports to the EU, since the VPA came into force on 1st December 2011. This is not what was expected since the VPA creates the opportunity to award FLEGT licenses to Cameroon's wood operators. This license grants the operators automatic access to the EU's wood market and exempts them for the due diligence requirement (and the accompanying costs) [56]. As such, a VPA has a number of elements in common with FTAs. Cameroon's wood sector also expects to gain better access to the EU's market due to the VPA (Cerutti et al. 2013, Carodenuto and Cerutti 2014).

The explanation for the negative impact of the VPA – once in force – is threefold. First, as yet, Cameroon has been unable to develop an approved assurance system to issue FLEGT licenses. This is a result of the poor forest and value chain management practices in Cameroon's wood sector. Anecdotal evidence by Carodenuto and Cerutti (2014), for example, describes how the market works without any coordination: "nobody can tell you exactly where their wood comes from; it's from wherever you can find it". This is problematic for the implementation of a legality assurance system. The lack of an operational FLEGT licensing system does not necessarily negatively impacts Cameroon trading position. However, despite the lack of licensing system, the Cameroonian operators are facing other changes due to the VPA coming into force: governance reforms, legislative and policy reforms and impact monitoring (European Commission 2017d, Carodenuto and Cerutti 2014). This creates additional obligations and accompanying costs for Cameroon's operators. Other countries' operators do not face these additional obligations and costs. Hence, the VPA coming into force could negatively impact Cameroon's competitive position. This is in line with Ferreira and Vincent (2010), who describe how improved forest governance can reduce wood harvest in developing countries, and Greaker (2006), who described how environmental standards (licensing) can damage international trade if producers cannot meet the requirements. Note however that other authors found that improved forest governance can increase wood extraction (Wendland et al. 2014).

Second, a considerable number of (especially small-scale) Cameroonian wood operators cannot bear the high upfront investment costs in order to become eligible for FLEGT licensing. Carodenuto and Cerutti (2014) described how the underdeveloped banking system worsens this barrier to FLEGT

[56] The due diligence requirement only came into force in March 2013, which gave wood operators time to adapt.

licensing at company level. Large-scale operators, with access to funding, manage to comply with the VPA stipulations. Since they can invest upfront, they benefit from easier access to the EU's wood market. This is in line with the findings of Rodrigue and Soumonni (2014), who describe how investments in abatement in the Indonesian wood industry improve export performance. Also Fontagné et al. (2015) found that larger operators are more able to attenuate the negative impact of the trade barrier created by environmental norms. Following Foellmi and Oechslin (2010), however, this phenomenon comes with a risk of increased income disparity. While wealthy entrepreneurs take advantage of new export opportunities, the relatively poor entrepreneurs lose wealth and market power.

Third, expert consultation (Global Timber Platform 2017, European Forest Institute 2017) indicates that the stipulations in the current VPA's legality grid are too vague. Consequently, operators are unaware of what exactly they have to comply with. This prevents exporters from shipping wood to the EU, even if they are eligible for FLEGT licensing or able to establish a due diligence system. Instead, "the haziness pushes a considerable number of operators directly to markets without due diligence requirements. In the long run, this is problematic since it will become gradually more difficult to return to the EU's wood market." Put differently, the unclear texts weaken the EU's impact and trading position in Africa. Instead, intra-African trade is becoming more important for Cameroon's producers as the total wood production in Cameroon did not plummet (FAO 2016b).

Note that this period's exogenous variable does not have a significant impact on the exports by the counterfactual. This strengthens the earlier arguments which specifically link to the Cameroonian case.

5.2. Impact of VPA negotiations

The VARX model indicates that Cameroon's wood exports are negatively affected by the VPA negotiations, while no impact is detected on exports by the counterfactual. The detection of the structural change point which coincides with the start of the VPA negotiations in Cameroon provides additional proof for the negative impact of this period on Cameroon's exports.

In theory, the wood trading conditions between the EU and Cameroon should not change during the VPA negotiations. Nevertheless, the VPA negotiations distorted on Cameroon's exports. The explanation for this phenomenon links to the initial reason that this chapter also investigated the impact of the period before the VPA came into force: the possibility of anticipative behavior. Eichengreen and Irwin (1998) explained the anticipation effect by arguing that suppliers redirect 'their exports in anticipation of future market openings'. In the case of the VPA in Cameroon, the wood operators possibly feared that the costs of the additional obligations outweighed the VPA's benefits. Consequently, they started to redirect their exports away from the EU, in anticipation of too stringent export conditions on the EU wood market.

A second explanation for the anticipatory effect was provided by Csilla and Nilsson (2015) and Fontagné et al. (2015). They argue that reduced trade policy uncertainty, also in relation to environmental norms, triggers anticipative behavior. The outcome of a VPA negotiation, however, is highly uncertain. Each VPA is tailor made according to the needs of the wood-producing country (European Commission 2017b). Hence, the type of products covered by each VPA, and the VPA implementation phase, differ from country to country (Van Heeswijk and Turnhout 2013, Wiersum and Elands 2013). The uncertainty which characterizes the VPA negotiation phase could have reduced Cameroon's exports to the EU. In future, attention should be paid to these negative consequences of often lengthy[57] negotiation periods, as it is difficult for vulnerable markets to recover from setbacks. Carodenuto and Cerutti (2014) provide a number of reasons that also make Cameroon's wood market vulnerable, e.g. a lack of organization, corruption, and illegal production.

During the negotiation phase in Cameroon, the counterfactual's wood exports to the EU did not decrease, despite the overall decreasing trend in 2000 – 2015. This can be explained by the substitution effect between Cameroon and the counterfactual as wood suppliers to the EU. Reduced exports by Cameroon were compensated by exports from the counterfactual. Ferreira and Vincent (2010) provide an alternative explanation for this phenomenon. They describe the nonmonotonic marginal impact of improved forest governance on wood harvests in developing countries: countries with improving forest governance experience reduced harvests, while harvests in countries with weaker governance were increased.

5.3. Impact of the VPA agreement prior to its entry into force

Cameroon's wood exports to the EU seemed to revive again in the period between the VPA agreement and it coming into force. This contrasts with the negative impact of the VPA negotiations (due to uncertainty and anticipative behavior) and the VPA coming into force (too stringent trade conditions). Further analysis demonstrated that the monthly export levels throughout this period were significantly higher (7.16 index points) than the export levels for the same month in the previous year. This indicates that Cameroon's exports increased significantly between the agreement and the VPA coming into force.

This 19 month period of increased exports is exceptional for two reasons. First, this was the longest consecutive period which showed a significantly increasing trend throughout the entire 2000 – 2015 period. The runner-up period only comprised 12 months. Second, this period of increased

[57] The negotiation period in Gabon, the Democratic Republic of Congo, and Côte d'Ivoire is even lengthier. They started in September 2010, October 2010 and February 2013, respectively, but at the time of writing have not yet been concluded.

Cameroonian exports occurred between the VPA negotiations and the VPA coming into force. Both periods even accelerated the decline of Cameroon's exports.

This chapter argues that the timing of the revival of exports by Cameroon is not coincidental. We have already argued that the uncertainty concerning the VPA negotiations negatively affected Cameroon's exports. The conclusion of the negotiations in May 2010 ended this period of uncertainty. In addition, the wood operators became aware of the more stringent trading conditions they would face once the VPA came into force. This prepared the ground for opportunistic behavior to increase exports from Cameroon to the EU. This behavior corresponds to the type of behavior observed when (international) trade quotas for natural resources are managed according to a 'first-come, first-served' basis (Larabi et al. 2013)[58]. This technique is also most often applied by the EU (European Commission 2017c, De Gorter and Sheldon 2000). Operators export increased volumes of wood as long as the more advantageous trading conditions apply (as long as the quota is not filled). Once the more stringent trading conditions apply (or the quota is filled), exports drop. Unfortunately, this kind of short term opportunistic behavior threatens the sustainable management of natural resources and creates the risk of overexploitation (Larabi et al. 2013).

Note that in between the VPA agreement and VPA coming into force, the VARX model indicates a negative impact on the counterfactual's exports. This is again explained by the substitution effect between Cameroon and the counterfactual as wood suppliers to the EU. While the EU is obtaining more wood from Cameroon, this occurs at the expense of the counterfactual's exports.

5.4. Possibility to extrapolate results

This research applies a VARX model individually for Cameroon because each VPA is unique. Our analysis does not allow the simultaneous analysis for different exporting countries (e.g. panel data including the exporting countries separately, and adding dummy variables to control for the implementation phases of the different VPAs). Consequently, our research results cannot easily be extrapolated and the conclusions remain suggestive. Therefore we repeated the analysis for those West-African countries which also implemented a VPA, except Liberia and Ghana. The research initially focused on Cameroon because of the importance of, and presence of interesting features in the Cameroonian case (e.g. their implementation process was much shorter, or finalized in the recent past). The analysis was not completed for Ghana, as this country's exports are not stationary, nor for Liberia as this country only recently concluded its VPA (end of 2013, leaving only 14 observations).

The results of this analysis are presented in Table 4-2. The results cannot confirm a negative impact of the VPA negotiation period on the exports by the Republic of Congo and the Central African

[58] This is, for example, the case where fishery quotas are opened. The competitive nature of the sector results in high fill rates of the quota, and the so-called phenomenon of the "race for fish".

Republic. However, this might be due to the short negotiation periods in those countries. The observations for the period in between the VPA agreement and its entry into force in the Republic of Congo are more interesting. For the Republic of Congo, this period encompasses 46 months, and surpasses the length of the same period in Cameroon. In accordance with our observation in Cameroon, this analysis finds a significant negative impact for this period on Republic of Congo's counterfactual export towards the EU. In addition, we observe a positive impact on Republic of Congo's own exports. This estimate was not found significant in the case of Cameroon, albeit the fact that we observed a significant revival of Cameroon's exports throughout this period. Hence, the findings for the Republic of Congo confirm the developed rationale for short-term overexploitation of a VPA partner country's forest just prior to a VPAs entry into force. Finally, the analysis finds a negative impact for the VPA entry into force on both Republic of Congo and Central African Republic, and simultaneously on the trade flows by their counterfactual. The impact on the VPA partner countries' exports is considerably higher however.

Notice as well that both Republic of Congo and Central African Republic were part of Cameroon's counterfactual, for which no impact was found at the entry into force of the VPA in Cameroon. This seems to confirm the idea that taking the mean of the exports of a sufficient number of neighboring countries levels out the effect of country specific events (such as political unrest, but also a country's VPA implementation process). In addition, these findings confirm that the VARX approach manages to capture the impact of the VPA entering into force.

Table 4-2: Coefficients for the VARX models of all VPA implementing countries in the counterfactual

Country	Models' coefficients		
	Negotiations	Agreement	Into force
Rep of the Congo	N.S. (11 months)	14.697 (46 months)	-67.11
Rep of the Congo – counterfactual	N.S. (11 months)	-10.352 (46 months)	-4.217
CAR	N.S. (15 months)	N.S. (18 months)	-13.646
CAR – counterfactual	N.S. (15 months)	N.S. (18 months)	-6.09
Cameroon	-3.621 (30 months)	N.S. (20 months)	-4.175
Cameroon – counterfactual	N.S. (30 months)	-8.554 (20 months)	N.S.

NOTE.- Implementation process in Central African Republic: start negotiations in October 2009, agreement in December 2010, entry into force in July 2012. Implementation process in the Republic of Congo: start negotiations in June 2008, agreement in May 2009, entry into force in March 2013.

6. Limitations

The limitation on the possibility to extrapolate this research findings' is discussed and addressed in the previous section. An additional limitation follows the restriction to one destination country (i.e. the EU). This prevents the analysis of multilateral resistance terms (Behrens et al. 2012). However, the decreasing exports towards the EU contrast with stable or increasing wood production in Cameroon

between 2000 and 2015 (FAO 2016b). This suggests that Cameroon is shifting its exports towards new destination countries. Expert consultation confirms this finding, and identifies India and China as two main new destination countries (Global Timber Platform 2017).

A vast body of literature questions whether right-hand side dummy variables can be introduced to represent FTA 'treatment'. Baier and Bergstrand (2007) describe how instead countries are likely to select endogenously into FTA. The explanation for this self-selection might be unobservable or complex, but is often linked to the level of trade. This chapter nevertheless claims that VARX models can be applied since the number of wood producing countries which is implementing a VPA in the considered region is on the rise. This steadily diminishes the endogenous selection bias. In addition, we observed that less important wood exporting countries (e.g. Liberia, Ghana) were among the first to negotiate (not necessarily conclude) a VPA, while more important exporters (e.g. Gabon) only stepped in at later stage. Note as well that the exports by Cameroon were characterized by a downward trend prior to the start of the VPA negotiations as well, this does not fit the rationale of endogenous selection into the VPA because of trade volumes. Other observations however do point to endogenous selection into the VPA. First, at the start of the VPA negotiations, the EU accounted for 80% of the Cameroonian sawn timber exports. Second, Cameroon is the main African producer of wood (products) (FAO 2016b). Third, Cameroon and the EU have a stable relationship, especially in comparison to the EU-Gabon trade relationship which is more erratic.

This analysis finds a negative impact for the VPA implementation process in Cameroon. However, the VPA implementation is part of a wider policy that eventually imposed the Due Diligence System for all wood producing countries in 2013. We acknowledge that it is not feasible to analyze the impact of the Due Diligence System at this moment as this is too recent. However, it is possible and relevant to investigate the impact of the VPA implementation as Cameroon started this implementation at a moment no other wood producing country was facing legality verification requirements. As such, the early VPA's entry into force (December 2011) can provide Cameroon with a 'head start' over other countries as Cameroon prepared itself for the Due Diligence System. Nevertheless, it is necessary to stress the importance of the diminishing exports during the VPA implementation prior to the Due Diligence System requirement. Once a country shifts its exports away from the EU to countries with less strict legality requirements, it is difficult to return to the EU. If this implies that the EU becomes a less important destination market, this threatens the potential impact of FLEGT, its legality verification, and the tool of VPA in the tropical regions.

7. Conclusion

Cameroon's wood exports to the EU have been characterized by a decreasing trend throughout the 2000 – 2015 period. However, the VPA implementation process accelerated this downward trend

during two phases. The most straightforward drop was initiated when the VPA came into force (1st December, 2011). The drop in exports is explained by the observation that wood operators in Cameroon faced more stringent trading conditions, but were unable to become FLEGT licensed. The FLEGT license is key in acquiring access to the EU's wood market. In addition, once FLEGT licensing becomes possible, it will become a challenge to acquire a license. Challenges include high upfront costs, and the unclear prescriptions for legality. The high upfront costs also create a risk of increased income disparity in Cameroon, as only the most affluent operators can apply for a license and benefit from the new export opportunities.

An earlier drop was observed throughout the entire VPA negotiation period (November 2007 – May 2010). On the one hand, this drop is explained by the uncertainty of the outcome of the negotiations. On the other hand, anticipatory behavior could have triggered the redirection of Cameroon's exports towards countries with less stringent legality requirements. Both drops are problematic, since the VPA actually aims to strengthen Cameroon's competitive position in the international wood market. For a vulnerable wood market, it is hard to bridge longer periods with declining revenues and sales.

Cameroon's wood export recovered between the VPA agreement and it coming into force. Unfortunately, this revival was possibly due to the fact that wood operators wanted to benefit from the less stringent trading conditions as long as they were applied (i.e. until the VPA came into force). This opportunistic, and short-sighted, behavior is likely to harm sustainable forest management and could result in overexploitation.

Finally, this chapter also reveals a substitution effect between Cameroon and its neighboring countries as wood supplier to the EU. None of the countries supplies a unique product, so this comes as no surprise. This finding also links to the nonmonotonic impact of increased forest governance. It raises harvests in regions with weak governance, while it reduces harvest in regions with strong governance. Nonetheless, this increases the importance of a good trading relationship (through a VPA) with the EU as this could become a competitive advantage.

Chapter 5. The legality requirements in the EU Timber Regulation: non-tariff trade barrier or leverage effect?

Abstract. This chapter presents a spatial equilibrium model to analyze the leverage impact of the legality requirements in the EU Timber Regulation (EUTR). The EUTR is part of the EU's FLEGT program, which aims to stimulate legal wood production and sustainable forest management at global level. This leverage effect is an argument in favor of FLEGT but it has never been investigated thoroughly, or for demand and supply simultaneously. The leverage effect is measured in terms of the market share of wood that is accompanied by a certificate approving its legality (i.e. either an eco-certificate or a FLEGT-license through voluntary partnership agreements). Our research finds that FLEGT does not increase sustainable wood production and consumption. FLEGT creates a non-tariff trade barrier on the conventional wood markets in Europe and North America. This situation allows conventional wood producers to increase prices. The existence of transport costs prevents consumers from switching to foreign producers. In addition, producers in the South cannot compete on the certified market with the more efficient producers in the North. Being protectionist in nature, the legality requirements result in a non-optimal solution and reduce global welfare, with consumers especially being hit.

Context: Chapter 4 describes a negative impact of the introduction of legality verification through bilateral Voluntary Partnership Agreements. This chapter further investigates the impact of legality verification at global level through the EU Timber Regulation.

Based on:

Brusselaers, J., Buysse, J. (2017). 'The legality requirements in the EU Timber Regulation: non-tariff trade barrier or leverage effect?'. Submitted in April and currently in review process in *Journal of Forest Economics*

1. Introduction

This chapter investigates to what extent the legality requirements in the EU's Timber Regulation (EUTR) provide leverage for legal wood production and consumption at global level. Legal wood in this narrative implies environmental and social sustainability (Wiersum and Elands 2013). The market share of legal wood serves as a proxy indicator for the leverage effect of the EUTR.

Since 2013, the EUTR has required 'traders who place wood products on the EU market for the first time to exercise due diligence' (European Commission 2015b). Setting up an operational Due Diligence System (DDS) must minimize the risk of placing illegally harvested wood on the EU market[59]. The EUTR is part of the "Forest Law Enforcement, Governance and Trade Programme" (FLEGT) which aims to stimulate 'both legal wood production and good forest governance' at global level, and particularly in tropical countries (Wodschow et al. 2016, Wan and Toppinen 2016).

Setting up a DDS comes with a cost at company level which results in a non-tariff trade barrier (Global Timber Platform 2017). However, two instruments can avoid the burden of a DDS. Both instruments involve a type of certification. First, tropical countries can negotiate a Voluntary Partnership Agreement (VPA) with the EU. Each VPA requires the establishment of a functional legality assurance system. This assurance system allows the VPA-countries to award FLEGT-licenses to their wood operators. The FLEGT-license grants automatic access to the EU wood market, bypassing the due diligence requirement (European Commission 2017b, Wodschow et al. 2016). In addition, the VPA requires both environmental and societal efforts to improve the sustainability of forest governance in wood-producing countries. Second, (eco-)certificates, such as PEFC and FSC[60], must be in full compliance with the EUTR requirements (PEFC 2016, Trishkin et al. 2015). In fact, the eco-certification schemes even raised their standards in order to ensure compliance with the FLEGT requirements (Gulbrandsen 2014). For this reason, an eco-certificate is accepted as sufficient proof of legality within the EUTR (UNECE 2015), and eco-certified wood can pass a 'due diligence light' which entails lower costs.

This chapter defines legal wood as either eco-certified or VPA-licensed wood. Hence, eco-certification and VPA-licenses are assumed to be mutually equivalent, entailing the same costs and benefits. This is a mere simplification of reality, but expert consultation in the Southern hemisphere confirms that this

[59] The three key elements of the "due diligence system" are: 1) Information: The operator must have access to information describing the wood and wood products, country of harvest, species, quantity, details of the supplier and information on compliance with national legislation. 2) Risk assessment: The operator should assess the risk of illegal wood in his supply chain, based on the information identified above and taking into account criteria set out in the regulation. 3) Risk mitigation: When the assessment shows that there is a risk of illegal wood in the supply chain that risk can be mitigated by requiring additional information and verification from the supplier.
[60] FSC and PEFC are the two main eco-certificates for the wood industry at global level.

is, at present, a legitimate assumption (Global Timber Platform 2017, WWF 2015). This assumption is further explained in section two.

Albeit potentially of interest for producers exporting to the EU, both eco-certification and VPA are not very present in the Southern hemisphere. In May 2015, 10.9% of the total global forest area was eco-certified. However, the Northern hemisphere accounts for 89% of this certified area, while the Southern hemisphere only accounts for 11% (UNECE 2015). Accordingly, only 7 countries signed and implemented a VPA[61], so far only Indonesia has managed to issue FLEGT licenses (European Commission 2017d).

The poor uptake of certification (and the absence of leverage by FLEGT) in the Southern hemisphere is investigated by making use of a Spatial Equilibrium Model (SEM) at global level. The traditional SEM, as developed by Takayama and Judge (1971), has been modified according to Brusselaers et al. (2017). This modification is necessary to distinguish the certified (eco-certified and VPA-licensed) wood from the conventional wood[62] and thus to investigate the leverage effect of the legality requirement.

This chapter provides two essential contributions to literature. First, most of the previous research on the EUTR has focused on the legality aspects and principles of the EUTR (e.g. Wiersum and Elands (2013) or Trishkin et al. (2015)). Albeit useful, this type of research does not assess the policy objective: to provide leverage for sustainable wood production and consumption. Only Moiseyev et al. (2010) have conducted a global assessment of the VPAs' impact by making use of a SEM. But Moiseyev et al. (2010) exogenously determined the share of legal (certified) wood in a region's total wood consumption and production[63]. Instead, this chapter presents a SEM which endogenously determines the share of certified (legal) wood in a region's total wood production and consumption.

Second, previous research has predominantly investigated the impact of the EUTR at country-level (e.g. Atyi et al. (2013) or Roe et al. (2014)). Stand-alone case studies are not appropriate to investigate the EUTR's leverage effect, since different regions' wood markets are 'increasingly linked through international trade and global environmental policies' (Raunikar et al. 2010). Through these linkages, demand and supply shocks in one region can impact on other regions' wood markets. Accordingly, one region's forest conservation policy can lead to deforestation in other regions (Gan

[61] Cameroon, Central African Republic, Côte d'Ivoire, Ghana, Indonesia, Liberia, Republic of the Congo.
[62] Conventional wood is potentially, but not necessarily, illegal wood. In any case, certified wood guarantees the ecological and social trustworthiness of the product
[63] Also the EU commissioned official impact-monitoring. The ITTC became responsible for an independent market monitoring project. The project keeps track of some global trends, and how the EU and wider international markets for FLEGT-licensed wood develop during the establishment of the VPAs. But the monitoring has two main restrictions: 1) it does not provide insights into the dynamics which explain the monitored evolutions, and 2) it does not take into account the situation in countries which did not negotiate a VPA.

and McCarl 2007, Sedjo and Sohngen 2013). Hence, a global assessment, through a SEM, is more appropriate. Note that the global interlinkages validate the EU's assumption that its EUTR can indeed impact on other regions' wood markets. This assumption is further strengthened by the importance of the EU as a wood consumer: the EU accounts for 20 to 40 % of wood product consumption at global level (depending on the type of wood products) (FAO 2015b).

The basic framework, methods, and scenario details are described in the second part of this chapter. The third part discusses the outcomes of the model, while the fourth part discusses and explains some particularities of the outcome. The final part of the chapter provides a brief summary and conclusion.

2. Methods

This research applies the modified SEM according to Chapter 2 in order to investigate the impact of the EUTR. This chapter's SEM is not different from the second chapter's SEM, except for the baseline scenario and hence the starting point of the analysis. This chapter does not consider Green Public Procurement (GPP) in the baseline scenario. Consequently, there are more degrees of freedom for the optimization of the baseline scenario. This modified SEM is specifically designed in order to investigate wood markets which are characterized by the presence of certified wood alongside conventional wood. The technical details and limitations of the modified SEM can be found in Chapter 2; this section only discusses the adaptations made to the model to check the impact of the legality requirements.

The reasons to opt for the modified SEM are threefold. First, the SEM addresses the need for a global assessment of the legality requirements' impact. This need stems from the strong interlinkages between regional wood markets through trade (Buongiorno et al. 2014). Five regions are taken into account, ensuring global coverage: Europe (including Russia), Latin America, North America, Africa, and Asia (including Oceania).

Second, a SEM can distinguish a policy measure's welfare impact on the demand side from the welfare impact on the supply side of a market. Since the FLEGT goal is to increase both the demand for, and production of, certified wood it is essential to analyze both sides of the market simultaneously.

Third, applying the modified SEM allows the endogenous distinction between certified and conventional wood. This approach is appropriate to investigate the leverage effect of the EUTR for certified wood, because it allows producers and consumers to switch from one wood type to another. Certified (legal) wood is defined as either eco-certified or VPA-licensed wood. Hence, eco-certification and VPA-licenses are assumed to be mutually equivalent. This assumption deserves some further explanation for both the demand and supply side of the market.

