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POUR OBTENIR LE GRADE DE

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L'UNIVERSITÉ DE BORDEAUX

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SPÉCIALITÉ SCIENCES ÉCONOMIQUES

Par **Jeanne MÉTIVIER**

**Trade Disputes among Members of the World Trade
Organization**

**Différends Commerciaux au sein des Pays Membres de l'Organisation
Mondiale du Commerce**

Sous la direction de M. Antoine BOUËT et de Mme Sophie BRANA

Soutenue le 7 octobre 2019

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Chapter 0

General Introduction

Trade disputes reflect “broken promises” and may be thought of as failures to honour or interpret trade agreements mutually decided upon among a set of countries (World Trade Organisation, 2019a). Focusing on the largest group of nations that have agreed to follow a set of multilateral trade rules, members of the World Trade Organisation (WTO), we explore through three independent articles how these members may respond to trade disputes. In particular, we reflect on the WTO dispute settlement system (DSS) and its accessibility to developing countries, and on the welfare consequences of non-multilateral responses to trade disputes. Finding efficient and welfare-improving reactions to trade disputes seems essential in light of the large and growing number of trade disputes occurring among WTO members. The WTO DSS recorded a total of 574 trade complaints from its inception in 1995 to 2018. Furthermore, it received 40 charges in 2018, compared to 18 in 2017 and 2016, and 14 in 2015 (World Trade Organisation, 2018b). These statistics represent a conservative count of the total number of trade disputes existing between WTO members since some disputes are not reported to the WTO.¹

Trade disputes appear as inherent to trade agreements for several reasons. First, the large number of WTO members and their high volume of trade increases the probability that trade disputes occur between them. The greater the number of countries and/or the greater the number of goods traded among them, the higher the probability that these countries disagree on trade practices concerning specific products. With 164 WTO members representing 98 percent of world trade,² trade disputes among WTO members

¹For instance, WTO members may choose to bilaterally settle their trade disputes or use dispute settlement mechanisms set up in other trade agreements to which they belong.

²WTO members’ exports accounted for 98 percent of world merchandise and commercial services exports in 2017 (World Trade Organisation, 2018e).

seem doomed to occur.

Second, governments of these WTO members face protectionist pressure from special interest groups who wish to protect themselves from foreign competition. To satisfy these politically powerful groups, governments intervene in trade relations and implement measures that restrict trade with foreign countries. For example, WTO members have imposed 3,604 anti-dumping measures from 1995 to 2017 to protect specific domestic industries from foreign competition (World Trade Organisation, 2019b).

Third, international trade operations are complex due to technical barriers to trade, such as technical regulations, standards, and conformity assessment procedures. While these technical barriers may be necessary for WTO members to achieve legitimate objectives, such as human health protection and safety, they may hinder international trade and become the subject of trade disputes if they are not harmonised across WTO members.

Fourth, cultural differences across countries lead to diverging ideologies with regard to some products or to some production processes. As a result, a product or production process that is allowed in one country may not be accepted in another. For example, the European Communities' implementation in 1996 of Council Directive 96/22/EC that prohibited the use in livestock farming of certain substances having a hormonal action led to a trade conflict between the European Communities and the United States (US) that lasted for eighteen years.

Finally, differences in development levels between WTO members may lead to trade disputes. For instance, there are problems between developed and developing countries with regard to the latter's access to affordable medicines. Developing countries lacking pharmaceutical production capacity experience difficulties in importing medicines from developed countries for a reasonable price, in part due to intellectual property regulations, such as patent protection. To reduce these issues, the WTO amended its agreement on intellectual property in 2017 as to facilitate developing countries' access to affordable medicines (World Trade Organisation, 2017b).

This non-exhaustive list reveals the inevitability of trade disputes and drives us to consider how WTO members may respond to them.

As previously stated, WTO members may resort to the WTO dispute settlement system to solve their trade conflicts. In addition to serving as a forum for negotiations and providing a legal framework for international trade, the WTO regularly arbitrates trade disputes among its members. As further developed in Section 0.1, any WTO

member may file a dispute against another member to the WTO DSS, which may provide a ruling on the trade dispute. Although the WTO DSS has been widely used by its members, it does not resolve all conflicting trade cases for several reasons.

First, only governments can file trade disputes before the WTO DSS. Therefore, they may exclusively initiate disputes in which they have a political interest. Davis (2008) shows that the United States selection of WTO disputes follows a “political logic” favouring industries that are highly mobilised in the United States. As a result, other trade disputes are either negotiated outside of the WTO or ignored.