2.1. FLEGT and eco-certification on the supply side of the wood market

On the supply side of the market, environmental- and societal-friendly production practices restrict forest management options and increase production costs (Van Deusen et al. 2010). Following the assumption of competitive behavior, producers will only apply for a certificate if the additional costs are compensated by a price premium $Pprem_{s,i}$. The Willingness To Accept (WTA) is a measure of the requested price premium on the supply side of the market[64]. If the additional costs related to certification are not compensated, wood operators will face additional losses and might cease exports towards the EU and redirect their exports towards countries with less strict legality requirements.

This chapter assumes a comparable WTA for eco-certification and FLEGT-licensing. This assumption originates from the observation that both certification types comply with the EUTR's minimum legality criteria. In addition, expert knowledge confirms that the high set-up cost of a FLEGT-licensing system prevents the actual issuing of FLEGT-licenses (Global Timber Platform 2017), despite seven VPAs coming into force. As such, the VPA constitutes the supply-side measures of the FLEGT Action Plan. A VPA must increase the commitment to develop robust wood legality assurance systems, in addition to sustainable forest management practices (European External Action Service 2016). On the other hand, eco-certification is (marginally) present in the Southern hemisphere. This strengthens our belief that the costs of FLEGT-licensing are at least equal to the costs of eco-certification. If not equal, this approach could potentially underestimate the WTA for the FLEGT-license but this still prevents hasty conclusions (Global Timber Platform 2017).

In addition, considering both types of certification simultaneously is necessary to conduct a global impact assessment of the DDS on the supply side of the market. The EU negotiates VPAs at country level. Hence, including the possibility of eco-certification is necessary to offer countries without a VPA (e.g. in the Northern hemisphere) the possibility of demonstrating the legality of their wood exports, as is the case in reality. In specific cases, eco-certification even became a prerequisite for legality licensing (e.g. for state-owned forests in Indonesia, the only country which issues FLEGT licenses at present).

This research uses the regional WTA estimates for eco-certification as applied in Chapter 2 (Appendix B). This results in a logistic distributed WTA with a mean $\mu_{WTA,i}$ and accompanying variation $\pi^2\sigma^2_{WTA,i}/3$ per region i. The mean WTA differs regionally due to regional differences in the indirect and direct costs relating to certification. The indirect costs stem from the required changes to management practices to meet certification standards (Bass 2001). The magnitude of the indirect cost

[64] The compensation of costs relating to certification is probably not the only driver for certification. Other literature also identified producers' characteristics which explain the decision to opt for certification LOUREIRO, M. L. and ARCOS, F. D. (2012). 'Applying best–worst scaling in a stated preference analysis of forest management programs', *Journal of Forest Economics,* Vol. **18**, pp. 381-394.

is inversely related to the quality of the current management practices. Regions with good (legal) standards for forest management face low indirect costs. The direct costs are the costs of the certification process. The nominal value of the direct costs is independent of the size of a forest/company (Ebeling and Yasué 2009). Consequently, the costs are relatively low for large-scale producers and relatively high for small-scale producers (Gullison 2003). Because large-scale producers and operators tend to be located in the Northern hemisphere, the average WTA in this hemisphere also tends to be lower.

2.2. FLEGT and eco-certification on the demand side of the wood market

Certified wood is a credence good which is vertically differentiated by process attributes (Dulleck et al. 2011). The certificate (eco-certificate or FLEGT-license) demonstrates accordance with FLEGT's legality principles. The Willingness to Pay (WTP) for certified wood is a measure for the price premium consumers are prepared to pay in order to acquire certified wood. This turns certification into a market-based instrument with voluntary price signals (Pirard 2012, Veisten 2007). Note that the WTP is not the result of a contingent valuation method which monetarizes the environmental and societal gains. Instead the WTP measures the consumers' marginal utility for the credence qualities of certified wood.

This chapter assumes that eco-certification and FLEGT-licensing stimulate a similar WTP. This assumption is justified by the observation that the FLEGT-license, in accordance with eco-certificates, goes beyond the legality assurance and requires environmental and societal efforts (European Commission 2016f). This should provoke an equal interest from consumers. This approach has two limitations. First, the FLEGT-license is less of a marketing tool and less physically visible than eco-certificates. Nevertheless, the EU considers the EUTR (which prohibits the placing of illegal wood on the EU's wood market) as a demand-side measure. By setting standards to imported products in EU legislation, they oblige EU's consumers to exclusively buy legality verified wood. Second, eco-certification schemes actively pursue a price premium for eco-certified producers, whereas the price premium is not an explicit target of the FLEGT program. However, the ITTO (2017) reported on a Willingness to Pay (WTP) for FLEGT-licensed wood by wood operators. Hence, this research also considers a WTP for FLEGT-licensed wood and equates it to the WTP for eco-certified wood. This research argues that if the compliance costs related to legality verification are not compensated, no trade will occur in the long run. Hence, a WTP should be present in order to make FLEGT-licensing work in the long run.

In particular, this research applies the regional WTP estimates for eco-certification as applied in Chapter 2 (Appendix A). This results in a logistic distributed WTP with mean $\mu_{WTP,i}$ and

accompanying variation $\pi^2\sigma^2_{WTP,i}/3$ per region i. The mean WTP estimates differ regionally due to regional differences in income level (Greenstone and Jack 2015).

2.3. Model specifications

The price mechanism for certified wood prevents the use of the traditional multi-product SEMs for substitute goods. The certified wood price ($P^{cer}_{d,i}$ and $P^{cer}_{s,i}$ for demand and supply) consists of the conventional wood price ($P^{con}_{d,i}$ and $P^{con}_{s,i}$) to which a price premium ($Pprem_{d,i}$ and $Pprem_{s,i}$) is added. In accordance with earlier research (e.g. Cai and Aguilar (2013)), the price premium is expressed as a percentage increase in the conventional price:

$$P^{cer}_{d,i} = P_{d,i} * (1 + Pprem_{d,i}) \quad (5\text{-}1)$$

$$P^{cer}_{s,i} = P_{s,i} * (1 + Pprem_{s,i}) \quad (5\text{-}2)$$

Hence, the standard assumption of a positive (negative) cross-price elasticity for demand (supply) for substitute goods does not hold (Takayama and Judge 1970, O'Sullivan et al. 2011). Chapter 2 describes the technical details of the modified SEM, including the price premium mechanism, the specification of the regional demand and supply functions, and the bilateral trade costs.

The share of certified wood in a region's total wood demand and supply depends on two factors. First, the regional, and endogenously determined, price premium for demand and supply (equation 5-1 and 5-2). Second, the logistic distribution for the WTP and WTA per region (Appendix A and B). Each region i's cumulative distribution function for certified wood consumption can be constructed out of the known logistic distribution:

$$Share^{cer}_{d,i} = 1 - \frac{1}{1+e^{-(Pprem_{d,i}-\mu_{WTP,i})/\sigma_{WTP,i}}} \quad (5\text{-}3)$$

The cumulative distribution function determines the certified share of a region's total wood production for each price premium level. It has a downward slope (Figure 5-1). This implies that a low price premium $Pprem^{low}$ results in a high proportion of certified consumption ($Share^{cer}_{d,i}\ hi$) within the total equilibrium wood consumption $Q^*_{d,i}$. A high price premium $Pprem^{high}$ results in a small share: $Share^{cer}_{d,i}\ low$ in Figure 5-1.

In accordance with the WTP approach, a cumulative distribution function of certified production is constructed out of a region i's logistically distributed WTA (equation 5-4). This allows the SEM to endogenously determine the certified share of a region's production for each price premium:

$$Share^{cer}_{s,i} = \frac{1}{1+e^{-(Pprem_{s,i}-\mu_{WTA,i})/\sigma_{WTA,i}}} \quad (5\text{-}4)$$

Figure 5-1 visualizes the relationship between the price premium and the certified share of a region's wood production and consumption.

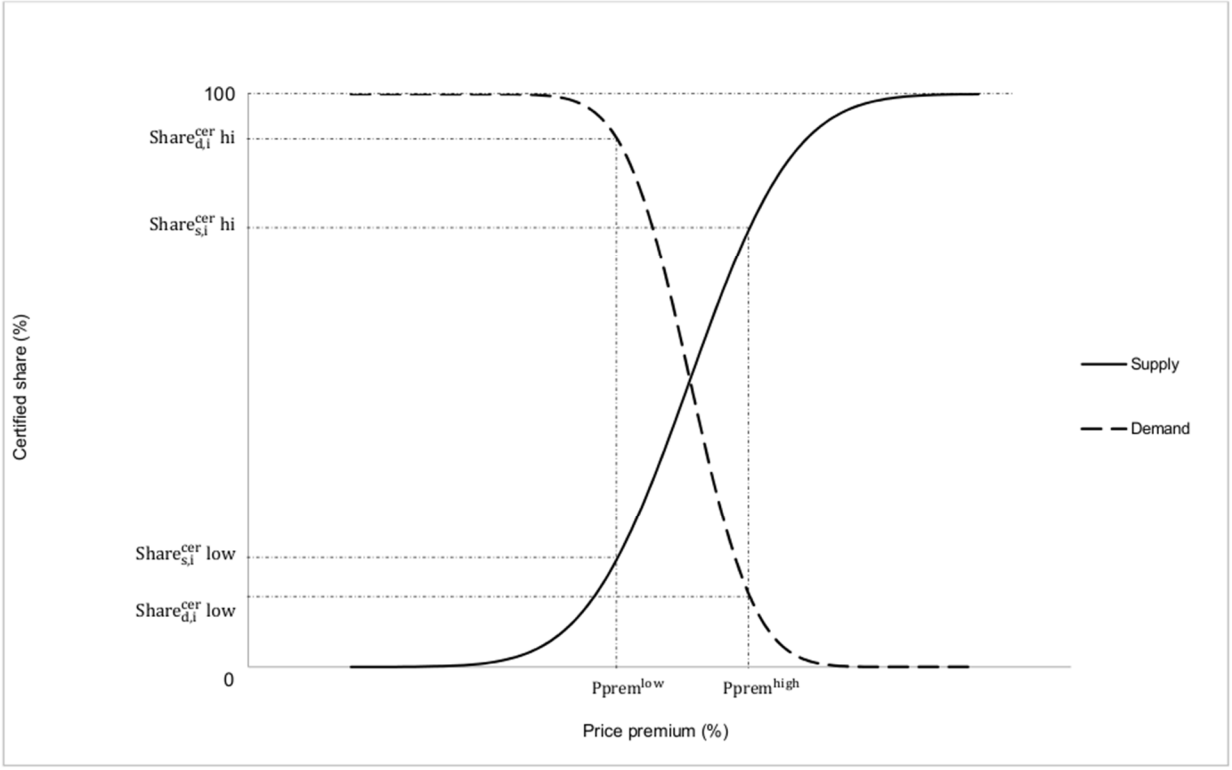

Figure 5-1: Cumulative distribution function of certified wood in total demand & supply for a region *i*.
NOTE.-The low and high price premium are determined arbitrarily.

2.4. Objective function

The modified SEM optimizes global economic welfare. This welfare is defined as the sum of all regions' quasi-welfare under the assumption of transport costs. A region's quasi-welfare equals the integration of the demand and supply function over the equilibrium quantity (Takayama and Judge 1971). This maximization of global welfare is retained in the modified SEM's objective function. The demand and supply functions according to Chapter 2, and integration of these functions is presented in Appendix I.

However, the demand and supply function do not distinguish between certified and conventional wood. Both certified and conventional wood are responsible for this regional quasi-welfare. The supply and demand function endogenously determines the response of the demanded and supplied quantities to price changes. The baseline values for the demanded and supplied quantities are calibrated to the current levels of registered production and consumption. At present, Europe, North America, and Asia produce the most wood (respectively 29.66%, 29.46%, and 25.89% of global production). Latin America and Africa produce less wood (12.57% and 2.42% respectively). The consumption pattern is comparable. Europe, North America, and Asia account for most of the wood

consumption (30.97%, 27.98%, and 26.30% respectively). Latin America and Africa account for smaller shares (12.72% and 2.03% respectively).

The modified SEM adds an additional welfare element to the traditional SEM's objective function. Figure 5-1 demonstrates how a low price premium $Pprem^{low}$ on the demand side of region i's market encourages a high percentage of the consumers ($Share_{d,i}^{cer}\,hi$) to acquire certified wood. However, most of the certified wood consumers are willing to pay an even higher price premium. The difference between the equilibrium price premium $Pprem^{low}$ and a consumer's individual WTP represents the additional consumer surplus relating to the introduction of certification and the price premium. The integral of the cumulative logistic distribution function (equation 5-3) over the right hand side of the equilibrium price premium adds all individual consumer surpluses. A maximum price premium of 100% is assumed:

$$CS_i^{cer} = \int_0^1 Share_{d,i}^{cer}\; dPprem_{d,i} - \quad \int_0^{Pprem_{d,i}} Share_{d,i}^{cer}\; dPprem_{d,i} \qquad (5\text{-}5)$$

Accordingly, an additional welfare element is calculated for the supply side of the market:

$$PS_i^{cer} = \int_0^{Pprem_{s,i}} Share_{d,i}^{cer}\; dShare_{d,i}^{cer} \qquad (5\text{-}6)$$

Both the additional consumer and producer surplus (equation 5-5 and 5-6, respectively) are multiplied with the regional equilibrium conventional wood price (respectively $P_{d,i}^*$ and $P_{s,i}^*$) and the regional equilibrium wood quantity (respectively $Q_{d,i}^*$ and $Q_{s,i}^*$). This multiplication is added to the traditional SEM's objective function in order to construct the modified SEM's objective function (Appendix I). The traditional SEM's price condition for trade and the trade balances remain valid in the modified SEM. However, the balances do account for the certified share of demand and production, and the price premiums, if necessary.

The modified SEM simultaneously solves each region's equilibrium under the assumption of bilateral trade costs (Appendix I). Hence, the transport costs separate, but do not isolate different regions' markets. The transport costs are retrieved from Buongiorno and Shushuai (2014), according to Chapter 2. The outcome of the modifications is an equilibrium state for the market which is no longer two-dimensional (price and quantity). Instead, the equilibrium consists of four dimensions: price ($P_{d,i}^*$ and $P_{s,i}^*$), quantity ($Q_{d,i}^*$ and $Q_{s,i}^*$), price premium ($\mathrm{Pprem_{d,i}}$ and $\mathrm{Pprem_{s,i}}$), and certified share of a region's total consumption and production ($\mathrm{Share_{d,i}^{cer}}$ and $\mathrm{Share_{s,i}^{cer}}$). This finally allows us to determine each region's quasi-welfare.

2.5. Policy scenario

This chapter compares a baseline scenario to the scenario in which FLEGT has come into force. In the baseline scenario, both conventional and certified wood can be imported into the EU. Importing wood

does not entail any additional costs, apart from the standard transport costs. In the FLEGT scenario, wood importers must provide sufficient proof of legality by establishing a DDS or by importing certified wood. Expert knowledge indicates that the costs of setting up a DDS at individual level surpass the costs of a certificate (Global Timber Platform 2017). For this reason, this chapter assumes that only certified wood is imported into the EU. This implies that the non-negativity constraint for the conventional wood quantity transported to Europe ($TQ_{j,EU}^{con}$) must be further tightened. This variable is set at zero for each region, except the EU:

$$\forall j \neq EU: TQ_{j,EU}^{con} = 0 \qquad (5\text{-}7)$$

European wood production is supposed to meet the EU's legality standards. Therefore, no certificate is explicitly required for European wood destined for the domestic market.

3. Results

3.1. Certified production

Table 5-1 presents the production ($Q_{s,i}$), supply price ($P_{s,i}$), and supply price premiums per region ($Pprem_{s,i}$) at regional and global level for both the baseline and FLEGT scenario. In addition, the table presents the production cost ($Pcost_{s,i}$). The production cost is below the received price because of the properties of the spatial model. This allows producers to generate additional producer surplus.

In a case where a region is trading wood, the difference between the production cost and the price originates from the transport costs. Note that the production cost can also be lower than the price received by consumers in cases where a region is not trading wood. In traditional welfare optimization without transport costs, this situation would foster an increase in both consumption and production in order to accomplish welfare gains by increasing both consumer and producer welfare. However, the spatiality in this model implies that regions cannot infinitely increase their wood production, as this depends on their natural capacity to produce. Accordingly, the demand for wood depends on macro-economic indicators and cannot increase infinitely. Additionally, the existence of the potential for trade impacts on the received price, even in cases where a region is not trading wood. If consumers do not pay a price at least equal to the demand price on a foreign market minus the transport costs, domestic producers will benefit more if they ship their wood to export markets.

In the baseline scenario, Europe and North America are the most important certified wood producers. Respectively 46.53% and 84.84% of their wood production is certified. The certified share of the three remaining regions' production is below 5%. Together, Africa, Latin America, and Asia only account for 3.05% of global certified wood production.

At global level, the production of certified wood decreased by 26.69% due to FLEGT. However, the regional impact on certified production is ambiguous. On the one hand, FLEGT increases certified wood production in the Southern Hemisphere. Africa, Latin America, and Asia increase their certified wood production by 18.16%, 18.16%, and 17.64% respectively. This results in a combined share of 5.17% of the global certified wood production for the Southern hemisphere in the FLEGT scenario.

On the other hand, certified wood production decreases in North America (-41.70%) and Europe (-0.83%). In Europe, FLEGT prevents the import of conventional wood. Hence FLEGT releases the European conventional wood producers from non-European competition. This allows European producers to exercise market power on the conventional wood market and increase the conventional wood price by 0.14% (Table 5-1). The increased price attracts less efficient conventional wood producers (facing higher production costs) to participate in the conventional wood market. The maximum production cost to join the conventional market is now 1.05% above the previous level (Table 5-1). Consequently, conventional wood production becomes more attractive and a proportion of the previously certified producers switch back to conventional production. The decreased interest in certified wood on the supply side of the market reduces the European price premium by 1.32%.

Certified production in North America decreases by 41.70%. This is due to the trade barrier for conventional wood in the EU. Consequently, the North American conventional wood is increasingly destined for the domestic market, which reduces the conventional price (-18.85%). This makes conventional wood attractive for the North American consumers who, to some extent, switch to conventional wood. Finally, this reintroduces the price premium in North America. However, more producers can sell conventional wood at a higher maximum production cost (+0.17%), which increases the producer surplus. The price premium simultaneously decreased by 21.23%. Less producers are able to offer certified wood (maximum production costs decreased by 5.49%). But those certified producers receive a high price. The evolution of wood prices in North America is strongly related to the evolution of prices in Europe. This follows from the observation that Europe is the most important competitor of North America in terms of volume produced. For conventional wood, the price increase in Europe allows the North American producers to increase their production cost without losing consumers to European producers. For certified wood, the reduction in the European price premium has the opposite effect. If North American producers want to remain competitive they have to reduce their price premium. Note that the North American price premium in the baseline scenario (36.27%) by far surpassed the European price premium (27.83%). The converging trend in the FLEGT scenario drives price premiums in both regions closer to each other (to 27.46% and 28.57% respectively). Hence, North America experiences a relatively bigger reduction in the price premium, which explains the sharp decrease in certified production in this region.

3.2. Certified consumption

In accordance with the global certified wood production, the global consumption of certified wood decreases by 26.69%. Table 5-2 presents the SEM's solution for each demand-related variable for both scenarios.

In this model, consumers can make a couple of decisions in order to optimize their quasi-welfare. First, they can switch between conventional and certified wood if one wood type becomes relatively more expensive than the other. Second, consumers can switch between domestically produced wood and imported wood for the same reason. However, transport costs impede the switch from domestic to foreign wood. These transport costs create an additional margin between a region's domestic demand price, and other regions' supply prices. This margin separates, but does not isolate, the different regions' markets. Due to the margin, the production cost of the most efficient region does not necessarily equal other regions' demand prices. Also the transport costs between the two regions must be remunerated. This allows less efficient producers in a less efficient region to participate in their domestic wood market, as long as their production cost does not surpass the minimum of the cost price of more efficient foreign producers and the bilateral transport costs. Consequently, high transport costs make consumers more dependent on the choices made by domestic producers.

This phenomenon is also observed in Europe and North America. The previous part provided an explanation for the growing interest in conventional production in both regions. North American and European consumers are obliged to follow this trend and consume more domestically produced conventional wood. In Europe, FLEGT prevents the switch towards foreign conventional wood. In addition, the transport costs impede consumers from substituting the previously domestically produced certified wood with certified wood produced abroad. Hence, the home effect of the increased conventional price outweighs the potential benefits of certified wood imports into Europe. This results in a 4.24% decrease in certified consumption in Europe, despite the relatively high European WTP for certified wood.

Also, North American consumers are obliged to follow the decisions of North American producers. This implies a 41.7% decrease in certified wood consumption. In the baseline scenario, certified wood consumption was the standard in North America, even to the extent that no price premium was present on the demand side of the market; the conventional price was sufficiently high for certified wood. In the FLEGT scenario, the price premium is reintroduced, which means that the certified price differs from the conventional price. This makes conventional wood consumption more appealing.

Certified wood consumption decreases in Africa and Asia. In these regions, the consumers did not follow the decisions of their domestic wood producers (i.e. to produce more certified wood). This follows the observation that most certified wood in these regions is destined for the foreign market.

The African and Asian WTP for certified wood is, due to their lower per capita income, which is not sufficiently high to 'compete' with the higher WTP in the export markets.

The explanation for the increase in certified wood consumption in Latin America is twofold. First, Latin American consumers follow the decisions of the domestic producers to produce more certified wood as a response to FLEGT. Second, a reduced price premium for consumption is observed in Latin America. This is an indirect result of the disappearance of African and Asian exports of conventional wood to Europe. Those two regions had a comparative advantage in conventional wood production. In contrast, Latin America had a comparative advantage in certified wood, and its producers could set an advantageous price premium. Due to FLEGT, production decisions no longer consider the comparative advantage. Instead all regions focus more on certified wood production. For this reason, Latin America faces higher competition from African and Asian certified wood producers. Consequently, the price premium for the consumption of certified wood decreases in Latin America. This creates more interest in certified wood consumption in Latin America and explains the certified wood import by Latin America out of Africa and Asia.

3.3. Welfare implication

The global welfare for wood consumption and production decreased by 0.26%. The welfare effect is further analyzed at regional level. Table 5-3 displays the percentage change for each region's total, consumer, and producer welfare. Some trends in Table 5-3 are apparent. At first, consumer welfare decreases in each region. This is a result of the increased price on the European conventional wood market. This increases the conventional wood prices in all regions. These increased prices, in turn, reduce the quantities consumed which results in decreasing consumer welfare. The only exception is the North American conventional wood price. In the baseline scenario, certified wood consumption was the standard in North America and the conventional price equaled the certified price. However, FLEGT initiated the reappearance of the price premium and a drop in certified wood production. The increased certified wood price damages North American consumer welfare.

A second trend concerns the increased producer welfare in all regions, except North America. The protectionist measures drive up prices, which encourages production. This leads to increased producer welfare. Only North American producers experience a welfare loss. The explanation for this phenomenon is twofold. First, the North American producers produce less certified wood. As a consequence, they miss out on a considerable amount of the price premium. This drop is less considerable in, for example, Europe. Second, FLEGT exempts the North American conventional wood producers from Europe's wood market. In the baseline scenario, North America exported conventional wood to Europe. The disappearance of the important European export market negatively impacts on North American producer welfare.

In General, a region's welfare decreases if the decrease in consumer welfare outweighs the increase in producer welfare. This is the case in all regions, except Europe and Africa. The increase in the African producer surplus is mainly explained by the certified wood exports (also to Latin America). The considerable welfare increase for the European producers (+1.42%) is a consequence of the higher price from which they can benefit on the conventional market.

Table 5-1: Production of wood, production of certified wood, supply prices, and supply price premiums (baseline scenario and FLEGT scenario)

	Africa		Latin America		Asia		Europe		North America		World	
	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT
Quantities:												
$Q_{s,i}$	.38	.38	1.95	1.96	3.34	3.35	4.61	4.65	4.58	4.59	14.87	14.92
$Q_{s,i}$change (%)		+.14		+.14		+.14		+.83		+.14		+.35
$Q_{s,i}^{cer}$	.01	.01	.04	.05	.15	.18	2.15	2.07	3.89	2.27	6.23	4.57
$Q_{s,i}^{cer}$ change (%)		+18.16		+18.16		+17.64		-3.65		-41.70		-26.69
$Share_{s,i}^{cer}$ (%)	2.12	2.51	2.12	2.51	4.52	5.31	46.53	44.46	84.84	49.39	41.94	30.63
$Share_{s,i}^{cer}$ change (%)		+18.00		+18.00		+17.48		-4.45		-41.78		-26.95
(Cost) Prices:												
$P_{s,i}$	1.33	1.33	1.27	1.27	1.26	1.26	1.26	1.26	1.55	1.26	1.34	1.26
$P_{s,i}$ change (%)		+.15		+.14		+.14		+.14		-18.81		-5.94
$Pcost_{s,i}$	1.05	1.06	1.05	1.06	1.05	1.05	1.05	1.06	1.05	1.06	1.05	1.06
$Pcost_{s,i}$ change (%)		+.17		+.17		+.17		+1.05		+.17		+.45
$Pprem_{s,i}$ (%)	27.83	28.57	27.83	28.57	27.83	28.57	27.83	27.46	36.27	28.57	33.10	28.07
$Pprem_{s,i}$ change (%)		+2.69		+2.69		+2.69		-1.32		-21.23		-37.83
$P_{s,i}^{cer}$	1.65	1.66	1.66	1.58	1.52	1.57	1.55	1.56	1.55	1.56	1.55	1.56
$P_{s,i}^{cer}$ change (%)		+.66		-4.54		+2.79		+.66		+.66		+.70
$Pcost_{s,i}^{cer}$	1.35	1.36	1.35	1.36	1.35	1.36	1.35	1.36	1.44	1.36	1.40	1.36
$P_{s,i}^{cer}$cost change (%)		+.76		+.76		+.76		+.76		-5.49		-3.23

NOTE.-Prices are in 100 USD per m³. Quantities are standardized. Asia encompasses Oceania and Europe encompasses Russia. The world prices are calculated as the volume weighted average of each region's prices. The percentage changes represent the change of the variable's value in the FLEGT scenario compared to the baseline scenario. The displayed price premiums are the percentage increase on top of the conventional wood price.

Table 5-2: Consumption of wood, consumption of certified wood, demand prices, and demand price premiums (baseline scenario and FLEGT scenario)

	Africa		Latin America		Asia		Europe		North America		World	
	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT	Baseline	FLEGT
Quantities:												
$Q_{d,i}$	.28	.28	1.81	1.81	4.00	4.00	4.64	4.64	4.13	4.19	14.87	14.92
$Q_{d,i}$ change (%)		-.07		-.06		-.03		-.01		+1.34		+0.35
$Q_{d,i}^{cer}$	.00	.00	.06	.19	.14	.05	2.15	2.05	3.89	2.27	6.23	4.57
$Q_{d,i}^{cer}$ change (%)		-18.54		+215.14		-59.99		-4.24		-41.70		-26.69
$Share_{d,i}^{cer}$ (%)	.80	.65	3.36	10.58	3.43	1.37	46.26	44.30	94.09	54.13	41.94	30.63
$Share_{d,i}^{cer}$ change (%)		-18.48		+215.34		-59.98		-4.24		-42.47		-26.95
Prices:												
$P_{d,i}$	1.33	1.33	1.27	1.27	1.26	1.26	1.26	1.26	1.55	1.26	1.34	1.26
$P_{d,i}$ change (%)		+.15		+.14		+.14		+.14		-18.81		-5.94
$Pprem_{d,i}$ (%)	23.60	24.24	30.50	24.40	20.81	24.00	23.35	23.98	0.00	23.98	8.80	24.00
$Pprem_{d,i}$ change (%)		+2.71		-20.02		+15.35		+2.71		+∞		+172.76
$P_{d,i}^{cer}$	1.65	1.66	1.66	1.58	1.52	1.57	1.55	1.56	1.55	1.56	1.55	1.56
$P_{d,i}^{cer}$ change (%)		+.66		-4.54		+2.79		+.66		+.66		+.70

NOTE.-Prices are in 100 USD per m³. Quantities are standardized. Asia encompasses Oceania and Europe encompasses Russia. The world prices are calculated as the volume weighted average of each region's prices. The percentage changes represent the change of the variable's value in the FLEGT scenario compared to the baseline scenario. The displayed price premiums are the percentage increase on top of the conventional wood price.

Table 5-3: Percentage change of the total, consumer, and producer welfare per region

	Regional Welfare	Producer welfare	Consumer welfare
Africa	0.0062	0.3052	-0.1902
Latin America	-0.4228	0.3040	-0.7896
Asia	-0.1717	0.3305	-0.2604
Europe	0.0331	1.4171	-0.0531
North America	-0.5979	-7.2989	-0.1091
World	-0.2601	-1.8366	-0.1161

NOTE.- Asia encompasses Oceania and Europe encompasses Russia. The percentage changes represent the change to the variable's value in the FLEGT scenario compared to the baseline scenario and are displayed in 100%.

4. Discussion

4.1. Trade barrier

FLEGT creates a trade barrier for conventional wood to Europe. The protectionist nature of this trade policy reduces global welfare (0.26%), with vulnerable consumers being particularly affected. North and Latin America were shipping conventional wood to Europe and are directly impacted by the import ban. The case of Latin America is different. The region managed to redirect its conventional wood flow from Europe to Asia. As such, Latin America exports an increased volume of conventional wood in the FLEGT scenario, which positively affects their producers' welfare. All other regions' conventional international wood exports collapsed. As a result, the international trade in conventional wood also decreased by 1.21%. Note that conventional wood is not necessarily illegal wood. Instead, this is wood produced by producers who cannot meet the environmental and societal standards set by eco-certification or FLEGT-licensing. Hence, the reduction in conventional trade flow does not necessarily represent a reduction in illegal trade.

Concerning international trade for certified wood, FLEGT does not stimulate certified wood exports to Europe. This is first of all explained by the transport costs, ad valorem tariffs, and price premium. Those elements complicate certified wood trade towards Europe because they do not allow European consumers to easily switch between domestic and foreign producers, or between certified and conventional producers. This links to earlier research which identified transport costs as the main obstacle to benefitting from FLEGT licensing (Sun 2017). Second, Europe itself is an efficient producer of certified wood. Europe can fulfil the remaining demand for certified wood itself. This finding is in line with the home-effect by Fajgelbaum et al. (2011) who explain why richer countries specialize in high-quality goods. As such, the expensive legality requirements create a trade barrier around the Northern hemisphere.

Nevertheless, the global trade in certified wood increased by 636.28%. This is due to increased exports of certified wood within the Southern hemisphere (i.e. from Africa and Asia to Latin America). These regions previously focused on conventional wood exports to the Northern regions but are not allowed to do this anymore. In the FLEGT scenario, the African and Asian producers are allowed to export conventional wood towards the EU, but cannot compete with the more efficient certified producers in the EU. Instead, shipping certified wood towards Latin America proofs to be the most beneficial alternative for a (limited) proportion of the African and Asian wood producers. Latin America became the export destination because this region is characterized by having the highest WTP of all Southern regions. The volumes of certified wood produced and traded in the Southern hemisphere remain small however.

The outcomes of this chapter's SEM describe how the tropical regions cannot compete with certified wood production in the Northern hemisphere. This is also observed in reality. The *International Tropical Timber Council* describes the dangers for the future of certification: if 'producers are forced to drop out from traditional markets, as has already happened in some cases, product prices are driven down'. In some regions, this can lead to a reduction in the value of the resource, encouraging its conversion into other uses (ITTC 2004).

4.2. Price premium as an incentive for certification

This chapter adheres to a strictly economic approach towards certification, based on the assumption of perfect competition. The SEM only allows producers to switch to certified production if the certification cost is compensated by the price premium. Experts of the ITTC (2004) confirm this economic approach: without 'tangible benefits deriving from certification in terms of profitability or competitiveness, enterprises will have little incentive to improve forest management with higher costs'. This problem is found to be particularly serious in the case of tropical wood-producing countries (Simula et al. 2004). Also Greaker (2006) described how an insufficient willingness to pay for green (certified) products can endanger foreign producers' profits.

Carlsen et al. (2012), on the other hand, stress the importance of less tangible benefits for eco-certified wood producers (e.g. community empowerment) (Carlson and Palmer 2016). This type of benefit is hard to capture in a monetary value.

4.3. Leverage effect

According to our simulations, production of certified wood decreased at global level. In practice, a region's certified wood production is positively linked to the region's certified forest area. Hence, FLEGT does not positively impact on forest conservation and sustainable forest management practices at global level. However, FLEGT is specifically targeted at forests in the Southern hemisphere and those regions managed to expand their certified production. Nevertheless, the certified share in those regions' production remains equal to or below 10%, and it is not targeted at the European market. One could also wonder to what extent the certification indeed enlarged the sustainably managed forest area. Blackman and Naranjo (2012), for example, describe how certification first tends to attract producers who already meet the certification standards.

Due to the reduced volume of certified wood produced, global certified wood consumption also decreased. The positive relationship between the WTP, the GDP, and the certified share in a region's consumption indicates that 'Willingness to Pay' is probably the wrong choice of words. It rather reflects the 'Capacity to Pay' for certified products. Only Latin American consumers increased their

certified wood consumption, but in this region the certified wood price decreased. Take note that the WTP is fixed in this model. However, Gulbrandsen (2014) described how government policies, by relying on (non-governmental) certification schemes, can award credibility to the certification schemes. Following this rationale, FLEGT might, in the long term, increase private consumers' WTP for, and consequently consumption of eco-certified wood.

The SEM's outcomes (Table B1) are also observed in reality: both eco-certification and FLEGT-licensing are not able to certificate considerable volumes of wood. This suggests that the cost of certification is higher than the price premium received by the producers in the Southern hemisphere. Government policies could aim to reduce the costs of certification to make certification more inclusive at global level. Potential points of attention are: the legislative framework in support of certification (Putz et al. 2000), the distance and convenience of wood transport (Gullison 2003), and the available financial means (ITTC 2004).

Governments can also invest in group dynamics and cooperative initiatives in the forest industry. A higher level of vertical integration along the production chain, for example, reduces certification costs (Atyi and Simula 2002). Cooperative initiatives among producers can also reduce the direct certification costs since the direct costs are not dependent on the size of a forest/company (Ebeling and Yasué 2009). Consequently, the costs are relatively low for large-scale producers and relatively high for small-scale producers (Gullison 2003). Moreover, large-scale wood producers are also favored over small-scale wood producers by the buyers of certified wood. Demand for certified wood is mainly driven by retail, which demands large volumes, consistent quality, and low prices. Large-scale wood producers are better able to meet these requirements (Molnar and Trends 2003, Rametsteiner and Simula 2003, Klooster 2005, Taylor 2005). However, large-scale producers and operators tend to be located in the Northern hemisphere. Cooperative initiatives in the Southern hemisphere can tackle the issue of scale, although a phased approach is needed for this kind of policy (Simula et al. 2004). In a more comprehensive strategy, certification can play a complementary role in sustainable forest management.

5. Conclusion

According to our model, FLEGT does not stimulate the consumption and production of certified wood at global level. However, a modest leverage effect is observed in production in the Southern hemisphere. Unfortunately, the market share for certified wood in these regions remains marginal. These findings are in line with what is currently observed in reality, suggesting that more attention must be devoted to the costs of certification. The leverage effect is not realized in Europe and North America (the main producers of wood). In Europe, FLEGT allows producers to switch to conventional production and benefit price increases in this market segment.

On the demand side of the market, this model's dynamics explain how, due to the transport costs, consumers are obliged, to some extent, to follow the production decisions of their domestic producers in favor of certified or conventional wood. Under this logic, the transport costs further separate the regional wood markets. Certified wood consumption decreased in all regions except Latin America. Latin America both produces and imports more certified wood. The certified wood is imported from Asia and Africa, who can no longer focus on the production of conventional wood, due to the implementation of FLEGT. The comparative advantages which are supposed to determine production decisions and trade flows are ruled out due to the policy.

The innovative features added to traditional Spatial Equilibrium Modelling also allow us to analyze the impact of the policy for each region's quasi-welfare. At global level, the quasi-welfare decreased due to FLEGT's protectionist nature. Protectionism, by default, led to non-optimal welfare outcomes. The considerable weight of consumer welfare in the quasi-welfare of Latin America, Asia, and North America reduces their regional quasi-welfare. These reductions occur at the expense of a welfare increase in Europe (the initiator of FLEGT) and Africa. For both continents, the welfare increase is due to an improved producer surplus, since consumers are also worse off in those regions.

This model is a simplified representation of reality. Therefore it cannot be used for exact forecasting of the leverage effect of FLEGT on each region's certified share of wood consumption and production. The value of the model lies in revealing mechanisms which impact on a country with a profile comparable to one of the five regions' profiles.

Chapter 6. Conclusions

1. Research objective and conclusions

This thesis analyzed government policies that aim to sustain wood (products) consumption and production. More in particular, the thesis' focus is policies that imply a set of minimum requirements to which the wood (products) must comply. The two policies analyzed are GPP and FLEGT. In this context, the minimum set of requirements must guarantee that the wood is extracted from, respectively, sustainable or legally managed forests.

This chapter first provides an overview of three general conclusions that are drawn from similarities or comparisons between the different chapters' conclusions. This provides insights and conclusions for the main research objective of this thesis. Subsequently, an overview of chapter-specific conclusions is provided. Hereafter, this concluding chapter provides an overview of policy recommendations addressing some of this thesis' conclusions. Finally, this chapter identifies future – potential – research trajectories.

1.1. Non-inclusive policies towards wood producers

At present, both eco-certification and FLEGT-licensing are not inclusive towards producers in the Southern hemisphere. In the context of eco-certification, the southern hemisphere only accounts for 13% of the globally certified forest area. In the context of FLEGT, only six wood-producing countries have managed to conclude a VPA with the EU. At present, only one of these six countries – Indonesia – has managed to issue FLEGT-licenses. Hence, neither GPP, nor FLEGT, is fully inclusive towards all regions' producers. Consequently, neither of the policies increases the uptake of the sustainability or legality standards in forest management and wood production in the South.

This is demonstrated in Chapter 4, which provides a historical analysis of Cameroon's wood exports to the EU before, during, and after the VPA implementation process. The analysis finds that the VPA negatively impacted on Cameroon's wood exports when it came into force (and during part of the implementation process). Also, Chapters 2 and 5 describe how the EU-wide implementation of, respectively, GPP and FLEGT does not promote the uptake of certification and legality criteria, respectively, in each region's wood market. In the GPP scenario, certified production manages an increase at global level. However, certified production decreases in North America and Africa. In the FLEGT scenario, certified production decreases at global level, and notably in North America and the EU. In addition, neither policy succeeds in increasing the share of certified production in the South above 5% of the SEM's global certified production. In particular situations conventional wood production is even stimulated. This is observed in the volume of conventional wood produced in the SEMs in Chapters 2 and 5, as well as in the substitution effect between Cameroon and its regional counterfactual as wood supplier in Chapter 4.

The interaction between transport costs and the compliance costs for eco-certification, or legality criteria are held responsible for these observations. The transport costs separate the different regions' wood markets. This reduces competition between the different regions' producers. In addition, the high compliance costs in the South explain the limited importance of the South in global certified wood production. These high costs are insufficiently compensated by a price premium. The explanation for the insufficient price premium is based on the assumption of perfect competition. The use of this approach is justified by other authors who state that without tangible benefits, the uptake of certification will remain limited (ITTC 2004, Simula et al. 2004). Note that in the case of FLEGT, not only do the high compliance costs impede trade, but also the non-operative FLEGT-licensing system neglects access to the EU's wood market.

Comparison of both policies demonstrates that GPP provides a better stimulus for sustainable wood production. GPP is more positive in nature as it tends to activate a latent demand for wood products. This still allows each region to specialize in the wood type for which they have a comparative advantage. In contrast, FLEGT is more negative in nature, as it restricts trade in conventional wood. In this case, comparative advantages do not determine the production choices.

1.2. Non-inclusive policies towards wood consumers

GPP aims to increase the consumption of sustainable wood (Chapter 1). The findings in Chapter 2 demonstrate that GPP can indeed stimulate private consumption of certified wood, both in Europe and in other regions. Private consumption of certified wood, however, decreases in Asia and North America. Chapter 5 indicates that FLEGT has a more negative impact on private consumption of certified (legal) wood compared to GPP. Private consumption of certified wood decreases in all regions, except Latin America, due to FLEGT requirements for legality.

The findings in Chapter 3 provide also useful insights in this respect. In general, private consumers indicate support for GPP. However, this support significantly decreases when GPP entails negative consequences (i.e. increased price, crowding-out of private consumption). Hence, the reductions in private consumption, as observed in the SEMs in Chapters 2 and 5, are likely to provoke some resistance.

1.3. Interaction between non-governmental and governmental initiatives

Chapter 1 defines eco-certification as a transnational, non-governmental approach to environmental regulation and development. Although non-governmental in nature, Chapters 2 and 5 describe the strong interlinkages between eco-certification and government policies (notably GPP and FLEGT).

GPP for wood relies on eco-certification for a number of reasons. The main reason is the issue of limited availability of universal environmental criteria for products/services (European Commission 2016a). In addition, the use of certification can make public procurement decisions more consistent (Parikka-Alhola 2008). Finally, governments are increasingly interested in socially responsive forestry administration, next to transparency in trade. Eco-certification complies with these concerns (Atyi et al. 2013). Besides GPP, FLEGT also interacts with eco-certification. FLEGT acknowledges the full compliance of the two main eco-certification schemes – FSC and PEFC – with the EUTR requirements (Trishkin et al. 2015, PEFC 2016).

Hence, some government policies rely on eco-certification, but their interest in eco-certification can also push the certification schemes to improve their standards. The latter is explained in Chapter 5 and confirmed by Gulbrandsen (2014), who noticed that 'several certification schemes are developing legality assurance standards in response to the EU FLEGT and Timber Regulation, as well as member-state procurement policies'. Hence, government policies and non-governmental eco-certification mutually reinforce each other. In addition, Chapters 2 and 5 describe how the approval of eco-certification schemes by government policies can enhance the rulemaking authority and signal the credibility of the schemes to procurers and buyers. This could provide an important contribution to the uptake of private consumption of eco-certified wood, since a lack of trust prevents this uptake (Chapter 4).

1.4. Chapter specific conclusions

This section discusses chapter specific conclusions which have not been discussed previously. The chapters are not discussed in the correct order.

1.4.1. Chapter 2

Applying GPP increases global welfare in Chapter 2's SEM. If governments opt for the lowest bid, they cannot tap into all potential quasi-welfare. However, applying GPP allows them to take other dimensions of (e.g. environmental) quality into account and purchase eco-certified wood at a price premium. Paying the price premium taps into previously unused quasi-welfare.

However, increased global welfare is not a Pareto efficient improvement. Whether or not an individual region increases its quasi-welfare due to GPP in Europe mainly depends on the evolution of its consumer surplus. Europe, Africa, and Latin America managed to increase their consumer surplus and regional quasi-welfare, mainly due to increased certified purchases. However, quasi-welfare decreased in North America and Asia.

1.4.2. Chapter 5

In contrast to GPP, the implementation of FLEGT reduces global welfare. Again, some regions manage to increase their individual quasi-welfare (Europe, Africa) while some regions experience a decrease in individual quasi-welfare (North America, Latin America, Asia). More apparent is the observation that the consumer surplus decreased in each single region. In contrast, the producer surplus increased in each region, except North America.

This is due to the restrictive nature of the legality requirements in FLEGT. These requirements prevent conventional wood trade to Europe. This further separates the regional wood markets, which allows most regions' producers to increase their prices. As such, FLEGT has elements in common with protectionist trade policies. Protectionism generally tends to reduce global welfare. Note that, in the latter situation, a region's comparative advantage is no longer indicative of production decisions.

1.4.3. Chapter 3

This chapter analyses private consumers' intentions to buy eco-certified wood in combination with their support for GPP. In relation to the intention to buy, Chapter 3 confirms the significance of environmental concern, subjective norm, and attitude towards eco-certified purchases as drivers for eco-certified wood consumption. However, contrary to expectations, perceived consumer effectiveness does not impact on intention to buy eco-certified wood. This is explained by the low frequency of wood purchases which reduces the perceived consumer effectiveness of wood compared to the perceived consumer effectiveness of products and services that are purchased more regularly.

Private consumers, in general, support government purchases of eco-certified wood. Their level of support is positively correlated to attitude towards eco-certified purchases and environmental concern. However, the level of support significantly decreases when GPP entails negative consequences (i.e. increased prices, crowding-out of private consumption). This decrease in support for GPP is significantly and positively correlated to environmental concern. Environmental concern (measured as the score on the NEP) is traditionally labelled as an altruistic driver for sustainable consumption. This chapter's analysis demonstrates that the score on the NEP also captures an element of self-interest. This self-interest is explained by the high level of involvement of the private consumers.

1.4.4. Chapter 4

Chapter 4 for the first time analyses historical trade data to check the impact of a VPA coming into force. More in particular, it finds a negative impact of the VPA coming into force on Cameroonian wood exports to the EU. This is explained by the inability to issue FLEGT licenses, and the high, upfront, compliance costs for wood producers.

The historical analysis also reveals an unusual pattern of anticipative behavior. The negotiation period negatively impacts on exports because this period is marked by uncertainty about the outcome of the negotiations. In addition, wood operators redirect their trade flows in anticipation of more stringent trade conditions in future. In contrast, the exports briefly revive between the conclusion of the VPA negotiations and it coming into force. This short revival is a manifestation of short term, rent-seeking behavior by wood traders who aim to benefit from the old, less stringent, export conditions. This leads to increased wood extraction, and threatens long term, sustainable forest management.

2. Policy recommendations

2.1. Uptake of eco-certification and FLEGT-licensing in wood production

The economic approach applied by this thesis implies that producers will only switch to certified, or FLEGT-licensed, wood production once the compliance costs are compensated by a price premium. The validity of this approach is confirmed by numerous authors (ITTC 2004, Simula et al. 2004). Since the uptake of eco-certification and FLEGT-licensed production in the Southern hemisphere remains marginal, this suggests that inclusive policies should also aim to reduce compliance costs. Numerous policies that aim to reduce compliance costs are listed throughout this thesis.

At individual producer level, a cost reduction can be effected by improving: the legislative framework in support of certification, weak land tenure rights, the distance and convenience of transporting wood, the bureaucratic requirements for eco-certification and legality assurance, and the available financial means (Chapter 2 and Chapter 5). Addressing these issues requires a comprehensive strategy in which certification or FLEGT licensing plays a complementary role to sustainable forest management. This type of strategy requires a phased approach (Simula et al. 2004). According to Meijaard et al. (2014), an important part of this comprehensive approach should focus on the simplification of the criteria and indicators. This would allow less costly monitoring and auditing systems.

Instead of focusing at the individual producer level, cooperative initiatives can address the same issues for four reasons. First, cooperative initiatives can reduce the direct costs of certification by distributing these costs over a higher number of producers. This could be especially beneficial for the small-scale producers in the Southern hemisphere. At present, the South's large-scale forest enterprises, rather than small-scale concession holders, particularly benefit from export opportunities to the North (Atyi et al. 2013). Second, the demand for eco-certified wood is mainly driven by retail, which demands large volumes, consistent quality, and low prices (Chapter 2). Cooperative initiatives better allow these requirements to be met. Third, a high level of vertical integration along the production chain reduces certification costs (Chapter 5). In addition, cooperative initiatives might reverse the trend of power concentration in the large concession groupings. Carodenuto and Cerutti (2014) indicated that

international forest policies such as FLEGT (and its VPAs) may cause further expansion of this power concentration and lead to fragmentation of smaller forestry enterprises in the Congo Basin. Fourth, giving voice to the small and medium forest enterprises reinforces the integrity of the proposed legality assurance system (and eco-certification) and allows those enterprises to reap benefits from the schemes' implementation (Carodenuto and Cerutti 2014).

Numerous authors have investigated obstacles for cooperatives, both in the context of eco-certification and FLEGT-licensing. Future policies should avoid these pitfalls. The main obstacles are potential conflicts between centralized forestland ownership and decentralized forest tenure, identification of plantation or natural forest, monitoring of potential effects of forest management, decreases in cost efficiency, weak legitimation, and identification and conservation of high conservation value forests (He et al. 2015, Nurrochmat et al. 2016).

2.2. Uptake of eco-certification and FLEGT-licensing in wood consumption

In addition to addressing the compliance costs, policies can stimulate demand and WTP for sustainable wood. The lack of demand for certified wood in the South is a considerable constraint for certified production, and hard to address given the positive correlation between the WTP and income (Chapter 2). However, the WTP by consumers in the North also insufficiently compensates the compliance costs. Chapter 3 identifies three drivers for a (European, Belgian) private consumer's intention to buy eco-certified wood: environmental concern, subjective norm, and attitude towards eco-certified purchases. A government can try to increase environmental concern, by, for example, improving knowledge of environmental issues and trust in eco-certification and FLEGT-licensing (Pagiaslis and Krontalis 2014). Note that Chapter 3 also stresses the importance of trust in eco-certification schemes for the intention to buy eco-certified wood.

Finally, Chapter 3 identifies different segments of private consumers. These insights can be used to develop specific communication strategies for the distinct segments in order to encourage the consumption of sustainable wood (e.g. focus on knowledge transfer to the least interested segment, and focus on attitude towards eco-certified consumption for the more interested segments).

2.3. GPP

The EU set an indicative target that, by 2010, 50% of all public tendering should be green (Chapter 2). However, the uptake of GPP has been estimated once in 2011, and is not systematically monitored. Better monitoring would allow a trustworthy assessment of the importance of GPP across the EU. The European Commission (2016b) stresses the importance of trustworthy monitoring of GPP because this allows the improvement of GPP activities. Standard points of attention are the training of staff,

development of practical tools and information, a more systematic implementation and integration of GPP into management systems and cooperation between authorities to foster the uptake of GPP (European Commission 2016a).

Ideally, GPP enjoys ample support by private consumers. Chapter 3 described how this support tends to decrease when GPP entails negative consequences. The policy recommendations on the uptake of eco-certification can avoid the emergence of these negative consequences. The issue of building trust in eco-certification and FLEGT-licensing among private consumers, as described above, is crucial in reversing this negative trend.

2.4. FLEGT

Chapter 4 identified an unusual pattern of anticipative behavior prior to the VPA coming into force. This pattern provides insights for present and future negotiations on VPAs between the EU and wood-producing countries in the South.

Less lengthy negotiation periods could restrict the uncertain period and the redirection of trade flows. This is important because the reduced trade flow also reduces the relevance of the EU as an export market for Cameroonian wood producers. If the EU loses part of its relevance, this might also restrict the potential impact of a VPA in the producing countries. In addition, the EU could also pay attention to the negative perceptions of the impact of the VPA when it comes into force, which drives the redirection of trade flows (Chapter 4).

The few months prior to the VPA coming into force are marked by increased exports to the EU. The EU should prevent this short term, rent-seeking behavior as it jeopardizes long term sustainable forest management in the VPA countries. For example by increasing the number of trading partners in one single VPA.

A region-wide approach, instead of negotiating VPAs at individual country level, could be more useful in addressing sustainability issues in forest management in the South. The country-level approach risks the transfer of non-sustainable practices to neighboring countries. This is indicated by the substitution effect between Cameroon and its regional counterfactual as wood supplier. This effect suggests that more stringent conditions in Cameroon entail higher production levels in its surrounding countries (Chapter 4). This can potentially result in deforestation in the surrounding countries (Gan and McCarl 2007, Sedjo and Sohngen 2013). An alternative explanation for the substitution effect between Cameroon and its neighbors is the smuggling of wood from Cameroon to its neighboring countries (Jianbang et al. 2016, Maryudi 2016). The region-wide approach can prevent the transfer of unsustainable practices to the surrounding regions.

Finally, the wood-producing countries need more assistance in the establishment of an approved FLEGT licensing system. At present, none of the VPA countries, except Indonesia, manages to issue FLEGT licenses. In addition, Chapters 4 and 5 indicate that compliance to FLEGT criteria entails considerable costs throughout the wood value chain. However, FLEGT does not specifically acknowledge these costs, nor does it aim for a price premium as compensation for the additional costs. This attributes all responsibility and burden to the supply side of the market, which already occupies the weaker position in the wood value chain (Meijaard et al. 2014).

2.5. Trade barrier

Both Chapter 2 and Chapter 5 introduce transport costs in the modified SEM. The transport costs consist of per unit shipment costs and an ad-valorem tariff. Both chapters' analyses demonstrate how the transport costs further separate the different regions' wood markets. This leads to a non-optimal solution for the SEMs in terms of global welfare maximization. Lower ad-valorem tariffs allow an increase in global welfare.

3. Future research

3.1. Modelling challenges

This thesis presents two comparative static partial SEMs. These entail a number of limitations which can be addressed by future research. First, comparative static models do not allow the incorporation of dynamics within the models' parameters. Chapter 2 describes how public procurement and legality assurance, which rely on eco-certification, can increase the trustworthiness of the certification schemes. To what extent this increases private consumers' trust in the certification schemes, and subsequently their WTP for eco-certified wood, has not been estimated. While Gulbrandsen (2014) suggests that procurement policies have had a broad effect on the uptake of eco-certification, Georghiou et al. (2014) claim that there is currently no theoretical or empirical basis for the impact of GPP.

Second, the SEMs do not allow a price reduction for certified wood, once certified wood gains importance in a region's total wood production and consumption. Nevertheless, such a trend could be expected. First of all, there are indicators that if price premiums exceed the direct operational costs of certification, the excess profit will disappear when more producers enter the market (Nebel et al. 2005). Second, once certified wood acquires a strong position in a region's wood market, it could be more beneficial to pursue a type of horizontal specialization within a region's wood sector and entirely switch to certification. This would allow benefits to be gained from "collective efficiency" (Giuliani et al. 2005, Schmitz 1995) through economies of scale, and avoid the costs of separating the value chains

for conventional and certified wood. Modelling these kind of dynamics in trade models can provide relevant insights in future.

Third, a general, instead of a partial, equilibrium model could take different sectors' behavior, and substitutes for wood into account. But this would not contribute to the main issues addressed in this thesis.

Finally, the SEMs in Chapters 2 and 5 do not take into account preferences relating to the geographical origin of the wood produced. This could be done by introducing Armington elasticities which would entail rigidity in the adaptation to new circumstances (Armington 1969). The analysis of historical trade data in Chapter 4 indicates a substitution effect between suppliers. Hence Europe's foreign wood suppliers appear to be highly interchangeable within a region (e.g. Africa, or West-Africa). Nevertheless, Armington elasticities can introduce a preference for domestically produced wood, as described by Aguilar and Cai (2010), or wood produced in a specific region. Armington elasticities are not introduced in this thesis' SEMs because of a lack of appropriate estimates for (industrial round-) wood at global level. It can be expected that they would increase the existing trade barriers, and impede the uptake of certification even more.

3.2. Cooperative initiatives

As indicated, cooperative initiatives are an interesting tool to promote the uptake of eco-certification and legality assurance in the South. However, research on this type of forest management initiatives is limited, and predominantly focuses on Asian case studies (Fujiwara et al. 2015, Ota and Kamakura 2016, He et al. 2015). Further research could investigate this potential pathway towards lower compliance costs. One particularly interesting cooperative initiative aims for the simplification of the criteria and indicators through self-monitoring at community level. This would allow less costly monitoring and auditing systems and could substantially reduce compliance costs Meijaard et al. (2014). According to Fry (2011), 'locally based monitoring has the potential to shape the future of conservation management. Depending on the monitoring requirements and the social/geographical dynamic of the site, local involvement can be included to varying degrees and appropriate techniques can be employed. This all relies on careful and participatory planning before any monitoring activity begins'. However, Fry (2011) described the possibility of self-monitoring in the context of REDD+. Albeit interesting, further research on self-monitoring is required since this would still require external auditing to check compliance, as this is also required within the context of REDD+.

3.3. Historical data

Chapter 4 uses EUROSTAT (2017) data on bilateral trade flows between the EU, on the one hand, and Cameroon and its neighboring countries on the other hand. This analysis could be improved by making use of databases which do not solely provide bilateral trade flows between the EU and its trade partners. Making use of more comprehensive databases such as GTAP would allow the analysis of Cameroon's exports to other countries as well as the EU. This could quantify the magnitude and destination of the redirected trade flows. Export knowledge indicates that intra-African trade, and exports to Asia are becoming increasingly important (Global Timber Platform 2017), but this has not been checked thoroughly in this thesis. However, the observation that Cameroon's wood production did not decrease (FAO 2016b) in combination with the negative impact of the VPA on the Cameroon-EU wood trade flow provides sufficient evidence for the redirection of Cameroonian exports.

4. Concluding remarks

This thesis does not intend to provide arguments against eco-certification, nor against GPP for eco-certified wood or legality assurance systems. Instead, this thesis provides arguments in favor of more guidance towards sustainable forest management and wood production. The models presented cannot be used for exact forecasting of a policy's impact. However, they reveal mechanisms which, at present, prevent the uptake of sustainable wood production and forest management in specific regions, or which can reduce the incentive for sustainable wood production and forest management.

According to my personal opinion, an improved form of eco-certification and supportive policies should remain important instruments towards better forest management because of its specific properties. First of all, its non-governmental nature turns eco-certification into an interesting instrument in regions which lack strong governments. Second, its transnational approach, and the required involvement on the demand side of the market can turn eco-certification into a collective effort towards sustainable forest management. The latter is necessary because of the strong international linkages between regional wood markets, and the internationalization of the wood value chain.

According to this thesis' results, GPP appears to entail less negative consequences compared to FLEGT. While governments can exert their preferences as wood consumers through GPP, FLEGT is much more restrictive in nature. FLEGT sets stringent conditions for trade which entail high costs, without providing remuneration for those costs. This excludes an important number of producers from one of the world's most important wood markets.

Appendices

Appendix A: Determination of mean regional WTP and scale factor

To our knowledge, no comparative research on the WTP for certified wood exists at global level. However, Cai and Aguilar (2013) conducted a meta-analysis of the regional WTP assessments to gain a global picture of WTP. They found a global mean WTP for certified wood products of 12.2 % with a standard deviation of 8 %.

Each region's WTP distribution is determined based on the findings of Cai and Aguilar (2013). This is done by linking the WTP to the regional GDP per capita by making use of the double logistic regression model by Jacobsen and Hanley (2009). One of their models uses the GDP per capita as the sole explanatory variable for the WTP for ecosystem services. Their model estimates a coefficient of 0.38 for the GDP per capita. This coefficient describes the percentage change in the WTP following a one percentage change in the GDP per capita.

Hence, the percentage deviation for each region's WTP from the global mean WTP of 12.2 % is determined from the regional percentage deviation of the GPD per capita to the global mean GDP per capita:

$$WTP_i = 0.122 * (1 + 0.38 * \Delta\%GDP_i)$$

The results of these calculations are presented in Table A1.

Table A1: Calculation of the regional WTP and scale parameter estimates based on the regional GDP per capita.

Region	Annual GDP per capita (1000 USD)	Percentage deviation to global GDP per capita	WTP estimate (%)	Scale parameter (%)
Africa	1.56	-77.44	8.61	3.11
Latin America	9.25	33.85	13.77	4.98
Asia	2.78	-59.78	9.43	3.41
Europe	21.75	214.54	22.15	8.01
North America	26.76	287.07	25.51	9.22
World	6.91	-	12.20	-

SOURCE.-Cai and Aguilar (2013): Meta-analysis of consumer's willingness-to-pay premiums for certified wood products, and own calculation.
NOTE.-Asia encompasses Oceania and Europe encompasses Russia. If the percentage deviation to global GDP per capita is named *u*, the WTP estimate per region is found by 0.122*(1+0.38*u). If the percentage deviation to global GDP per capita is named μWTP_i, the scale parameter is found by 0.08/0.122* $\mu WTP*\sqrt{3}/\pi$.

Subsequently, it is necessary to determine the scale factor for the WTP logistic distribution. Cai and Aguilar (2013) found a standard deviation of 8 %. Transforming a normal distribution into a logistic

distribution requires the modification of the standard deviation into the logistic distribution's scale factor. In practice, this requires the multiplication of the standard deviation with factor $\sqrt{3}/\pi$. Hence, the scale factor for the global WTP's logistic distribution becomes 4.41 %. In order to determine the regional scale factors, this chapter continues to apply the $8\%/12.2\%$ fraction for the regional WTP estimate. The results are presented in Table A1.

Appendix B: Determination of mean regional WTA and scale factor

The price premium received at producer level varies depending on the type of forest product and country of production. Previous research estimates price premiums ranging from 1 % to 30 % on top of the conventional wood price (Yamamoto et al. 2014). FSC (2012) reported price premiums ranging between 15 and 25 %. This research follows the most optimistic estimate and assumes a price premium of 25%.

The data by UNECE/FAO (2014) demonstrates that the certified forest area per region varies considerably (Table B1). Only a marginal fraction of the forest in the Southern hemisphere is certified. In contrast, certification is more common in the Northern hemisphere. The regional differences are explained by the regional differences in WTA. The WTA expresses the price premiums producers require in order to produce certified wood. The higher the costs associated with certification, the higher the WTA.

Table B1: Calculation of the regional WTA and scale parameter estimates based upon the certified forest area

	Africa	**Latin America**	**Asia**	**Europe**	**North America**	**World**
Certified forest area (%)	1.0	1.8	2.2	65.2	35.4	10.9
WTA estimate (%)	44.64	41.80	41.08	21.88	27.96	25.0
Scale variable	9.86	9.44	9.28	4.94	6.32	8.00

SOURCE.-UNECE/FAO (2015): Forest Products Annual Market Review 2014 – 2015, and own calculation
NOTE.-Asia encompasses Oceania and Europe encompasses Russia. If the regional WTA estimate is named μWTA_s, the scale variable is found by (0.08/0.122)* μWTA_s*$\sqrt{3}/\pi$.

It is assumed that for each region, the WTA is symmetrically distributed around an unknown mean. With a known received $Pprem_{s,i}$ of 25 %, and known share of certified forests $Share_{s,i}$ it is then possible to determine the mean WTA per region ($\mu WTA_{s,i}$):

$$Share_{s,i} * \sigma WTA_{s,i} + 0.25 = \mu WTA_{s,i}$$

The standard deviation from the demand side of the market is also applied to the supply side of the market. However, the WTA distribution is transformed into a logistic distribution by computing new

scale variables. This is done by multiplying with $\sqrt{3}/\pi$ and simultaneously safeguarding the proportion $8\%/12.2\%$.

Appendix C: Mathematical construction of the objective function

A. Baseline scenario

The objective function in the modified SEM respects the logic of the standard SEM's objective function, as first developed by Takayama and Judge (1971). The standard SEM's objective function maximizes global quasi-welfare through the simultaneous solution of all regions' equilibria under the assumption of bilateral trade costs. This first requires the calculation of each region's quasi-welfare by integrating the regional demand (equation 2-3) and supply functions (equation 2-4) over the region's equilibrium price and quantity. Those integrals respectively represent the regional consumer and producer surplus. Equation 2-3 can be rewritten and subsequently integrated:

$$CS_i^{con} = \int_0^{Q_{d,i}^*} \left(\frac{Q_{d,i}^* * \mathrm{P}_{\mathrm{d,i}}^0}{\mathrm{Q}_{\mathrm{d,i}}^0 * \mathrm{e}_{\mathrm{d,i}}} - \frac{\mathrm{P}_{\mathrm{d,i}}^0}{\mathrm{e}_{\mathrm{d,i}}} + \mathrm{P}_{\mathrm{d,i}}^0 - \mathrm{P}_{\mathrm{d,i}}^*\right) \mathrm{d}Q_{d,i}^* = \mathrm{Q}_{\mathrm{d,i}}^* * \left(\mathrm{P}_{\mathrm{d,i}}^0 * \left(1 - \frac{1}{\mathrm{e}_{\mathrm{d,i}}}\right) - \mathrm{P}_{\mathrm{d,i}}^*\right) + \frac{{Q_{d,i}^*}^2 * \mathrm{P}_{\mathrm{d,i}}^0}{2 * \mathrm{e}_{\mathrm{d,i}} * \mathrm{Q}_{\mathrm{d,i}}^0}$$

Accordingly, equation 2-4 is rewritten and integrated:

$$PS_i^{con} = \int_0^{Q_{s,i}^*} \left(\frac{Q_{s,i}^* * \mathrm{P}_{s,\mathrm{i}}^0}{\mathrm{Q}_{s,\mathrm{i}}^0 * \mathrm{e}_{s,\mathrm{i}}} - \frac{\mathrm{P}_{s,\mathrm{i}}^0}{\mathrm{e}_{s,\mathrm{i}}} + \mathrm{P}_{\mathrm{s,i}}^0 - \mathrm{P}_{s,\mathrm{i}}^*\right) \mathrm{d}Q_{s,i}^* = \mathrm{Q}_{s,\mathrm{i}}^* * \left(\mathrm{P}_{s,\mathrm{i}}^0 * \left(1 - \frac{1}{\mathrm{e}_{\mathrm{s,i}}}\right) - \mathrm{P}_{s,\mathrm{i}}^*\right) + \frac{{Q_{s,i}^*}^2 * \mathrm{P}_{s,\mathrm{i}}^0}{2 * \mathrm{e}_{s,\mathrm{i}} * \mathrm{Q}_{\mathrm{s,i}}^0}$$

The standard SEM's objective function takes the difference of those two integrals to determine each region's quasi-welfare.

In addition, the modified SEM's objective function introduces the integrals of the logistic distribution function of the certified share of consumption and production in order to capture the welfare related to the price premium. In the baseline scenario, the consumer surplus represents what the current consumers of certified wood are willing to pay on top of the equilibrium price premium. This is the integral of the cumulative distribution function at the right hand side of the price premium. This integral is found by taking the difference of the integral over a maximum value for the price premium of 1 and the integral over the equilibrium price premium (as calculated above). The price premium's maximum value of 1 is not attained in the SEM. The additional consumer surplus relating to the purchases of certified wood is then:

$$CS_i^{cer} = \int_0^1 Share_{d,i}^{cer}\, dPprem_{d,i} - \int_0^{Pprem_{d,i}} Share_{d,i}^{cer}\, dPprem_{d,i}$$

Calculation of the integrals leads to:

$$CS_i^{cer} = 1 - G_i - (1 - G_i) * \sigma_{WTP,i} * \ln\left(e^{\mu_{WTP,i}/\sigma_{WTP,i}} + e^{1/\sigma_{WTP,i}}\right) - (1 - G_i) * Pprem_{d,i} + (1 - G_i) * \sigma_{WTP,i} * \ln\left(e^{\mu_{WTP,i}/\sigma_{WTP,i}} + e^{Pprem_{d,i}/\sigma_{WTP,i}}\right)$$

For the actual quasi-welfare calculation, CS_i^{cer} is multiplied with the equilibrium conventional wood price of demand and the equilibrium consumed quantity.

Simultaneously, the additional producer surplus relating to the production of certified wood is the integral of the logistic distribution function of the WTA (equation 2-16):

$$PS_i^{cer} = \int_0^{Pprem_{s,i}} \text{Share}_{\text{d,i}}^{\text{cer}} \; d\text{Share}_{\text{d,i}}^{\text{cer}}$$

This equals:

$$PS_{cer,i} = \sigma_{WTA,i} * \ln\left(e^{\mu_{WTA,i}/\sigma_{WTA,i}} + e^{Pprem_{s,i}/\sigma_{WTA,i}}\right) - \mu_{WTA,i}$$

Also $PS_{cer,i}$ is multiplied with $P_{s,i}^*$ and $Q_{s,i}^*$ to find the additional producer surplus.

Finally, the modified SEM's objective function takes all transport costs into account for each bilateral trade flow between the 5 regions. For conventional wood, the per unit bilateral transport costs $TC_{i,j}$ consist of a fixed per unit cost $bilTC_{i,j}$ and an ad valorem transport costs $AV_{i,j}$:

$$TC_{i,j} = bil\,TC_{i,j} + P_{s,i} * AV_{i,j}$$

The price condition for bilateral certified wood trade takes the price premium into account:

$$TC_{i,j}^{cer} = bil\,TC_{i,j} + P_{s,i} * \left(1 + Pprem_{s,i}\right) * AV_{i,j}$$

The combination of the standard SEM's objective function and the additional elements added due to the modifications then results in the following objective function:

$$Max\ GW = \sum_i CS_i^{con} + \sum_i (P_{d,i}^* * Q_{d,i}^* * CS_i^{cer}) + \sum_i PS_i^{con} + \sum_i (P_{s,i}^* * Q_{s,i}^* * PS_i^{cer}) - \sum_i \sum_j (TQ_{i,j}^{con} * TC_{i,j} + TQ_{i,j}^{cer} * TC_{i,j}^{cer}) \quad \text{(A1)}$$

This objective function maximizes the global quasi-welfare GW.

B. GPP scenario

Due to GPP for wood in Europe, the maximum certified share of wood consumption becomes 100% (instead of 100% - G_{EU}). This requires the substitution of the additional welfare calculation related to the purchases of certified in equation A1 (for Europe only) by:

$$CS_{EU}^{cer} = 1 - (1 - G_{EU}) * \sigma_{WTP,EU} * \ln\left(e^{\mu_{WTP,EU}/\sigma_{WTP,EU}} + e^{1/\sigma_{WTP,EU}}\right) - Pprem_{d,EU} + (1 - G_{EU}) * \sigma_{WTP,EU} * \ln\left(e^{\mu_{WTP,EU}/\sigma_{WTP,EU}} + e^{Pprem_{d,EU}/\sigma_{WTP,EU}}\right)$$

Appendix D: OLS regression on intention to buy eco-certified wood

The following output is the result of an OLS regression analysis conducted in R. The abbreviations and measurement scale per variable are:

- ITB = Intention To Buy eco-certified wood (5-point scale, minimum of 1, maximum of 5)
- PCE = Perceived Consumer Effectiveness (5-point scale, minimum of 1, maximum of 5)
- NEP = Environmental concern (calculated as the score on the New Environmental Paradigm, 5-point scale, minimum of 1, maximum of 5)
- SubNorm = Subjective Norm (5-point scale, minimum of 1, maximum of 5)
- ATE = Attitude towards eco-certified purchases (5-point scale, minimum of 1, maximum of 5)

```
Formula: ITB = PCE + NEP + SubNorm + ATE


Residuals:
Min            1Q            Median          3Q            Max
-3.8897        -0.3427       0.1028          0.4327        1.3783

Coefficients:
               Estimate      Std. Error      t value       Pr(>|t|)
(Intercept)    -0.990158     0.555427        -1.783        0.0758 .
PCE            -0.006394     0.051126        -0.125        0.9006
NEP            0.461985      0.109821        4.207         3.54e-05 ***
SubNorm        0.402033      0.082353        4.882         1.81e-06 ***
ATE            0.396371      0.081560        4.860         2.01e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6706 on 267 degrees of freedom
Multiple R-squared:  0.2952,   Adjusted R-squared:  0.2847
F-statistic: 27.96 on 4 and 267 DF,  p-value: < 2.2e-16
```

The following output is the result of an OLS regression analysis conducted in R, explaining the Intention to Buy eco-certified wood and including socio-demographic variables as explanatory variables. The abbreviations and measurement scale per variable are:

- ITB = Intention To Buy eco-certified wood (5-point scale, minimum of 1, maximum of 5)
- PCE = Perceived Consumer Effectiveness (5-point scale, minimum of 1, maximum of 5)
- NEP = Environmental concern (calculated as the score on the New Environmental Paradigm, 5-point scale, minimum of 1, maximum of 5)
- SubNorm = Subjective Norm (5-point scale, minimum of 1, maximum of 5)
- ATE = Attitude towards eco-certified purchases (5-point scale, minimum of 1, maximum of 5)
- Conf = Confidence in eco-certification

- Fin = Self-assessed financial status
- Rur = living in rural area (0 = living in urban area): self-assessed
- Pur = Purchasing responsibility
- AGE = Age
- GENDER = Gender

```
Formula: ITB ~ PCE + NEP + SubNorm +
    ATE + Conf + Fin + Rur +
    Pur + AGE + GENDER)
Residuals:
Min             1Q             Median          3Q             Max
-3.8173         -0.3474        0.0512          0.4357         1.3461
Coefficients:
                    Estimate   Std. Error  t value            Pr(>|t|)
(Intercept)         -2.047109   1.017235    -2.012            0.0452 *
PCE                 -0.004656   0.051675    -0.090            0.9283
NEP                 0.496632    0.111297    4.462             1.21e-05 ***
SubNorm             0.386778    0.085303    4.534             8.82e-06 ***
ATE                 0.408027    0.083436    4.890             1.76e-06 ***
Conf                0.038048    0.069657    0.546             0.5854
Fin                 0.054062    0.054412    0.994             0.3214
Rur                 0.043274    0.087835    0.493             0.6227
Pur                 0.025972    0.054824    0.474             0.6361
AGE                 0.023265    0.041625    0.559             0.5767
GENDER              0.138305    0.083982    1.647             0.1008
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6717 on 261 degrees of freedom
Multiple R-squared:  0.3087,   Adjusted R-squared:  0.2823
F-statistic: 11.66 on 10 and 261 DF,  p-value: < 2.2e-16
```

The findings for the OLS regression above are cross-checked by making use of ordinal logistic regression, which is more appropriate for the analysis of an ordinal dependent variable. The findings are fully in line with the earlier findings:

```
Formula: ITB ~ PCE + NEP + SubNorm + ATE + GENDER + Fin + Pur + AGE + Rur +
Conf,
data = data, Hess = TRUE)

Coefficients:
                  Value     Std. Error         t value
PCE            -0.06187     0.1607             -0.3850
NEP             1.61302     0.3535             4.5632
SubNorm         1.20716     0.2794             4.3208
ATE             1.71597     0.2905             5.9068
GENDER          0.46934     0.2595             1.8084
Fin             0.10592     0.1656             0.6395
Pur            -0.09799     0.1791             -0.5473
AGE             0.04768     0.1221             0.3903
Rur             0.08219     0.2707             0.3036
Conf            0.12277     0.2197             0.5587
```

```
Intercepts:
    Value    Std. Error   t value
0|1 12.2221  3.2570       3.7525
1|2 12.9453  3.2219       4.0179
2|3 14.5674  3.2065       4.5431
3|4 17.6668  3.2655       5.4101
4|5 21.6194  3.3736       6.4085

Residual Deviance: 489.2653
AIC: 519.2653

Related confidence intervals:
                    2.5 %    97.5 %
PCE           -0.37810108 0.2528724
NEP            0.92872020 2.3165970
SubNorm        0.66703470 1.7643289
ATE            1.15746618 2.2983766
GENDER        -0.03758715 0.9812929
Fin           -0.21855759 0.4316401
Pur           -0.46717581 0.2418715
AGE           -0.19095898 0.2956132
Rur           -0.44863212 0.6143437
Conf          -0.30700675 0.5558121

Coefficients (Odds)
PCE         NEP        SubNorm         ATE          GENDER        Fin
0.9400044   5.0179222  3.3439606       5.5620855    1.5989395     1.1117298
Pur              AGE           Rur           Conf
0.9066569        1.0488305     1.0856645     1.1306235
```

Appendix E: OLS regression on the support for GPP

The following output is the result of an OLS regression analysis conducted in R. The abbreviations and measurement scale per variable are:

- GOV = Support for GPP (5-point scale, minimum of 1, maximum of 5)
- PCE = Perceived Consumer Effectiveness (5-point scale, minimum of 1, maximum of 5)
- NEP = Environmental concern (calculated as the score on the New Environmental Paradigm, 5-point scale, minimum of 1, maximum of 5)
- SubNorm = Subjective Norm (5-point scale, minimum of 1, maximum of 5)
- ATE = Attitude towards eco-certified purchases (5-point scale, minimum of 1, maximum of 5)

```
Formula: GOV = NEP + SubNorm + ATE + PCE
Residuals:
Min            1Q            Median          3Q            Max
-1.98261       -0.43190      0.06332         0.44272       1.97675

Coefficients:
               Estimate      Std. Error      t value       Pr(>|t|)
(Intercept)    0.79496       0.61407         1.295         0.196585
NEP            0.47929       0.12142         3.948         0.000101 ***
ATE            0.29902       0.09017         3.316         0.001039 **
SubNorm        0.07654       0.09105         0.841         0.401307
PCE            -0.08046      0.05652         -1.423        0.155759
---
```

```
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.7414 on 267 degrees of freedom
Multiple R-squared:  0.1547,   Adjusted R-squared:  0.142
F-statistic: 12.21 on 4 and 267 DF,  p-value: 3.915e-09
```

Appendix F: MANOVA on the intention to buy and support for GPP

The following analysis applies MANOVA since the correlation between the consumers' intention to buy certified wood, the support for GPP, and the loss of support when GPP entails negative consequences for private consumption are not sufficiently correlated to apply ANOVA. The analysis considers three dependent variables: consumers' intention to buy certified wood (ITB), the support for GPP (SUPGPP), and the loss of support when GPP entails negative consequences for private consumption (LOSS). In addition, it considers four independent variables: environmental concern (NEP), perceived consumer effectiveness (PCE), subjective norm (SUB), and attitude towards certified purchases (ATE).

The analysis demonstrates that PCE does not significantly impact the intention to buy certified wood, nor does it affect the support for GPP. The extent to which consumers lose support for GPP is only influenced by their environmental concern.

```
            Df  Pillai    approx       F num  Df den Df    Pr(>F)
NEP         1   0.195983  21.5317      3      265          1.641e-12 ***
SUB         1   0.152120  15.8481      3      265          1.656e-09 ***
ATE         1   0.111253  11.0576      3      265          7.303e-07 ***
PCE         1   0.008517   0.7588      3      265          0.5181
Residuals   267
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
 Response 1 : ITB
               Df   Sum Sq Mean  Sq          F value    Pr(>F)
NEP            1    16.269       16.2685     29.5943    1.204e-07 ***
SUB            1    2.751        2.7508      5.0039     0.0261153 *
ATE            1    6.724        6.7245      12.2326    0.0005499 ***
PCE            1    1.114        1.1139      2.0263     0.1557592
Residuals      267  146.775      0.5497
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

 Response 2 : LOSS
              Df   Sum Sq Mean   Sq         F value     Pr(>F)
NEP           1    11.330       11.3297    14.9251     0.0001405 ***
SUB           1    0.604        0.6044     0.7962      0.3730224
ATE           1    0.435        0.4355     0.5737      0.4494644
PCE           1    0.818        0.8181     1.0777      0.3001529
Residuals     267  202.680      0.7591
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

 Response 3 : SUPGPP
              Df   Sum Sq Mean   Sq        F value    Pr(>F)
NEP           1    18.863       18.8632   41.9423    4.496e-10 ***
SUB           1    20.609       20.6086   45.8232    8.190e-11 ***
```

```
ATE           1    10.819        10.8191   24.0563    1.628e-06 ***
PCE           1    0.007         0.0070    0.0156     0.9006
Residuals     267  120.081       0.4497
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Appendix G: Augmented Dickey Fuller test results for stationarity and correlation tests on the components of Cameroon’s and the counterfactual’s exports

Augmented Dickey Fuller tests

CAMEROON

Cameroon’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -4.0507, Lag order = 5, p-value = 0.01
alternative hypothesis: stationary
warning message:  p-value smaller than printed p-value
```

Random component Cameroon’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -8.5758, Lag order = 5, p-value = 0.01
alternative hypothesis: stationary
Warning message:  p-value smaller than printed p-value
```

General trend Cameroon’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -3.9284, Lag order = 5, p-value = 0.0142
alternative hypothesis: stationary
```

Seasonal component Cameroon’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -6.8137, Lag order = 5, p-value = 0.01
alternative hypothesis: stationary
Warning message:  p-value smaller than printed p-value
```

COUNTERFACTUAL

Counterfactual’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -7.2301, Lag order = 5, p-value = 0.01
alternative hypothesis: stationary
Warning message:  p-value smaller than printed p-value
```

Random component Counterfactual’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -8.8032, Lag order = 5, p-value = 0.01
alternative hypothesis: stationary
Warning message:  p-value smaller than printed p-value
```

General trend Counterfactual’s exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -3.2743, Lag order = 5, p-value = 0.07753
alternative hypothesis: stationary
```

Seasonal component Counterfactual's exports

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -12.657, Lag order = 5, p-value = 0.01
alternative hypothesis: stationary
Warning message:  p-value smaller than printed p-value
```

T-test to check whether the mean of the random terms of both decomposed time series equal each other

```
Welch Two Sample t-test
t = -0.20244, df = 246.73, p-value = 0.8397
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -3.296430  2.681952
sample estimates:
 mean of x  mean of y
-0.2012231  0.1060161
```

F test to compare two variances (of the random terms of both decomposed Time series equal each other):

```
F = 4.2347, num df = 179, denom df = 179, p-value < 2.2e-16
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
 3.156259 5.681618

sample estimates:
ratio of variances
          4.234697
```

Further exploration of seasonal component of both time series

Table G1: Seasonal component of Cameroon's and the counterfactual's exports

	Cameroon	Counterfactual
January	-0.673	4.451
February	-8.691	-5.407
March	-0.030	9.146
April	4.048	16.078
May	5.165	14.825
June	3.308	18.972
July	4.818	3.783
August	-8.838	-17.857
September	11.420	-2.484
October	7.158	-1.225
November	-4.384	-18.440
December	-13.301	-21.843

Correlation test and simple OLS between seasonal components of both time series demonstrates significant positive correlation (tsseason = seasonal component counterfactual's exports, tsseasonc = seasonal component Cameroon's exports):

```
Correlation: (tsseason,tsseasonc)
[1] 0.6659934

OLS: summary(lm(tsseason~tsseasonc))

Call:
lm(formula = tsseason ~ tsseasonc)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-16.704  -7.674   1.537   8.592  14.853

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 9.976e-18  7.208e-01    0.00        1
tsseasonc   1.245e+00  1.012e-01   12.31   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 9.988 on 190 degrees of freedom
Multiple R-squared:  0.4435,   Adjusted R-squared:  0.4406
F-statistic: 151.4 on 1 and 190 DF,  p-value: < 2.2e-16
```

Appendix H: Output VARX model

Exogenous variable = VPA negotiation	Exogenous variable = VPA agreed but not into force	Exogenous variable = VPA into force
constant term: est: 4.8906 26.0027 se: 3.437 5.4308 AR(1) matrix [,1] [,2] [1,] 0.322 0.111 [2,] -0.219 0.460 standard errors [,1] [,2] [1,] 0.076 0.048 [2,] 0.131 0.076 AR(2) matrix [,1] [,2] [1,] 0.265 -0.072 [2,] 0.215 0.000 standard errors [,1] [,2] [1,] 0.082 0.048 [2,] 0.123 1.000 AR(3) matrix [,1] [,2] [1,] 0.290 0 [2,] 0.295 0 standard errors [,1] [,2] [1,] 0.066 1 [2,] 0.113 1 Coefficients of exogenous lag- 0 coefficient matrix [1] -3.621 [2] 0.000 standard errors [1] 2.642 [2] 1 Residual Covariance Matrix tsiicam tsiireg tsiicam 167.2331 143.9404 tsiireg 143.9404 503.9470 ========== Information criteria: AIC: 11.18669 BIC: 11.39251	constant term: est: 0 28.7416 se: 1 5.6821 AR(1) matrix [,1] [,2] [1,] 0.320 0.128 [2,] -0.211 0.446 standard errors [,1] [,2] [1,] 0.076 0.045 [2,] 0.131 0.076 AR(2) matrix [,1] [,2] [1,] 0.267 -0.055 [2,] 0.211 0.000 standard errors [,1] [,2] [1,] 0.082 0.046 [2,] 0.122 1.000 AR(3) matrix [,1] [,2] [1,] 0.305 0 [2,] 0.281 0 standard errors [,1] [,2] [1,] 0.065 1 [2,] 0.112 1 Coefficients of exogenous lag- 0 coefficient matrix [1] 0 [2] -8.554 standard errors [1] 1 [2] 5.551 Residual Covariance Matrix tsiicam tsiireg tsiicam 170.0078 143.7355 tsiireg 143.7355 497.6940 ========== Information criteria: AIC: 11.18229 BIC: 11.37096	constant term: est: 7.6875 26.0027 se: 4.2062 5.4308 AR(1) matrix [,1] [,2] [1,] 0.317 0.108 [2,] -0.219 0.460 standard errors [,1] [,2] [1,] 0.077 0.048 [2,] 0.131 0.076 AR(2) matrix [,1] [,2] [1,] 0.257 -0.073 [2,] 0.215 0.000 standard errors [,1] [,2] [1,] 0.082 0.048 [2,] 0.123 1.000 AR(3) matrix [,1] [,2] [1,] 0.274 0 [2,] 0.295 0 standard errors [,1] [,2] [1,] 0.067 1 [2,] 0.113 1 Coefficients of exogenous lag- 0 coefficient matrix [1] -4.175 [0] 0 standard errors [1] 2.718 [2] 1 Residual Covariance Matrix tsiicam tsiireg tsiicam 166.8128 142.8839 tsiireg 142.8839 503.9470 ========== Information criteria: AIC: 11.18812 BIC: 11.39395

Analysis of stationarity of error terms of VARX model

```
Augmented Dickey-Fuller Test
Dickey-Fuller = -7.2064, Lag order = 5, p-value = 0.01
  alternative hypothesis: stationary
```

Appendix I: Main equations of the modified SEM

The demand and supply function are retrieved from Chapter 2. The demand function calculates the equilibrium consumption $Q^*_{d,i}$ and equilibrium conventional wood price $P^*_{d,i}$ from the baseline demand quantity $Q^0_{d,i}$ and the baseline demand price $P^0_{d,i}$ as a function of the response to a price change ($\Delta P_{d,i} = P^*_{d,i} - P^0_{d,i}$). The extent to which the demand quantity responds to price changes is determined by each region's price elasticity for demand $e_{d,i}$:

$$Q^*_{d,i} = Q^0_{d,i}\left(1 + e_{d,i}\frac{\Delta P_{d,i}}{P^0_{d,i}}\right)$$

Simultaneously, the supply function is constructed:

$$Q^*_{s,i} = Q^0_{s,i}\left(1 + e_{s,i}\frac{\Delta P_{s,i}}{P^0_{s,i}}\right)$$

The baseline value of each region's $e_{d,i}$, $e_{s,i}$, $Q^0_{d,i}$, $Q^0_{s,i}$, $P^0_{d,i}$, and $P^0_{s,i}$ is based on Buongiorno and Shushuai (2014)[65].

Integration of both the demand and supply function over the equilibrium quantities leads to the consumer surplus CS_i and producer surplus PS_i related to a region's total wood production and consumption (no distinction between certified and conventional wood is made):

$$CS_i = \int_0^{Q^*_{d,i}} \left(\frac{Q^*_{d,i} * \mathrm{P^0_{d,i}}}{\mathrm{Q^0_{d,i}} * \mathrm{e_{d,i}}} - \frac{\mathrm{P^0_{d,i}}}{\mathrm{e_{d,i}}} + \mathrm{P^0_{d,i}} - \mathrm{P^*_{d,i}}\right)\mathrm{d}Q^*_{d,i} = \mathrm{Q^*_{d,i}}\left(\mathrm{P^0_{d,i}}\left(1 - \frac{1}{\mathrm{e_{d,i}}}\right) - \mathrm{P^*_{d,i}}\right) + \frac{{Q^*_{d,i}}^2 * \mathrm{P^0_{d,i}}}{2 * \mathrm{e_{d,i}} * \mathrm{Q^0_{d,i}}}$$

[65] Buongiorno et al. (2014) developed the Global Forests Product Model (GFPM). This is a dynamic economic model which determines production, consumption, trade, and prices for the most important forest products in world markets. This chapter only considers industrial roundwood and will abstract the necessary data for this wood product. This still allows the analysis of GPP, since Input-Output parameters in the GFPM ensure that an increased share of certified end products requires an increasing share of certified raw material (e.g. industrial roundwood). In reality, the certifications' Chain of Custody policies also stipulate that certified material must be tracked throughout the entire value chain.
The data by Buongiorno et al. (2014) provides information at country level. This chapter calculates regional weighted means (based on volume) from their data. This is necessary, since country level information does not exist for all other parameters (e.g. the WTP and WTA).
The GFPM cannot be used to analyse our research question, because it does not differentiate between certified and conventional wood. Nor has it ever been developed to distinguish public from private procurement.

[65] This finding is in line with the standard theory that price elasticity is positively related to the importance of a product in the overall consumer budget (GORDON, B. R., GOLDFARB, A. and LI, Y. (2013). 'Does price elasticity vary with economic growth? A cross-category analysis', *Journal of Marketing Research*, Vol. **50**, pp. 4-23.).

$$PS_i = \int_0^{Q^*_{s,i}} \left(\frac{Q^*_{s,i} * \mathrm{P}^0_{s,\mathrm{i}}}{\mathrm{Q}^0_{s,\mathrm{i}} * \mathrm{e}_{s,\mathrm{i}}} - \frac{\mathrm{P}^0_{s,\mathrm{i}}}{\mathrm{e}_{s,\mathrm{i}}} + \mathrm{P}^0_{s,\mathrm{i}} - \mathrm{P}^*_{s,\mathrm{i}}\right) \mathrm{d}Q^*_{s,i} = \mathrm{Q}^*_{s,\mathrm{i}}\left(\mathrm{P}^0_{s,\mathrm{i}}\left(1 - \frac{1}{\mathrm{e}_{\mathrm{s,i}}}\right) - \mathrm{P}^*_{s,\mathrm{i}}\right) + \frac{{Q^*_{s,i}}^2 * \mathrm{P}^0_{s,\mathrm{i}}}{2 * \mathrm{e}_{s,\mathrm{i}} * \mathrm{Q}^0_{\mathrm{s,i}}}$$

Equation 5-5 and Equation 5-6 describe how additional consumer surplus CS_i^{cer} and producer surplus PS_i^{cer} is calculated due to the introduction of the price premium. Calculating these integrals results in:

$$CS_i^{cer} = \int_0^1 Share_{d,i}^{cer}\, dPprem_{d,i} - \int_0^{Pprem_{d,i}} Share_{d,i}^{cer}\, dPprem_{d,i}$$

$$= 1 - \sigma_{WTP,i} * \ln\left(e^{\mu_{WTP,i}/\sigma_{WTP,i}} + e^{1/\sigma_{WTP,i}}\right) - Pprem_{d,i} + \sigma_{WTP,i} * \ln\left(e^{\mu_{WTP,i}/\sigma_{WTP,i}} + e^{Pprem_{d,i}/\sigma_{WTP,i}}\right)$$

And:

$$PS_i^{cer} = \int_0^{Pprem_{d,i}} Share_{d,i}^{cer}\, dPprem_{d,i}$$

$$= \sigma_{WTA,i} * \ln\left(e^{\mu_{WTA,i}/\sigma_{WTA,i}} + e^{Pprem_{s,i}/\sigma_{WTA,i}}\right) - \mu_{WTA,i}$$

Both the CS_i^{cer} and PS_i^{cer} still need to be multiplied by the equilibrium price and quantity in order to quantify these surpluses at the same scale as the CS_i and PS_i.

The modified SEM's objective function also takes the transport costs for each bilateral trade flow between the regions into account. Bilateral transport costs are the per unit transport costs between the two regions ($TC_{i,j}$) multiplied with the traded quantities of certified and conventional wood (respectively $TQ_{i,j}^{cer}$ and $TQ_{i,j}^{con}$):

$$\sum_i \sum_j (TQ_{i,j}^{cer} + TQ_{i,j}^{con}) * TC_{i,j}$$

The combination of the standard SEM's objective function and the additional elements added due to the modifications then results in the following objective function which maximizes the global quasi-welfare GW:

$$Max\ GW = \sum_i CS_i + \sum_i (P^*_{d,i} * Q^*_{d,i} * CS_i^{cer}) + \sum_i PS_i + \sum_i (P^*_{s,i} * Q^*_{s,i} * PS_i^{cer}) - \sum_i \sum_j ((TQ_{i,j}^{cer} + TQ_{i,j}^{con}) * TC_{i,j})$$

Whether a region *i* transports wood towards region *j* depends on the trade balances. These trade balances stipulate that trade can only occur if the importing region's demand price at least compensates the exporting region's supply price and the bilateral trade costs. For conventional wood this results in the following trade balance:

$$P^*_{s,i} + TC_{i,j} \leq P^*_{d,j} \rightarrow TQ^{con}_{i,j} > 0$$

No trade occurs ($TQ^{con}_{i,j} = 0$) in the alternative scenario. The trade balance for certified wood takes the price premium into account:

$$P^*_{s,i} + Pprem_{s,i} + TC_{i,j} \leq P^*_{d,j} + Pprem_{d,j} \rightarrow TQ^{con}_{i,j} > 0$$

The unit costs of shipping wood between two regions comprise two parts. This data is retrieved from Buongiorno and Shushuai (2014) as applied in Chapter 2. The first component is a fixed cost of shipping one unit from one region to another (USD 20.2). The second component is a region-dependent ad valorem percentage. This ad valorem percentage varies from 7.197% for Africa to 0% for Europe and North America.

A region cannot export more than it produces. This leads to the following constraints on the export of respectively conventional and certified wood:

$$(1 - Share^{cer}_{s,i}) * Q^*_{s,i} \leq \sum_j TQ^{con}_{i,j}$$

$$Share^{cer}_{s,i} * Q^*_{s,i} \leq \sum_j TQ^{cer}_{i,j}$$

These equations also include the production for the domestic market ($TQ_{i,i}$). A region cannot simultaneously import more than it consumes:

$$Share^{cer}_{d,i} * Q^*_{d,i} \leq \sum_j TQ^{cer}_{r,j}$$

$$Share^{cer}_{s,i} * Q^*_{s,i} \leq \sum_j TQ^{cer}_{i,j}$$

Finally, a non-negativity constraint is set for the following variables: $P^*_{d,i}$ $P^*_{s,i}$, $Q^*_{d,i}$, $Q^*_{s,i}$, and $TQ^*_{i,j}$. The SEM also assumes that the price premiums $Pprem_{d,i}$ and $Pprem_{s,i}$ are non-negative. This implies that the price of conventional wood is below, or equal to, the certified wood price.

Appendix J: Questionnaire

Dear consumer,

This questionnaire probes for the attitude of consumers concerning sustainable wood purchases. Completing the questionnaire requires 15 minutes of your time. The results will be treated anonymously, and only for research purposes. Thank you in advance, and good luck

Part 1: Attitude towards environment

This first part probes for your attitude concerning the environment. To what extent do you agree with the following statements?

1. We are approaching the limit of the number of people the Earth can support.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

2. Humans have the right to modify the natural environment to suit their needs.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

3. When humans interfere with nature it often produces disastrous consequences.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

4. Human ingenuity will insure that we do not make the Earth unlivable.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

5. Humans are seriously abusing the environment

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

6. The Earth has plenty of natural resources if we just learn how to develop them.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

7. Plants and animals have as much right as humans to exist.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

9. Despite our special abilities, humans are still subject to the laws of nature.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

10. The so-called “ecological crisis” facing humankind has been greatly exaggerated.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

11. The Earth is like a spaceship with very limited room and resources

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

12. Humans were meant to rule over the rest of nature.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

13. The balance of nature is very delicate and easily upset.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

14. Humans will eventually learn enough about how nature works to be able to control it.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

15. Things continue on their present course, we will soon experience a major ecological catastrophe

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

16. A single person cannot do much for the environment.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

17. One person's efforts in support of the environment are useless as long as other persons do nothing.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

18. Refusing to use products which harm the environment is good practice to change the value chain the offer of products.

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

19. Each individual can make a difference for nature by choosing environmental-friendly products

Strongly disagree	Disagree	Neutral	Agree	Completely Agree
O	O	O	O	O

Part 2: Forests

This part probes for your attitude towards forests.

Deforestation is one of the main causes of climate change. It accounts for over 18% of the current carbon emissions, this is a more important contribution than for example the transport sector. Simultaneously, forest can play an important role in climate change mitigation. The last decennia, forests managed to store 33% of the global carbon emissions.

FSC and PEFC are two eco-certification schemes. Their labels indicate that products are produced by making use of sustainably produced wood. You can find their labels on paper, books, furniture, wood,… Sustainable in this narrative has both an environmental and societal aspect. The eco-certification schemes operate at global level, from Flanders to the tropical forests.

20. Did you know the FSC label?

O YEs

O No

21. Did you know the PEFC label?

O Yes

O No

22. "For me to buy eco-certified wood in future is…"

Valuable	O	O	O	O	O	Worthless
Harmful	O	O	O	O	O	Beneficial
Good	O	O	O	O	O	Bad
Enjoyable	O	O	O	O	O	Unenjoyable
Unpleasant	O	O	O	O	O	Pleasant

23. Next time I buy a wood product, I will opt for an eco-certified product.

Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
O	O	O	O	O

24. Do you trust thee co-certification schemes

To what extent do you believe that eco-certified wood products are…?	Not sure at all	Not sure	Neutral	Sure	Very sure
… produced in an environmental-friendly way					
… supporting rural development					
… generating a fair income for wood producers					
… produced without interfering in the natural habitat of animals					
… a good choice for me as private consumer					
… not aggravating climate change					

25. Does your social environment value eco-certification? Assume your environment is aware of the concept of eco-certification of wood products.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Most people who are important to me buy eco-certified wood					
The people in my life whose opinions I value would buy eco-certified wood					
My friends never buy eco-certified wood					
My family appreciates it when I buy eco-certified wood.					
Persons who influence my consumption decisions buy eco-certified wood.					

Also governments buy important volumes of wood products (e.g. paper, furniture for its employees, wood for construction projects…). Within Europe, governments account for approximately 26% of all purchases of wood products.

26. The government should only buy eco-certified wood.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
O	O	O	O	O

27. The government should only buy eco-certified wood, even when this increases the price of eco-certified wood

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
O	O	O	O	O

28. The government should only buy eco-certified wood, even when this implies no eco-certified wood is available for my personal consumption.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
O	O	O	O	O

Part 3: General information

29. What is your gender?

- O Male
- O Female

30. What is your age?

……

31. How would you describe your financial situation?

Difficult		Average		Well-off
O	O	O	O	O

32. Where do you live?

- O Rural: village,, small community, countryside
- O Urban: Metropolis, city, urban village

33. Are you the main responsible for consumption decisions at home or your student residence?

- O Yes
- O Shared responsibility
- O No, somebody else is more responsibly

Appendix K: Constructs

New Environmental Paradigm

This research uses the revised New Environmental Paradigm (NEP) statements in order to determine the NEP construct. This procedure is fully described by Dunlap et al. (2000). The fifteen required – generic - statements for the NEP construct are questions 1 to 15 in the questionnaire (Appendix J). The seven even numbered statements endorse the dominant social paradigm (which is opposite to the NEP). The eight odd numbered statements endorse the NEP. Hence, the scores for the seven even statements are reversed prior to running the Cronbach Alpha test, and eventually compiling all scores.

Perceived Consumer Effectiveness

This research applies the procedures as described by Ellen et al. (1991) in order to construct the Perceived Consumer Effectiveness (PCE) scale. The four required statements for this scale are question 16 to 19 in the questionnaire (Appendix J). Question 16 and 17, if agreed with, endorse the idea that a person does not believe that his/her personal choices contribute to a reduction in the environmental impact of consumption. In contrast, question 18 and 19, if agreed with, endorse the feeling that an individual's choices can contribute to a reduction in the environmental impact of consumption. Subsequently, the scores of question 16 and 17 are reversed, prior to running the Cronbach Alpha test on the four questions, and compiling the scores.

Attitude towards eco-certified purchases

The score for the attitude towards eco-certified purchases is determined according to Ajzen (1991). The required statements are listed in question 22 of the questionnaire (Appendix J). In the questionnaire, we ensure that the questionnaire counterbalances the positive and negative endpoints, in order to counteract possible response sets. As such, the scores for the last sample are first reversed prior to running the Cronbach Alpha test, and compiling the scores.

In addition, the type of endpoints is also selected based upon Ajzen (1991). He describes how the final set of scales should include a generic good-bad scale which tends to capture overall evaluation well. In addition, both instrumental and experiential components must be present. Instrumental components are represented by adjective pairs as valuable-worthless and harmful-beneficial. Experiential components are represented by adjective pairs such as pleasant-unpleasant and enjoyable-unenjoyable.

Subjective Norm

According to Ajzen (1991), good measurements for the subjective norm should probe for the injunctive quality of other persons' approval of specific behavior. This is done in the fourth statement of question 25 of the questionnaire (Appendix J). However, this might result in low variability as

'important others generally approve desirable behaviors and disapprove undesirable behavior'. Therefore, the questionnaire also probes for descriptive norms in the remaining statements of question 25, i.e. whether important others themselves perform the behavior in question.

Confidence in eco-certification schemes

The belief of the respondents in the sustainable character of eco-certified wood is measured in accordance with the methodology applied by Vermeir and Verbeke (2006). They assessed the belief about the sustainable character of cheese products by using a 6-point scale. Our questionnaire applies a 5-point scale for reasons of consistency: the 5-point scale is also applied for the other constructs. The measurement pays attention to different aspects of sustainability: ecology, rural development, income, personal benefit.

References

AGRAWAL, A., CHHATRE, A. and HARDIN, R. (2008). 'Changing governance of the world's forests', *Science,* Vol. **320**, pp. 1460-1462.

AGRAWAL, A., WOLLENBERG, E. and PERSHA, L. (2014). 'Governing agriculture-forest landscapes to achieve climate change mitigation', *Global Environmental Change,* Vol. **29**, pp. 270-280.

AGUILAR, F. X. and CAI, Z. (2010). 'Conjoint effect of environmental labeling, disclosure of forest of origin and price on consumer preferences for wood products in the US and UK', *Ecological Economics,* Vol. **70**, pp. 308-316.

AGUILAR, F. X. and VLOSKY, R. P. (2007). 'Consumer willingness to pay price premiums for environmentally certified wood products in the US', *Forest Policy and Economics,* Vol. **9**, pp. 1100-1112.

AJZEN, I. (1991). 'The theory of planned behavior', *Organizational behavior and human decision processes,* Vol. **50**, pp. 179-211.

AKENJI, L. (2014). 'Consumer scapegoatism and limits to green consumerism', *Journal of Cleaner Production,* Vol. **63**, pp. 13-23.

ALLABY, M. and PARK, C. (2013) *A dictionary of environment and conservation,* OUP Oxford.

ALVES-PINTO, H. N., NEWTON, P. and PINTO, L. F. G. (2015). 'Reducing deforestation and enhancing sustainability in commodity supply chains: interactions between governance interventions and cattle certification in Brazil', *Tropical Conservation Science,* Vol. **8**, pp. 1053-1079.

ANGELSEN, A. (2010). 'Policies for reduced deforestation and their impact on agricultural production', *Proceedings of the National Academy of Sciences,* Vol. **107**, pp. 19639-19644.

ANGELSEN, A. and RUDEL, T. K. (2013). 'Designing and implementing effective REDD+ policies: A forest transition approach', *Review of Environmental Economics and Policy,* Vol. **7**, pp. 91-113.

ANNUNZIATA, A. and SCARPATO, D. (2014). 'Factors affecting consumer attitudes towards food products with sustainable attributes', *Agricultural Economics,* Vol. **60**, pp. 353-363.

ARMINGTON, P. S. (1969). 'A theory of demand for products distinguished by place of production', *Staff Papers,* Vol. **16**, pp. 159-178.

ATKESON, A. and BURSTEIN, A. T. (2010). 'Innovation, Firm Dynamics, and International Trade', *Journal of Political Economy.* pp. 433 - 484.

ATYI, R. E. A., ASSEMBE-MVONDO, S., LESCUYER, G. and CERUTTI, P. (2013). 'Impacts of international timber procurement policies on Central Africa's forestry sector: The case of Cameroon', *Forest Policy and Economics,* Vol. **32**, pp. 40-48.

ATYI, R. E. A. and SIMULA, M. (2002) *Forest certification: pending challenges for tropical timber,* International Tropical Timber Organization Yokohama, Japan.

AULD, G., GULBRANDSEN, L. H. and MCDERMOTT, C. L. (2008). 'Certification schemes and the impacts on forests and forestry', *Annual review of environment and resources,* Vol. **33**, pp. 187.

BAIER, S. L. and BERGSTRAND, J. H. (2007). 'Do free trade agreements actually increase members' international trade?', *Journal of International Economics,* Vol. **71**, pp. 72-95.

BAIER, S. L., BERGSTRAND, J. H. and FENG, M. (2014). 'Economic integration agreements and the margins of international trade', *Journal of International Economics,* Vol. **93**, pp. 339-350.

BARBIER, E. B., DELACOTE, P. and WOLFERSBERGER, J. (2017). 'The economic analysis of the forest transition: A review', *Journal of Forest Economics,* Vol. **27**, pp. 10-17.

BARBIER, E. B. and TESFAW, A. (2015). 'Explaining forest transitions: The role of governance', *Ecological Economics,* Vol. **119**, pp. 252-261.

BASS, S. (2001) *Certification's impacts on forests, stakeholders and supply chains,* IIED.

BEHARRELL, B. and DENISON, T. J. (1995). 'Involvement in a routine food shopping context', *British Food Journal,* Vol. **97**, pp. 24-29.

BEHRENS, K., ERTUR, C. and KOCH, W. (2012). ''Dual'gravity: Using spatial econometrics to control for multilateral resistance', *Journal of Applied Econometrics,* Vol. **27**, pp. 773-794.

BERGER, I. E. and CORBIN, R. M. (1992). 'Perceived consumer effectiveness and faith in others as moderators of environmentally responsible behaviors', *Journal of Public Policy & Marketing*, pp. 79-89.

BLACKMAN, A., GOFF, L. T. and RIVERA-PLANTER, M. (2015). 'Does Eco-certification Stem Tropical Deforestation? Forest Stewardship Council Certification in Mexico'.

BLACKMAN, A. and NARANJO, M. A. (2012). 'Does eco-certification have environmental benefits? Organic coffee in Costa Rica', *Ecological Economics,* Vol. **83**, pp. 58-66.

BRANDT, J. S., NOLTE, C. and AGRAWAL, A. (2016). 'Deforestation and timber production in Congo after implementation of sustainable forest management policy', *Land Use Policy,* Vol. **52**, pp. 15-22.

BRUSSELAERS, J., VAN HUYLENBROECK, G. and BUYSSE, J. (2017). 'Green Public Procurement of Certified Wood: Spatial Leverage Effect and Welfare Implications', *Ecological Economics,* Vol. **135**, pp. 91-102.

BUONGIORNO, J. (2003) *The Global Forest Products Model - Structure, Estimations, and Applications,* Elsevier Science, Massachusetts.

BUONGIORNO, J. (2014). 'Calibrating and Updating the Global Forest Products Model (GFPM version 2014 with BPMPD)', Madison.

BUONGIORNO, J., ROUGIEUX, P., BARKAOUI, A., ZHU, S. and HAROU, P. (2014). 'Potential impact of a Transatlantic Trade and Investment Partnership on the global forest sector', *Journal of Forest Economics,* Vol. **20**, pp. 252-266.

BUONGIORNO, J. and SHUSHUAI, Z. (2014). 'Global Forest Products Model - Calibration', Department of Forest and Wildlife Ecology - University of Wisconsin, Madison, WI.

BURFISHER, M. E., ROBINSON, S. and THIERFELDER, K. (2001). 'The impact of NAFTA on the United States', *The Journal of Economic Perspectives,* Vol. **15**, pp. 125-144.

BURIVALOVA, Z., HUA, F., KOH, L. P., GARCIA, C. and PUTZ, F. (2017). 'A critical comparison of conventional, certified, and community management of tropical forests for timber in terms of environmental, economic, and social variables', *Conservation Letters,* Vol. **10**, pp. 4-14.

CAI, Z. and AGUILAR, F. X. (2013). 'Meta-analysis of consumer's willingness-to-pay premiums for certified wood products', *Journal of Forest Economics,* Vol. **19**, pp. 15-31.

CANADELL, J. G. and RAUPACH, M. R. (2008). 'Managing forests for climate change mitigation', *Science,* Vol. **320**, pp. 1456-1457.

CARLSEN, K., HANSEN, C. P. and LUND, J. F. (2012). 'Factors affecting certification uptake—Perspectives from the timber industry in Ghana', *Forest Policy and Economics,* Vol. **25**, pp. 83-92.

CARLSON, A. and PALMER, C. (2016). 'A qualitative meta-synthesis of the benefits of eco-labeling in developing countries', *Ecological Economics,* Vol. **127**, pp. 129-145.

CARODENUTO, S. and CERUTTI, P. O. (2014). 'Forest Law Enforcement, Governance and Trade (FLEGT) in Cameroon: Perceived private sector benefits from VPA implementation', *Forest Policy and Economics,* Vol. **48**, pp. 55-62.

CARODENUTO, S. and RAMCILOVIC-SUOMINEN, S. (2014). 'Barriers to VPA implementation: a case study of Cameroon's private forestry sector', *International Forestry Review,* Vol. **16**, pp. 278-288.

CASHORE, B., GALE, F., MEIDINGER, E. and NEWSOM, D. (2006) *Confronting sustainability: forest certification in developing and transitioning countries,* Yale University Faculty of Environmental Studies Publication Series.

CENTRE FOR EUROPEAN POLICY STUDIES, C. O. E. (2012). The uptake of Green Public Procurement in the EU27. Brussels.

CERUTTI, P. O., TACCONI, L., LESCUYER, G. and NASI, R. (2013). 'Cameroon's hidden harvest: Commercial chainsaw logging, corruption, and livelihoods', *Society & Natural Resources,* Vol. **26**, pp. 539-553.

CHAN, K. and CHUNG, Y. P. (1995). 'Vector autoregression or simultaneous equations model? The intraday relationship between index arbitrage and market volatility', *Journal of banking & finance,* Vol. **19**, pp. 173-179.

CIFOR (2016). 'Forests and climate change', CGIAR, Bogor, Indonesia.

CORBERA, E. and SCHROEDER, H. (2011). 'Governing and implementing REDD+', *Environmental Science & Policy,* Vol. **14**, pp. 89-99.

COULIBALY, S. (2007). 'Evaluating the trade effect of developing regional trade agreements: a semi-parametric approach', *World Bank Policy Research Working Paper*.

CROCE, M. E., JUAN-RAMON, M. V. H. and ZHU, F. (2004) *Performance of Western hemisphere trading blocs: A cost-corrected gravity approach,* International Monetary Fund.

CSILLA, L. and NILSSON, L. (2015) *The EU-Korea free trade agreement: Anticipation, trade policy uncertainty and impact,* Directorate General for Trade, European Commission.

DAMETTE, O. and DELACOTE, P. (2011). 'Unsustainable timber harvesting, deforestation and the role of certification', *Ecological Economics,* Vol. **70**, pp. 1211-1219.

DAUVERGNE, P. and LISTER, J. (2010). 'The prospects and limits of eco-consumerism: shopping our way to less deforestation?', *Organization & Environment,* Vol. **23**, pp. 132-154.

DE FRENNE, P. and VERHEYEN, K. (2016). 'Weather stations lack forest data', *Science,* Vol. **351**, pp. 234-234.

DE GORTER, H. and SHELDON, I. M. (2000). 'Issues in the administration of tariff-rate import quotas in the agreement on agriculture in the WTO: An introduction', *Agricultural and Resource Economics Review,* Vol. **29**, pp. 54-57.

DOETTERL, S., KEARSLEY, E., BAUTERS, M., HUFKENS, K., LISINGO, J., BAERT, G., VERBEECK, H. and BOECKX, P. (2015). 'Aboveground vs. belowground carbon stocks in African tropical lowland rainforest: Drivers and implications', *PloS one,* Vol. **10**, pp. e0143209.

DOOLEY, K. and OZINGA, S. (2011). 'Building on forest governance reforms through FLEGT: the best way of controlling forests' contribution to climate change?', *Review of European Community & International Environmental Law,* Vol. **20**, pp. 163-170.

DRANOVE, D. and JIN, G. Z. (2010). 'Quality Disclosure and Certification: Theory and Practice', *Journal of Economic Literature,* Vol. **48**, pp. 935-963.

DULLECK, U., KERSCHBAMER, R. and SUTTER, M. (2011). 'The economics of credence goods: an experiment on the role of liability, verifiability, reputation, and competition', *American Economic Review,* Vol. **101**.

DUNLAP, R. E. and VAN LIERE, K. D. (1984). 'Commitment to the dominant social paradigm and concern for environmental quality', *Social Science Quarterly,* Vol. **65**, pp. 1013.

DUNLAP, R. E., VAN LIERE, K. D., MERTIG, A. G. and JONES, R. E. (2000). 'New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale', *Journal of social issues,* Vol. **56**, pp. 425-442.

EBELING, J. and YASUÉ, M. (2009). 'The effectiveness of market-based conservation in the tropics: Forest certification in Ecuador and Bolivia', *Journal of environmental management,* Vol. **90**, pp. 1145-1153.

EDLER, J., GEORGHIOU, L., UYARRA, E. and YEOW, J. (2015). '2. The meaning and limitations of public procurement for innovation: a supplier's experience', *Public Procurement for Innovation.* pp. 35.

EFECA (2010). 'An assessment of the impacts of the UK Government's timber procurement policy', London, UK.

EICHENGREEN, B. and IRWIN, D. A. (1998). 'The role of history in bilateral trade flows', *The regionalization of the world economy.* University of Chicago Press, pp. 33-62.

ELLEN, P. S., WIENER, J. L. and COBB-WALGREN, C. (1991). 'The role of perceived consumer effectiveness in motivating environmentally conscious behaviors', *Journal of Public Policy & Marketing*, pp. 102-117.

ELLIOTT, C. (2000) *Forest certification: a policy perspective,* Cifor.

EU FLEGT FACILITY (2016). 'Information for operators', EU FLEGT Facility.

EUROPEAN COMMISSION (2008). COM(2008) 400 - Public procurement for a better environment Brussels.

EUROPEAN COMMISSION (2011). Buying green! A handbook on environmental public procurement. Brussels.

EUROPEAN COMMISSION (2012). Green Public Procurement a collection of good practices. Luxembourg.

EUROPEAN COMMISSION (2014). 'EU FLEGT - National initiatives'.

EUROPEAN COMMISSION (2015a). National GPP Action Plans (policies and guidelines). Luxembourg.

EUROPEAN COMMISSION (2015b). 'Timber Regulation: what's new', Brussels, Belgium.

EUROPEAN COMMISSION (2016a). 'Barriers to the take-up of GPP'.

EUROPEAN COMMISSION (2016b) *Buying green! A handbook on green public procurement. 3rd Edition*, Brussels.

EUROPEAN COMMISSION (2016c). 'Green Public Procurement Criteria for Office Building Design, Construction and Management', in JRC (ed.), Seville, pp. 140.

EUROPEAN COMMISSION (2016d). 'Public procurement for a better environment', Brussels.

EUROPEAN COMMISSION (2016e). 'REDD+ and FLEGT interactions'.

EUROPEAN COMMISSION (2016f). 'VPA output'.

EUROPEAN COMMISSION (2017a). 'Australian Illegal Logging Prohibition Act 2012', Brussels.

EUROPEAN COMMISSION (2017b). 'How are VPAs negotiated?', European Commission,, Brussels.

EUROPEAN COMMISSION (2017c). 'Quotas', *Export - Help Desk.*

EUROPEAN COMMISSION (2017d). 'Voluntary Partnership Agreements', Brussels.

EUROPEAN EXTERNAL ACTION SERVICE (2016). 'Indonesia begins issuing FLEGT licensing scheme for verified legal timber products ', Brussels.

EUROPEAN FOREST INSTITUTE (2017). 'Communication on VPA implementation', in BRUSSELAERS J (ed.).

EUROPEAN UNION (2014). 'DIRECTIVE 2014/24/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL', in OFFICIAL JOURNAL OF THE EUROPEAN UNION (ed.).

EUROPEAN UNION (2016). Rapport annuel conjoint sur la mise en oeuvre de l'APV FLEGT au Cameroun: Cameroun et l'Union Européénne.

EUROSTAT (2015). 'GDP and main components (output, expenditure and income)', in UNION E (ed.).

EUROSTAT (2017). 'International trade in goods - detailed data since 1988 by HS2-HS4', in COMMISSION E (ed.).

FAJGELBAUM, P., GROSSMAN, G. M. and HELPMAN, E. (2011). 'Income distribution, product quality, and international trade', *Journal of Political Economy,* Vol. **119**, pp. 45.

FAO (2013). FAO, forests and climate change. Rome.

FAO (2014a). Forest Products Annual Market Review, 2013 - 2014. Geneva.

FAO (2014b). 'State of the world's forests, enhancing the socio-economic benefits from forests', FAO, Rome.

FAO (2015a). Durban declaration - 2050 vision for forests and forestry. Durban.

FAO (2015b). 'FAO yearbook of forrest products 2014'.

FAO (2015c). Global Forest Resource Assessment 2015

Desk Reference. Rome.

FAO (2016a). 'Forestry and climate change'.

FAO (2016b). State of the timber sector in Cameroon (2015).

FARIA, W. R. and ALMEIDA, A. N. (2016). 'Relationship between openness to trade and deforestation: Empirical evidence from the Brazilian Amazon', *Ecological Economics,* Vol. **121**, pp. 85-97.

FEDERICI, S., TUBIELLO, F. N., SALVATORE, M., JACOBS, H. and SCHMIDHUBER, J. (2015). 'New estimates of CO 2 forest emissions and removals: 1990–2015', *Forest Ecology and Management,* Vol. **352**, pp. 89-98.

FERRARO, P. J. and KISS, A. (2002). 'Direct payments to conserve biodiversity', *Science,* Vol. **298**, pp. 1718-1719.

FERRARO, P. J. and SIMPSON, R. D. (2002). 'The cost-effectiveness of conservation payments', *Land Economics,* Vol. **78**, pp. 339-353.

FERREIRA, S. (2007). 'Trade policy and natural resource use: The case for a quantitative restriction', *Environmental and Resource Economics,* Vol. **37**, pp. 361-376.

FERREIRA, S. and VINCENT, J. R. (2010). 'Governance and timber harvests', *Environmental and Resource Economics,* Vol. **47**, pp. 241-260.

FISHBEIN, M. and AJZEN, I. (1977). 'Belief, attitude, intention, and behavior: An introduction to theory and research'.

FLETCHER, R., DRESSLER, W., BÜSCHER, B. and ANDERSON, Z. R. (2016). 'Questioning REDD+ and the future of market-based conservation', *Conservation Biology*.

FOELLMI, R. and OECHSLIN, M. (2010). 'Market imperfections, wealth inequality, and the distribution of trade gains', *Journal of International Economics,* Vol. **81**, pp. 15-25.

FOLLOWS, S. B. and JOBBER, D. (2000). 'Environmentally responsible purchase behaviour: a test of a consumer model', *European journal of Marketing,* Vol. **34**, pp. 723-746.

FONTAGNÉ, L., OREFICE, G., PIERMARTINI, R. and ROCHA, N. (2015). 'Product standards and margins of trade: Firm-level evidence', *Journal of International Economics,* Vol. **97**, pp. 29-44.

FOSTER, N., POESCHL, J. and STEHRER, R. (2011). 'The impact of Preferential Trade Agreements on the margins of international trade', *Economic Systems,* Vol. **35**, pp. 84-97.

FREUND, C. L. and ORNELAS, E. (2010). 'Regional trade agreements', *World Bank Policy Research Working Paper Series*.

FRY, B. P. (2011). 'Community forest monitoring in REDD+: the 'M'in MRV?', *Environmental Science & Policy,* Vol. **14**, pp. 181-187.

FSC (2012). 'FSC-certified wood and products fetch higher prices'.

FSC (2015). Deforestation - free forest products from 187 million hectares globally. Brussels.

FSC (2016). FSC®: A tool to implement the sustainable development goals. Oaxaca, Mexico.

FSC INTERNATIONAL (2015). 'Personnal communication with Kim Carstensen – CEO (@FAO World Forest summit, September 2015, Durban, SA)'.

FUJIWARA, T., AWANG, S., WIDAYANTI, W., SEPTIANA, R., HYAKUMURA, K. and SATO, N. (2015). 'Effects of national community-based forest certification on forest management and timber marketing: a case study of Gunung Kidul, Yogyakarta, Indonesia', *International Forestry Review,* Vol. **17**, pp. 448-460.

GALINATO, G. I. and GALINATO, S. P. (2016). 'The effects of government spending on deforestation due to agricultural land expansion and CO 2 related emissions', *Ecological Economics,* Vol. **122**, pp. 43-53.

GALLI, A. (2015). 'On the rationale and policy usefulness of Ecological Footprint Accounting: The case of Morocco', *Environmental Science & Policy,* Vol. **48**, pp. 210-224.

GAMFELDT, L., SNÄLL, T., BAGCHI, R., JONSSON, M., GUSTAFSSON, L., KJELLANDER, P., RUIZ-JAEN, M. C., FRÖBERG, M., STENDAHL, J. and PHILIPSON, C. D. (2013). 'Higher levels of multiple ecosystem services are found in forests with more tree species', *Nature communications,* Vol. **4**, pp. 1340.

GAN, J. and MCCARL, B. A. (2007). 'Measuring transnational leakage of forest conservation', *Ecological Economics,* Vol. **64**, pp. 423-432.

GEORGHIOU, L., EDLER, J., UYARRA, E. and YEOW, J. (2014). 'Policy instruments for public procurement of innovation: Choice, design and assessment', *Technological Forecasting and Social Change,* Vol. **86**, pp. 1-12.

GIULIANI, E., PIETROBELLI, C. and RABELLOTTI, R. (2005). 'Upgrading in global value chains: lessons from Latin American clusters', *World development,* Vol. **33**, pp. 549-573.

GLOBAL FOOTPRINT NETWORK (2016). 'National Footprint Account results (2016 Edition)', Oakland.

GLOBAL FOOTPRINT NETWORK (2017). 'Ecological footprint'.

GLOBAL TIMBER PLATFORM (2017). 'Communication on VPA implementation', in BRUSSELAERS J (ed.).

GOETZ, S. J., HANSEN, M., HOUGHTON, R. A., WALKER, W., LAPORTE, N. and BUSCH, J. (2015). 'Measurement and monitoring needs, capabilities and potential for addressing reduced emissions from deforestation and forest degradation under REDD+', *Environmental Research Letters,* Vol. **10**, pp. 123001.

GÓMEZ-BAGGETHUN, E. and MURADIAN, R. (2015). 'In markets we trust? Setting the boundaries of Market-Based Instruments in ecosystem services governance', *Ecological Economics,* Vol. **117**, pp. 217-224.

GORDON, B. R., GOLDFARB, A. and LI, Y. (2013). 'Does price elasticity vary with economic growth? A cross-category analysis', *Journal of Marketing Research,* Vol. **50**, pp. 4-23.

GREAKER, M. (2006). 'Eco-labels, trade and protectionism', *Environmental and Resource Economics,* Vol. **33**, pp. 1-37.

GREENSTONE, M. and JACK, B. K. (2015). 'Envirodevonomics: A research agenda for an emerging field', *Journal of Economic Literature,* Vol. **53**, pp. 5-42.

GROOM, B. and PALMER, C. (2010). 'Cost-effective provision of environmental services: the role of relaxing market constraints', *Environment and Development Economics,* Vol. **15**, pp. 219-240.

GROOM, B. and PALMER, C. (2014). 'Relaxing constraints as a conservation policy', *Environment and Development Economics,* Vol. **19**, pp. 505-528.

GULBRANDSEN, L. H. (2014). 'Dynamic governance interactions: Evolutionary effects of state responses to non-state certification programs', *Regulation & Governance,* Vol. **8**, pp. 74-92.

GULLISON, R. E. (2003). 'Does forest certification conserve biodiversity?', *Oryx,* Vol. **37**, pp. 153-165.

HAJJAR, R. and KOZAK, R. A. (2017). 'The evolution of forest producer associations and their current role in REDD+: case studies from Quintana Roo, Mexico', *Land Use Policy,* Vol. **60**, pp. 373-383.

HANDLEY, K. and LIMAO, N. (2015). 'Trade and investment under policy uncertainty: theory and firm evidence', *American Economic Journal: Economic Policy,* Vol. **7**, pp. 189-222.

HANSEN, M. C., POTAPOV, P. V., MOORE, R., HANCHER, M., TURUBANOVA, S., TYUKAVINA, A., THAU, D., STEHMAN, S., GOETZ, S. and LOVELAND, T. (2013). 'High-resolution global maps of 21st-century forest cover change', *Science,* Vol. **342**, pp. 850-853.

HAWCROFT, L. J. and MILFONT, T. L. (2010). 'The use (and abuse) of the new environmental paradigm scale over the last 30 years: A meta-analysis', *Journal of Environmental psychology,* Vol. **30**, pp. 143-158.

HE, M., WU, Z., LI, W. and ZENG, Y. (2015). 'Forest Certification in Collectively Owned Forest Areas and Sustainable Forest Management: A Case of Cooperative-Based Forest Certification in China', *Small-scale Forestry,* Vol. **14**, pp. 245-254.

HEILMAYR, R. and LAMBIN, E. F. (2016). 'Impacts of nonstate, market-driven governance on Chilean forests', *Proceedings of the National Academy of Sciences,* Vol. **113**, pp. 2910-2915.

HILY, E., GARCIA, S., STENGER, A. and TU, G. (2015). 'Assessing the cost-effectiveness of a biodiversity conservation policy: A bio-econometric analysis of Natura 2000 contracts in forest', *Ecological Economics,* Vol. **119**, pp. 197-208.

HINKLEY, D. V. (1970). 'Inference about the change-point in a sequence of random variables', *Biometrika,* Vol. **57**, pp. 1-17.

HOEKSTRA, A. Y. and WIEDMANN, T. O. (2014). 'Humanity's unsustainable environmental footprint', *Science,* Vol. **344**, pp. 1114-1117.

HOSONUMA, N., HEROLD, M., DE SY, V., DE FRIES, R. S., BROCKHAUS, M., VERCHOT, L., ANGELSEN, A. and ROMIJN, E. (2012). 'An assessment of deforestation and forest degradation drivers in developing countries', *Environmental Research Letters,* Vol. **7**, pp. 044009.

IIED (2017). 'Designing REDD+ to promote sustainable development and reduce poverty', London.

ITTC (2004). Report on financial cost-benefit analysis of forest certification and implementation of phased approaches. ITTC.

ITTO (2017). Strong potential of independent market monitoring to overcome obstacles to tropical wood market access. Yokohama, Japan.

JACOBSEN, J. B. and HANLEY, N. (2009). 'Are there income effects on global willingness to pay for biodiversity conservation?', *Environmental and Resource Economics,* Vol. **43**, pp. 137-160.

JAGER, W. (2000). 'Modelling consumer behaviour'.

JAUNG, W., PUTZEL, L., BULL, G. Q., KOZAK, R. and ELLIOTT, C. (2016). 'Forest Stewardship Council certification for forest ecosystem services: An analysis of stakeholder adaptability', *Forest Policy and Economics,* Vol. **70**, pp. 91-98.

JIANBANG, G., CERUTTI, P., MASIERO, M., PETTENELLA, D., ANDRIGHETTO, N. and DAWSON, T. (2016). Quantifying Illegal Logging and Related Timber Trade. Report 3902762705.

JONELL, M., CRONA, B., BROWN, K., RÖNNBÄCK, P. and TROELL, M. (2016). 'Eco-Labeled Seafood: Determinants for (Blue) Green Consumption', *Sustainability,* Vol. **8**, pp. 884.

KAIN, J. F. and QUIGLEY, J. M. (1972). 'Housing market discrimination, home-ownership, and savings behavior', *The American Economic Review,* Vol. **62**, pp. 263-277.

KANG, J., LIU, C. and KIM, S. H. (2013). 'Environmentally sustainable textile and apparel consumption: the role of consumer knowledge, perceived consumer effectiveness and perceived personal relevance', *International Journal of Consumer Studies,* Vol. **37**, pp. 442-452.

KEENAN, R. J., REAMS, G. A., ACHARD, F., DE FREITAS, J. V., GRAINGER, A. and LINDQUIST, E. (2015). 'Dynamics of global forest area: results from the FAO Global Forest Resources Assessment 2015', *Forest Ecology and Management,* Vol. **352**, pp. 9-20.

KILLICK, R., FEARNHEAD, P. and ECKLEY, I. A. (2012). 'Optimal detection of changepoints with a linear computational cost', *Journal of the American Statistical Association,* Vol. **107**, pp. 1590-1598.

KIM, Y. (2011). 'Understanding green purchase: The influence of collectivism, personal values and environmental attitudes, and the moderating effect of perceived consumer effectiveness', *Seoul Journal of Business,* Vol. **17**, pp. 65.

KISSINGER, G., HEROLD, M. and DE SY, V. (2012). Drivers of deforestation and forest degradation: a synthesis report for REDD+ policymakers.

KLOOSTER, D. (2005). 'Environmental certification of forests: The evolution of environmental governance in a commodity network', *Journal of Rural Studies,* Vol. **21**, pp. 403-417.

KRAMER, R., SCHAIK, C. V. and JOHNSON, J. (1997) *Last stand: protected areas and the defense of tropical biodiversity,* Oxford University Press.

LAKE, J. and YILDIZ, H. M. (2016). 'On the different geographic characteristics of Free Trade Agreements and Customs Unions', *Journal of International Economics,* Vol. **103**, pp. 213-233.

LAMBIN, E. F., MEYFROIDT, P., RUEDA, X., BLACKMAN, A., BÖRNER, J., CERUTTI, P. O., DIETSCH, T., JUNGMANN, L., LAMARQUE, P. and LISTER, J. (2014). 'Effectiveness and synergies of policy instruments for land use governance in tropical regions', *Global Environmental Change,* Vol. **28**, pp. 129-140.

LARABI, Z., GUYADER, O., MACHER, C. and DAURÈS, F. (2013). 'Quota management in a context of non-transferability of fishing rights: The French case study', *Ocean & coastal management,* Vol. **84**, pp. 13-22.

LEE, J. A. and HOLDEN, S. J. (1999). 'Understanding the determinants of environmentally conscious behavior', *Psychology and Marketing,* Vol. **16**, pp. 373-392.

LEIPOLD, S. (2016). 'How to move companies to source responsibly? German implementation of the European Timber Regulation between persuasion and coercion', *Forest Policy and Economics*.

LESNIEWSKA, F. and MCDERMOTT, C. L. (2014). 'FLEGT VPAs: Laying a pathway to sustainability via legality lessons from Ghana and Indonesia', *Forest Policy and Economics,* Vol. **48**, pp. 16-23.

LEVIN, K., MCDERMOTT, C. and CASHORE, B. (2008). 'The climate regime as global forest governance: can reduced emissions from Deforestation and Forest Degradation (REDD) initiatives pass a 'dual effectiveness' test?', *International Forestry Review,* Vol. **10**, pp. 538-549.

LEWIS, G. and BAJARI, P. (2011). 'Procurement contracting with time incentives: theory and evidence', *The Quarterly Journal of Economics,* Vol. **126**, pp. 1173-1211.

LIN, D., HANSCOM, L., MARTINDILL, J., BORUCKE, M., COHEN, L., GALLI, A., LAZARUS, E., ZOKAI, G., IHA, K., EATON, D. and WACKERNAGEL, M. (2016). Working Guidebook to the National Footprint Accounts: 2016. Oakland.

LOUREIRO, M. L. and ARCOS, F. D. (2012). 'Applying best–worst scaling in a stated preference analysis of forest management programs', *Journal of Forest Economics,* Vol. **18**, pp. 381-394.

MAGEE, C. S. (2008). 'New measures of trade creation and trade diversion', *Journal of International Economics,* Vol. **75**, pp. 349-362.

MALHOTRA, N. K. and BIRKS, D. F. (2007) *Marketing research: An applied approach,* Pearson Education.

MALTHUS, T. (1798). 'An essay on the principle of population, as it affects the future imporvement of society with remarks on the speculations of Mr. Godwin, M. Condorcet, and other writers', in JOHNSON J (ed.), *St. Paul's Church-yard, London.* London.

MARYUDI, A. (2016). 'Choosing timber legality verification as a policy instrument to combat illegal logging in Indonesia', *Forest Policy and Economics,* Vol. **68**, pp. 99-104.

MATHER, A. S. (1992). 'The forest transition', *Area*, pp. 367-379.

MCDERMOTT, C. L., IRLAND, L. C. and PACHECO, P. (2015). 'Forest certification and legality initiatives in the Brazilian Amazon: lessons for effective and equitable forest governance', *Forest Policy and Economics,* Vol. **50**, pp. 134-142.

MEIJAARD, E., WUNDER, S., GUARIGUATA, M. R. and SHEIL, D. (2014). 'What scope for certifying forest ecosystem services?', *Ecosystem Services,* Vol. **7**, pp. 160-166.

MICHAUD, C., LLERENA, D. and JOLY, I. (2012). 'Willingness to pay for environmental attributes of non-food agricultural products: a real choice experiment', *European Review of Agricultural Economics*, pp. jbs025.

MITEVA, D. A., LOUCKS, C. J. and PATTANAYAK, S. K. (2015). 'Social and environmental impacts of forest management certification in Indonesia', *PloS one,* Vol. **10**, pp. e0129675.

MOISEYEV, A., SOLBERG, B., MICHIE, B. and KALLIO, A. M. I. (2010). 'Modeling the impacts of policy measures to prevent import of illegal wood and wood products', *Forest Policy and Economics,* Vol. **12**, pp. 24-30.

MÖLDERS, F. and VOLZ, U. (2011). 'Trade creation and the status of FTAs: empirical evidence from East Asia', *Review of World Economics,* Vol. **147**, pp. 429-456.

MOLNAR, A. and TRENDS, F. (2003) *Forest certification and communities: looking forward to the next decade,* Forest Trends Washington, DC.

MULYANI, M. and JEPSON, P. (2015). 'Social learning through a REDD+ 'village agreement': Insights from the KFCP in Indonesia', *Asia Pacific Viewpoint,* Vol. **56**, pp. 79-95.

MURRAY, B. C. and ABT, R. C. (2001). 'Estimating price compensation requirements for eco-certified forestry', *Ecological Economics,* Vol. **36**, pp. 149-163.

NEBEL, G., QUEVEDO, L., JACOBSEN, J. B. and HELLES, F. (2005). 'Development and economic significance of forest certification: the case of FSC in Bolivia', *Forest Policy and Economics,* Vol. **7**, pp. 175-186.

NEWTON, P., MILLER, D. C., BYENKYA, M. A. A. and AGRAWAL, A. (2016). 'Who are forest-dependent people? A taxo nomy to aid livelihood and land use decision-making in forested regions', *Land Use Policy,* Vol. **57**, pp. 388-395.

NURROCHMAT, D. R., DHARMAWAN, A. H., OBIDZINSKI, K., DERMAWAN, A. and ERBAUGH, J. T. (2016). 'Contesting national and international forest regimes: Case of timber legality

certification for community forests in Central Java, Indonesia', *Forest Policy and Economics,* Vol. **68**, pp. 54-64.

NUSSBAUM, R. and SIMULA, M. (2013) *The forest certification handbook,* Taylor & Francis.

O'SULLIVAN, A., SHEFFRIN, S. and PEREZ, S. (2011) *Survey of Economics: Principles, Applications, and Tools,* Pearson Higher Ed.

OLANDER, L. P., GIBBS, H. K., STEININGER, M., SWENSON, J. J. and MURRAY, B. C. (2008). 'Reference scenarios for deforestation and forest degradation in support of REDD: a review of data and methods', *Environmental Research Letters,* Vol. **3**, pp. 025011.

OTA, I. and KAMAKURA, M. (2016). 'Obstacles to the Spread of Forest Certification Schemes on Small-scale Forestry in Japan', *Small-scale and Community Forestry and the Changing Nature of Forest Landscapes*, pp. 189.

OWARI, T., JUSLIN, H., RUMMUKAINEN, A. and YOSHIMURA, T. (2006). 'Strategies, functions and benefits of forest certification in wood products marketing: Perspectives of Finnish suppliers', *Forest Policy and Economics,* Vol. **9**, pp. 380-391.

PACHECO-BLANCO, B. and BASTANTE-CECA, M. J. (2016). 'Green Public Procurement as an initiative for Sustainable Consumption. An exploratory study of Spanish public universities', *Journal of Cleaner Production*.

PAGIASLIS, A. and KRONTALIS, A. K. (2014). 'Green consumption behavior antecedents: Environmental concern, knowledge, and beliefs', *Psychology & Marketing,* Vol. **31**, pp. 335-348.

PAN, Y., BIRDSEY, R. A., FANG, J., HOUGHTON, R., KAUPPI, P. E., KURZ, W. A., PHILLIPS, O. L., SHVIDENKO, A., LEWIS, S. L. and CANADELL, J. G. (2011). 'A Large and Persistent Carbon Sink in the World's Forests', *Science*, pp. 988-993.

PAPPILA, M. (2013). 'Forest certification and trust—Different roles in different environments', *Forest Policy and Economics,* Vol. **31**, pp. 37-43.

PARIKKA-ALHOLA, K. (2008). 'Promoting environmentally sound furniture by green public procurement', *Ecological Economics,* Vol. **68**, pp. 472-485.

PATEL, T., DHIAULHAQ, A., GRITTEN, D., YASMI, Y., DE BRUYN, T., PAUDEL, N. S., LUINTEL, H., KHATRI, D. B., SILORI, C. and SUZUKI, R. (2013). 'Predicting future conflict under REDD+ implementation', *Forests,* Vol. **4**, pp. 343-363.

PEFC (2001). An advisory note for retailers. Sheffield, UK.

PEFC (2009). 'Who Gains from FSC's Latest Effort to Undermine Other Forest Certification Systems?', Sh.

PEFC (2011). 'PEFC and FSC Global Sustainable Forest Management Certification Schemes', in PEFC (ed.).

PEFC (2016). 'EU Timber Regulation (EUTR)'.

PERMAN, R. (2003) *Natural resource and environmental economics,* Pearson Education.

PIRARD, R. (2012). 'Market-based instruments for biodiversity and ecosystem services: A lexicon', *Environmental Science & Policy,* Vol. **19**, pp. 59-68.

PRESTEMON, J. P. (2015). 'The impacts of the Lacey Act Amendment of 2008 on US hardwood lumber and hardwood plywood imports', *Forest Policy and Economics,* Vol. **50**, pp. 31-44.

PUTZ, F. E., DYKSTRA, D. P. and HEINRICH, R. (2000). 'Why poor logging practices persist in the tropics', *Conservation Biology,* Vol. **14**, pp. 951-956.

RAMETSTEINER, E. and SIMULA, M. (2003). 'Forest certification—an instrument to promote sustainable forest management?', *Journal of environmental management,* Vol. **67**, pp. 87-98.

RAUNIKAR, R., BUONGIORNO, J., TURNER, J. A. and ZHU, S. (2010). 'Global outlook for wood and forests with the bioenergy demand implied by scenarios of the Intergovernmental Panel on Climate Change', *Forest Policy and Economics,* Vol. **12**, pp. 48-56.

RICARDO, D. (1817). 'On foreign trade', *Principles of political economy and taxation*.

ROBERTSON, N. (1984). 'The ritual background of the Erysichthon story', *The American Journal of Philology,* Vol. **105**, pp. 369-408.

RODRIGUE, J. and SOUMONNI, O. (2014). 'Deforestation, foreign demand and export dynamics in Indonesia', *Journal of International Economics,* Vol. **93**, pp. 316-338.

ROE, B., EASTIN, I. and GANGULY, I. (2014). 'The impact of timber legality regulations on business practices in Vietnam', *The Forestry Chronicle,* Vol. **90**, pp. 651-659.

SCARLETT, L. and BOYD, J. (2015). 'Ecosystem services and resource management: institutional issues, challenges, and opportunities in the public sector', *Ecological Economics,* Vol. **115**, pp. 3-10.

SCHALTEGGER, S., BURRITT, R., AMANN, M., ROEHRICH, J. K., EßIG, M. and HARLAND, C. (2014). 'Driving sustainable supply chain management in the public sector: The importance of public procurement in the European Union', *Supply Chain Management: An International Journal,* Vol. **19**, pp. 351-366.

SCHAUBROECK, T., DECKMYN, G., GIOT, O., CAMPIOLI, M., VANPOUCKE, C., VERHEYEN, K., RUGANI, B., ACHTEN, W., VERBEECK, H. and DEWULF, J. (2016). 'Environmental impact assessment and monetary ecosystem service valuation of an ecosystem under different future environmental change and management scenarios; a case study of a Scots pine forest', *Journal of environmental management,* Vol. **173**, pp. 79-94.

SCHMITZ, H. (1995). 'Collective efficiency: Growth path for small-scale industry', *The journal of development studies,* Vol. **31**, pp. 529-566.

SCOTT, A. J. and KNOTT, M. (1974). 'A cluster analysis method for grouping means in the analysis of variance', *Biometrics*, pp. 507-512.

SEDJO, R. A. and SOHNGEN, B. (2013). 'Wood as a major feedstock for biofuel production in the United States: Impacts on forests and international trade', *Journal of Sustainable Forestry,* Vol. **32**, pp. 195-211.

SEDLACEK, T. (2011) *Economics of good and evil: The quest for economic meaning from Gilgamesh to Wall Street,* Oxford University Press.

SHOJI, Y., NAKAO, N., UEDA, Y., KAKIZAWA, H. and HIRAI, T. (2014). 'Preferences for certified forest products in Japan: A case study on interior materials', *Forest Policy and Economics,* Vol. **43**, pp. 1-9.

SIMULA, M., ASTANA, S., ISHMAEL, R., SANTANA, E. and SCHMIDT, M. (2004). Report on financial cost-benefit analysis of forest certification and implementation of phased approaches.

SLOAN, S. (2015). 'The development-driven forest transition and its utility for REDD+', *Ecological Economics,* Vol. **116**, pp. 1-11.

SMITH, A. (1776). 'An inquiry into the nature and causes of the wealth of nations: Volume One', London: printed for W. Strahan; and T. Cadell, 1776.

SMITH, R., MUIR, R. D., WALPOLE, M. J., BALMFORD, A. and LEADER-WILLIAMS, N. (2003). 'Governance and the loss of biodiversity', *Nature,* Vol. **426**, pp. 67-70.

STTC (2016). Give value to forests. Brussels.

SUN, L. B., BRYAN E.C. (2017). 'Trade incentives for importers to adopt policies to address illegally logged timber: The case of non-tropical hardwood plywood', *Journal of Forest Economics,* Vol. **27**, pp. 18-27.

SUNDERLIN, W., SILLS, E., DUCHELLE, A., EKAPUTRI, A., KWEKA, D., TONIOLO, M., BALL, S., DOGGART, N., PRATAMA, C. and PADILLA, J. (2015). 'REDD+ at a critical juncture: assessing the limits of polycentric governance for achieving climate change mitigation', *International Forestry Review,* Vol. **17**, pp. 400-413.

SWOBODA, A. K. (1972). 'Equilibrium, quasi-equilibrium, and macroeconomic policy under fixed exchange rates', *The Quarterly Journal of Economics*, pp. 162-171.

TAJIBAEVA, L. S. (2012). 'Property rights, renewable resources and economic development', *Environmental and Resource Economics,* Vol. **51**, pp. 23-41.

TAKAYAMA, T. and JUDGE, G. (1970). 'Alternative spatial equilibrium models', *Journal of Regional Science,* Vol. **10**, pp. 1-12.

TAKAYAMA, T. and JUDGE, G. G. (1971) *Spatial and temporal price and allocation models,* North-Holland Amsterdam.

TARANTINI, M., LOPRIENO, A. D. and PORTA, P. L. (2011). 'A life cycle approach to Green Public Procurement of building materials and elements: A case study on windows', *Energy,* Vol. **36**, pp. 2473-2482.

TAYLOR, P. L. (2005). 'In the market but not of it: Fair trade coffee and forest stewardship council certification as market-based social change', *World development,* Vol. **33**, pp. 129-147.

TEGEGNE, Y., OCHIENG, R., VISSEREN-HAMAKERS, I., LINDNER, M. and FOBISSIE, K. (2014). 'Comparative analysis of the interactions between the FLEGT and REDD+ regimes in Cameroon and the Republic of Congo', *International Forestry Review,* Vol. **16**, pp. 602-614.

TEGEGNE, Y. T., RAMCILOVIC-SUOMINEN, S., FOBISSIE, K., VISSEREN-HAMAKERS, I. J., LINDNER, M. and KANNINEN, M. (2017). 'Synergies among social safeguards in FLEGT and REDD+ in Cameroon', *Forest Policy and Economics,* Vol. **75**, pp. 1-11.

TESTA, F., IRALDO, F., FREY, M. and DADDI, T. (2012). 'What factors influence the uptake of GPP (green public procurement) practices? New evidence from an Italian survey', *Ecological Economics,* Vol. **82**, pp. 88-96.

THE GLOBAL CARBON PROJECT (2016). The Global Carbon Budget 2016. Canberra, Australia.

TRISHKIN, M., LOPATIN, E. and KARJALAINEN, T. (2015). 'Exploratory assessment of a company's due diligence system against the EU timber regulation: A case study from Northwestern Russia', *Forests,* Vol. **6**, pp. 1380-1396.

UN REDD (2017). 'REDD+ Helpdesk'.

UNECE (2013). 'Forest Products Annual Market Review 2012-2013', Geneva, Switzerland, pp. 155.

UNECE (2015). Forest Products Annual Market Review 2014 - 2015. Geneva, Switzerland.

UNECE (2016). Forest products annual market review 2015-2016. Geneva, Switzerland.

UNECE/FAO (2014). Forest Products Annual Market Review 2012-2013. Geneva.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2013). Afforestation and Reforestation Projects under the Clean Development Mechanism. Bonn, Germany.

VAN DEUSEN, P. C., WIGLEY, T. B. and LUCIER, A. A. (2010). 'Some indirect costs of forest certification', *Forestry,* Vol. **83**, pp. 389-394.

VAN HEESWIJK, L. and TURNHOUT, E. (2013). 'The discursive structure of FLEGT (Forest Law Enforcement, Governance and Trade): The negotiation and interpretation of legality in the EU and Indonesia', *Forest Policy and Economics,* Vol. **32**, pp. 6-13.

VAN KOOTEN, G. C., NELSON, H. W. and VERTINSKY, I. (2005). 'Certification of sustainable forest management practices: a global perspective on why countries certify', *Forest Policy and Economics,* Vol. **7**, pp. 857-867.

VANHONACKER, F., VAN LOO, E. J., GELLYNCK, X. and VERBEKE, W. (2013). 'Flemish consumer attitudes towards more sustainable food choices', *Appetite,* Vol. **62**, pp. 7-16.

VEDEL, S. E., JACOBSEN, J. B. and THORSEN, B. J. (2015). 'Forest owners' willingness to accept contracts for ecosystem service provision is sensitive to additionality', *Ecological Economics,* Vol. **113**, pp. 15-24.

VEISTEN, K. (2007). 'Willingness to pay for eco-labelled wood furniture: Choice-based conjoint analysis versus open-ended contingent valuation', *Journal of Forest Economics,* Vol. **13**, pp. 29-48.

VERMEIR, I. and VERBEKE, W. (2006). 'Sustainable food consumption: Exploring the consumer “attitude–behavioral intention” gap', *Journal of Agricultural and Environmental ethics,* Vol. **19**, pp. 169-194.

VLAAMSE WOONRAAD (2011). Wonen en armoede. Brusseles.

WAN, M. and TOPPINEN, A. (2016). 'Effects of perceived product quality and Lifestyles of Health and Sustainability (LOHAS) on consumer price preferences for children's furniture in China', *Journal of Forest Economics,* Vol. **22**, pp. 52-67.

WANG, X., BIEWALD, A., DIETRICH, J. P., SCHMITZ, C., LOTZE-CAMPEN, H., HUMPENÖDER, F., BODIRSKY, B. L. and POPP, A. (2016). 'Taking account of governance: Implications for land-use dynamics, food prices, and trade patterns', *Ecological Economics,* Vol. **122**, pp. 12-24.

WENDLAND, K. J., LEWIS, D. J. and ALIX-GARCIA, J. (2014). 'The effect of decentralized governance on timber extraction in European Russia', *Environmental and Resource Economics,* Vol. **57**, pp. 19-40.

WIERSUM, K. F. and ELANDS, B. H. (2013). 'Opinions on legality principles considered in the FLEGT/VPA policy in Ghana and Indonesia', *Forest Policy and Economics,* Vol. **32**, pp. 14-22.

WODSCHOW, A., NATHAN, I. and CERUTTI, P. (2016). 'Participation, public policy-making, and legitimacy in the EU Voluntary Partnership Agreement process: The Cameroon case', *Forest Policy and Economics,* Vol. **63**, pp. 1-10.

WOLFERSBERGER, J., DELACOTE, P. and GARCIA, S. (2015). 'An empirical analysis of forest transition and land-use change in developing countries', *Ecological Economics,* Vol. **119**, pp. 241-251.

WORLD BANK (2016). 'Forests - Overview', Washington, D.C.

WWF (2015). 'Personnal communication on eco-certification's role in legality verification with Karen Mo (R&D) and Gijs Breuking (Foristry coordinator)', in BRUSSELAERS J (ed.), Durban, SA.

XU, X. (2000). 'International trade and environmental regulation: time series evidence and cross section test', *Environmental and Resource Economics,* Vol. **17**, pp. 233-257.

YAMAMOTO, Y., TAKEUCHI, K. and SHINKUMA, T. (2014). 'Is there a price premium for certified wood? Empirical evidence from log auction data in Japan', *Forest Policy and Economics,* Vol. **38**, pp. 168-172.

YASMI, Y., KELLEY, L., MURDIYARSO, D. and PATEL, T. (2012). 'The struggle over Asia's forests: An overview of forest conflict and potential implications for REDD+', *International Forestry Review,* Vol. **14**, pp. 99-109.

YEDLA, M., PATHAKOTA, S. R. and SRINIVASA, T. (2010). 'Enhancing K-means clustering algorithm with improved initial center', *International Journal of computer science and information technologies,* Vol. **1**, pp. 121-125.

ZHU, Q., GENG, Y. and SARKIS, J. (2013). 'Motivating green public procurement in China: An individual level perspective', *Journal of environmental management,* Vol. **126**, pp. 85-95.

Summary

Forests provide services which are key in halting climate change, and mitigating the current and future effects of climate change on people. For this reason, numerous governmental and non-governmental initiatives aim to sustain forest management and achieve afforestation. Those initiatives differ in terms of scale, funding, geographical focus, and approach. The initiatives considered in this thesis acknowledge that forests can contribute to climate change protection as well as offering economic, environmental, and sociocultural benefits. In their rationale, forests must not necessarily become non-productive. Instead, forests are, and should be, 'more than trees' and are essential for food security and improving livelihoods.

However, productive forests can only contribute to climate change protection when they are sustainably managed. Therefore, demand for wood which is extracted legally, or out of sustainably managed forests must be stimulated. This requires a level of involvement at the demand side of the wood market.

In this context, two strategies are widely promoted: state-based legality initiatives and non-state eco-certification. The distinction between governmental and non-governmental initiatives is useful, but in the EU, both types of initiatives often interact and mutually reinforce each other. On the one hand, two important governmental initiatives in support of legal or sustainable wood production and consumption rely upon non-governmental eco-certification. First, eco-certified wood is acknowledged as the green alternative in public procurement policies which take environmental criteria into account. This type of policy is called Green Public Procurement (GPP). Second, the EU acknowledges compliance of non-governmental eco-certification schemes to its legality requirements. On the other hand, several certification schemes developed more ambitious legality assurance standards in response to the EU Forest Law Enforcement, Governance and Trade (FLEGT) programme and the EU Timber Regulation, as well as member-state procurement policies.

This thesis quantifies the leverage effect of Green Public Procurement and state-based legality initiatives in the EU on the global consumption and production of sustainable wood. This is necessary because the state-based legality initiatives and non-state eco-certification in the North are expected to stimulate the uptake of sustainable wood production and forest management practices both in the North and in the South. It is widely accepted that the strong interlinkages between the different regional wood markets through trade effectuate this kind of pass-through effect of one regional policy to other regions' wood markets.

However, at present, the Southern hemisphere only accounts for 11% of the globally certified area. Simultaneously, only six countries concluded a Voluntary Partnership Agreement (VPA) with the EU. A VPA combines legality licensing with multi-stakeholder processes which aim to address underlying problems of forest governance in the country concerned. The legality licensing must assure the legal origin of wood and award access to the EU's wood market.

The limited importance of the South in global certified, or legality verified wood production is explained by the high compliance costs in the South. The magnitude of the compliance cost is inversely related to the quality of the current management practices. Regions with good (legal) standards for forest management face low indirect costs, those regions are predominantly situated in the Northern hemisphere.

This thesis presents two comparative Spatial Equilibrium Models that investigate the impact of GPP in the EU, respectively legality initiatives by the EU's FLEGT on the uptake of eco-certified or legality verified wood production and consumption. Neither policy succeeds in increasing the share of certified production in the South above 5% of the SEM's global certified production. In contrast, some regions experience an increased conventional wood production. Both models reveal the decision mechanism which impedes an important shift towards sustainable forest management and wood production practices: the high compliance costs in the South are insufficiently compensated by a higher price.

Thorough comparison of both models demonstrates important differences in both policies' impact. In general, GPP provides a better stimulus for sustainable wood production. GPP is more positive in nature as it tends to activate a latent demand for wood products. This still allows each region to specialize in the wood type (i.e. conventional or eco-certified) for which they have a comparative advantage. Activating the latent demand also allows an increase in global welfare. In contrast, FLEGT is more negative in nature, as it restricts trade in conventional wood. In this case, comparative advantages do not determine the production choices. Consequently, some conventional wood producers can benefit from increased prices and increase their conventional production. The restrictive nature of FLEGT negatively impact the global welfare.

In the context of FLEGT, the models' results are supported by the historical analysis of Cameroon's volume of exported wood to the EU. The analysis finds that the VPA negatively impacted on Cameroon's wood exports when it came into force. Furthermore, the historical analysis identifies a unique anticipative pattern in the Cameroonian exports. During the VPA negotiations, wood operators redirect their trade flows in anticipation of more stringent trade conditions in future. In contrast, the exports briefly revive between the VPA agreement and it coming into force. This short revival is a manifestation of short term, rent-seeking behavior by wood traders who aim to benefit from the old, less stringent, export conditions. This leads to increased wood extraction, and threatens long term, sustainable forest management.

In the context of GPP, the models indicate that increased government purchases of eco-certified wood stimulates the uptake of eco-certified consumption and production at global level. However, the increased purchases by governments push up prices for eco-certified wood and drive consumers out of the eco-certified market segment. However, GPP initially aims to foster consumption of eco-certified wood by reducing the transaction costs for adapting to new products and stimulate the uptake of

innovations. Therefore, this thesis further investigates private consumers' level of support towards government purchases of eco-certified wood. This analysis distinguishes different segments of private consumers. The consumer segment with a high environmental awareness, subjective norm, and attitude towards eco-certified wood also displays the highest intention to buy eco-certified wood. In general, all consumers are supportive towards GPP. However, the level of support significantly decreases when GPP entails negative consequences (i.e. increased prices, crowding-out private consumers). This decrease in support for GPP is significantly and positively correlated to environmental concern. Environmental concern is traditionally labelled as an altruistic driver for sustainable consumption. This analysis demonstrates that the score on the New Environmental Paradigm, as measure for environmental concern, also captures an element of self-interest.

Samenvatting

Bossen leveren een essentiële bijdrage in de strijd tegen klimaatopwarming. Bovendien kunnen ze ervoor zorgen dat de huidige en toekomstige impact van klimaatopwarming voor de mens beperkt blijft. Om deze redenen streven verschillende initiatieven naar (her)bebossing en een verduurzaming van het bosbeheer. Deze initiatieven verschillen echter sterk in aard. Zo kan een overheid gouvernementele initiatieven initiëren, maar kunnen hiernaast ook niet-gouvernementele initiatieven ontstaan. Verder kunnen initiatieven verschillen in – bijvoorbeeld – omvang (schaal), geografisch doelgebied, benadering en financiering. Een zogenaamd Market-Based Initiatief (MBI) veronderstelt dat bossen een bijdrage kunnen leveren in de strijd tegen klimaatopwarming en tegelijkertijd een economische, ecologische en socio-culturele meerwaarde kunnen creëren. In dit opzicht zijn bossen 'meer dan bomen' en worden ze gebruikt in de productie van goederen en diensten. Op deze manier beschermen en verhogen ze de levensomstandigheden en voedselzekerheid van verschillende huishoudens.

Productieve bossen kunnen enkel een bijdrage leveren in de strijd tegen klimaatopwarming wanneer ze duurzaam worden beheerd. MBI-en stimuleren duurzaam beheer door gebruik te maken van de werking van de houtmarkt (prijsvorming en andere economische variabelen). Meer in het bijzonder hoopt een MBI de vraag naar legaal en duurzaam hout te verhogen. Dit vereist een zeker engagement aan de vraagzijde van de houtmarkt.

Twee strategieën worden steeds meer naar voor geschoven in de context van MBI-en: legaliteitseisen opgelegd door een overheid en niet-gouvernementele duurzaamheid labels. Theoretisch is het onderscheid tussen overheids- en niet-gouvernementele initiatieven duidelijk, maar binnen de EU interageren beide types initiatieven vaak met elkaar. Zo steunen twee belangrijke overheidsinitiatieven ter promotie van legale en duurzame houthandel sterk op niet-gouvernementele duurzaamheid labels. Ten eerste wordt aangenomen dat gelabeld hout voldoet aan de legaliteitsprincipes van de EU. Ten tweede fungeert gelabeld hout vaak als 'groen alternatief' in richtlijnen voor duurzame overheidsaankopen. Duurzame overheidsaankopen beschouwen naast economische ook ecologische criteria tijdens de selectie van leveranciers/producten voor de overheid. Anderzijds versterken de vermelde overheidsinitiatieven ook de werking van de duurzaamheidslabel. Zowel FSC als PEFC, de twee meest bekende duurzaamheid labels, verstrengden hun legaliteitsnormen om te voldoen aan de vereisten van de EU Timber Regulation en duurzame overheidsaankopen in de EU-lidstaten.

Deze thesis kwantificeert het hefboomeffect van duurzame overheidsaankopen enerzijds en overheidseisen inzake de legaliteit van hout producten anderzijds. In de thesis wordt steeds vertrokken vanuit beleid dat zijn oorsprong vindt in de EU, maar tegelijkertijd wordt ook erkend dat het beleid een impact kan hebben op de globale consumptie en productie van duurzaam en/of legaal hout. Deze globale aanpak is nodig omdat de legaliteitsvereisten en duurzame overheidsaankopen in de EU ook daadwerkelijk de intentie hebben om de productie van duurzaam hout en duurzaam bosbeheer op

globaal niveau te stimuleren. Bovendien wordt algemeen aangenomen dat de houtmarkten van de verschillende regio's sterk met elkaar verbonden zijn door handelsstromen. Dit maakt het mogelijk dat de vraag en/of aanbodschokken in een bepaald regio (eventueel geïnitieerd door overheidsbeleid) een impact hebben op de houtmarkt van andere regio's.

Ondanks de goede intenties hebben de aangehaalde initiatieven tot op heden nog niet geleid tot een sterke toename van duurzame of legale houtproductie in het Zuidelijke halfrond. Slechts 11% van de wereldwijde eco-gecertificeerde houtproductie vindt plaats in Afrika, Azië of Latijns-Amerika. Ook zijn er slechts 6 landen die er in slaagden om een Voluntary Partnership Agreement (VPA) in werking te laten treden. Een VPA is bilaterale overeenkomst tussen de EU en een hout-producerend land in het Globale Zuiden. Het combineert een certificerings-systeem met een multi-stakeholder proces. De uitgereikte certificaten moeten aantonen dat het gecertificeerde hout 100% legaal hout is. Op deze manier verlenen de certificaten automatische toegang tot de Europese houtmarkt. Het multi-stakeholder proces moet specifieke problemen in de houtsector van het hout-producerende land oplossen.

De kosten verbonden aan legale of duurzame houtproductie zijn veel hoger in het Zuidelijke halfrond dan in het Noordelijke halfrond. Dit verklaart het beperkte succes van duurzame of legale houtproductie in het globale Zuiden. De kosten ligger hoger komt omdat de kosten omgekeerde evenredig verbonden zijn met de kwaliteit van de huidige bosbeheerpraktijken. Landen en regio's die goede standaarden ontwikkelden voor (legale) houtproductie worden met lagere indirecte kosten geconfronteerd. Deze regio's vind je hoofdzakelijk in het Noordelijke halfrond.

Deze thesis beschrijft de resultaten van twee vergelijkende 'Spatial Equilibrium' Modellen. De modellen onderzoeken de impact van duurzame overheidsaankopen en legaliteitsvereisten in de EU op de globale productie en consumptie van respectievelijk duurzaam en legaal hout. Geen van de vermelde initiatieven slaagt er in om het aandeel van het Zuidelijke halfrond te vergroten tot 5% van de globale legale of duurzame houtproductie. In sommige regio's daalt het belang van de legale of duurzame houtproductie zelfs. Beide modellen onthullen het beslissingspatroon die een verschuiving richting duurzame en legale bosbeheer praktijken verhinderd: de hoge kosten verbonden aan duurzame of legale houtproductie worden onvoldoende gecompenseerd door een verhoogde prijs voor duurzaam of legaal hout.

Een vergelijking tussen de twee modellen toont aan dat de impact van beide initiatieven sterk verschilt. Algemeen gesteld zijn duurzame overheidsaankopen de beste stimulus voor de productie van duurzaam hout. Duurzame overheidsaankopen zijn een positief beleid dat een latent aanwezige vraag naar duurzaam hout hoopt te activeren. Het activeren van de latent aanwezige vraag leidt uiteindelijk ook tot een verhoging van de globale welvaart. Dit beleid laat ook nog toe dat elke regio zich kan specialiseren in het type hout, conventioneel of duurzaam, waarvoor zij een comparatief voordeel

heeft. Hier tegenover staan de legaliteitsvereisten die resulteren uit FLEGT. Legaliteitsvereisten verhinderen de import van hout waarvan de legaliteit niet expliciet kan aangetoond worden. Dit wil niet noodzakelijk zeggen dat het verbannen hout per definitie illegaal is. Het verbod op handel voor dat niet aantoonbaar legaal is zorgt maakt dat legaliteitsvereisten een restrictiever (negatief) karkater hebben. In deze situatie zijn de comparatieve voordelen van de verschillende landen minder belangrijk in hun productiekeuze voor conventionele of aangetoond-legale productie. Hierdoor profiteren sommige conventionele houtproducenten van stijgende prijzen en verhogen ze hun conventionele houtproductie. De restrictieve aard van de legaliteitsvereisten verkleint de globale welvaart.

De resultaten van beide modellen worden geruggesteund door de resultaten van een analyse van de verhandelde hoeveelheid hout van Cameroon naar de EU sinds 2000. Deze analyse toont aan dat de invoering van het VPA in Cameroon de export naar de EU deed dalen. Bovendien onthulde de analyse een bijzondere vorm van anticipatief gedrag voor de invoering van het VPA. De houthandelaren verschoven hun handelsstromen reeds tijdens de onderhandelingen van het VPA. Hierdoor ging steeds minder hout naar de EU. Ze anticipeerden hiermee op de strengen handelsvoorwaarden waarmee ze in de toekomst zouden geconfronteerd worden. Echter, de export van Cameroon naar de EU herleefde gedurende de korte periode tussen afronding van de onderhandelingen en voor de effectieve inwerkingtreding van het VPA. Deze heropflakkering van de houtexport is het gevolg van korte-termijn denken van de houthandelaren waarbij ze op zoek gaan naar korte termijn voordelen/winsten. Nu duidelijk is waarmee ze in de toekomst geconfronteerd zullen worden willen ze nog even genieten van de minder strenge handelsvoorwaarden. Hierdoor wordt er tijdens deze korte periode meer hout geproduceerd worden, wat een bedreiging vormt voor het duurzame (lange termijn) bosbeheer in Cameroon. Dit effect werd ook geobserveerd in de Republiek Congo (Congo-Brazzaville).

Het model dat de impact van overheidsaankopen analyseert toont aan dat dit beleid de globale productie en consumptie van duurzaam hout kan doen toenemen. De verhoogde overheidsaankopen resulteren echter in een verhoogde prijs voor duurzaam hout. De particuliere consumenten die deze hogere prijs niet kunnen of willen betalen worden op deze manier uit de markt voor duurzaam hout gedreven. Dit effect conflicteert met de initiële logica van duurzame overheidsaankopen. Duurzame overheidsaankopen hopen de transactiekosten voor de aankoop van nieuwe – duurzame – producten te verlagen en innovaties te stimuleren. Op deze manier hoopt de overheid ook de (privé) consumptie van duurzaam hout te verhogen. Deze tegenstrijdigheid tussen intentie en effect wordt verder bestudeerd in een studie naar de steun van particuliere consumenten voor duurzame overheidsaankopen. Deze laatste analyse deelt consumenten op in verschillende segmenten op basis van hun karakteristieken, meer bepaald op basis van hun ecologische bekommernis, sociale druk om duurzame producten aan te kopen en houding (positief of negatief) ten opzichte van duurzame aankopen. Op deze manier kan een voluntaristisch segment worden geïdentificeerd die ook een sterke intentie signaleert om in de toekomst duurzaam hout aan te kopen. Algemeen gesteld steunen consumenten een duurzaam

aankoopbeleid van hun overheid. Deze steun daalt echter significant wanneer het duurzame aankoopbeleid negatieve gevolgen heeft voor hun persoonlijke situatie. Voorbeelden van negatieve gevolgen zijn een stijgende prijs voor duurzaam hout, of een beperkte beschikbaarheid van duurzaam hout. Opvallend genoeg is de mate waarin de steun voor het duurzame aankoopbeleid daalt positief gecorreleerd met de ecologische bekommernis van een consument. Traditioneel wordt de ecologische bekommernis van een consument beschouwd als een altruïstische drijfveer voor duurzame consumptie. Bovenstaande analyse suggereert echter dat de score op het 'New Environmental Paradigm', als maatstaaf voor het ecologische bewustzijn, ook een element van eigenbelang omvat.

Scientific Curriculum Vitae

PERSONAL INFORMATION

Jan Brusselaers


Berkenlaan 15, 9150 Kruibeke, Belgium


(+32) 471 81 20 86


janbrusselaers@hotmail.com

Date of birth: 30 October 1985 | Nationality: Belgian

ACADEMIC DEGREES

2010 **Master of Art 'Economics of International Trade and European Integration**

Erasmus Mundus program:

- Université Sciences et Technologies de Lille 1 (France) - (1st semester)
- Antwerp University (Belgium) – (2nd semester)
- University of Economics VSE Prague (Czech Republic) (3rd semester)
- Thesis topic: Long run correlation between trade and migration flows towards the EU

2009 **Master in Applied Economics**

Antwerp University (Belgium)

- Greatest distinction
- Specialization: International management and diplomacy
- Thesis topic: Assessment of the Belgian – DR Congo trade relationship in the post-Mobutu era

WORK EXPERIENCE

April 2012 – today **Teaching assistant Ghent University (50%) – Ghent University**

Department of Agricultural Economics

- Teaching activities in the courses of: Econometrics, Advanced Research Methods, Economics of animal production, Micro-Economic theory and farm management, Scientific Communication, Natural Resource Management.
- Supervision of 17 Master Dissertations pursued by MSc students in the field of Agricultural Economics and Natural Resource Management.

April 2012 – today **Doctoral researcher (50%) – Ghent University**

Department of Agricultural Economics -
MODERNA unit :**M**odelling and **O**ptimization of **D**ecisions in **E**conomics, **R**esources, **N**ature and **A**griculture:

- Research contribution:
  - Sector analysis: Pig production in West-Flanders.
  - Assessment of Low carbon society Policy Instruments (ALPI)

Jan 2011 – Mar 2012 **Economist – Researcher @ LEI – Wageningen University & Research**

Department of international value chains

- Impact monitoring and assessment of policy options and project impact.
- Research contribution to 'Support for farmers' cooperatives'.

- Field work experience (data gathering) in Ghana & Kenya in context of impact assessment at farmer level of thee and cocoa certification schemes.

PUBLICATIONS

Peer reviewed

1. Brusselaers, J., Van Huylenbroeck, G., Buysse, J. (2017) Green Public Procurement of Certified Wood: Spatial Leverage Effect and Welfare Implications, *Ecological Economics 135 (May),* pp. 91-102. DOI: 10.1016/j.ecolecon.2017.01.012.

2. Brusselaers, J., Poppe, K., Garcia Azcarate, T. (2014) Do policy measures impact the position and performance of farmers' cooperatives in the EU?, *Annals of public and cooperative economics 84(*4), pp.531-553.

Conference full papers

1. Brusselaers, J., Buysse, J. Introducing (eco-)certification in spatial equilibrium modelling: EUTR trade barrier or leverage. *17th Annual Conference European Trade Study Group,* September 8 to 10, 2016, Helsinki, Finland.

2. Brusselaers, J., Buysse, J. The Due Diligence System in the EU's Timber Regulation: non-tariff trade barrier or leverage effect?. *European Association of Environmental and Resource Economists, 22nd annual conference, Papers*, June 22 to 25, 2016, Zurich, Switzerland.

3. Dupeux, B.E.T.I., Brusselaers, J., and Buysse, J. Welfare analysis of organic dairy certification: a graphical assessment. *ICAE 2015 Congress 'Agriculture in an interconnected world'*, August 8 to 14, 2015, Milan, Italy.

4. Brusselaers, J., Buysse, J. Procurement policies in Europe: leverage- and welfare-effect in Africa. *Ghent Africa Platform GAPSYM 9,* December 17, 2015, Ghent, Belgium.

5. Brusselaers, J., Van Huylenbroeck, G., Buysse, J. Green public procurement of certified wood: impact on international trade and global welfare. *XIV FAO World Forestry Congress, Papers*, September 7 to 11, 2015, Durban, South Africa.

6. Brusselaers, J., Van Huylenbroeck, G., Buysse, J., GPP of wood: alternative global welfare calculation. *ICAE 2015 Congress 'Agriculture in an interconnected world',* August 8 to 14, 2015, Milan, Italy.

7. Brusselaers, J., Buysse, J., GPP of Certified Wood: pass-through effect on the International Markets and Global Welfare. *European Association of Environmental and Resource Economists, 21st annual conference, Papers*, June 24 to 27, 2015, Helsinki, Finland.

8. Brusselaers, J., Van Huylenbroeck, G., Buysse, J. Green public procurement of certified wood: The impact on the international market, global welfare and welfare analysis. *20th Spring Meeting of Young Economists,* May 21 to 23, 2015, Ghent, Belgium.

Working papers

1. Brusselaers, J., Buysse, J. (2017). The legality requirements in the EU Timber Regulation: non-tariff trade barrier or leverage effect?. Submitted in April and currently in review process in *Journal of Forest Economics*

2. Brusselaers, J., Buysse, J. (2017). Implementation of the EU-Cameroon Voluntary Partnership Agreement: trade distortion, rent-seeking and anticipative behavior. Submitted in March and currently in review process in

Review of Environmental Economics & Policy

3. Brusselaers, J., Verbeke, W., Mettepenningen, E., Buysse, J. Drivers for intention to buy eco-certified wood and support for Green Public Procurement with negative consequences.

TRIVIA

2015 & 2016	Awarded with FWO international mobility grant for participation in international conference
2016	Post academic training in Big Data management
2014	Courses on 'The logical framework approach: methodology of the transversal analysis' in the International Intensive Course Program – Sustainability and Innovation in Rural Development. Kaunas, Lithuania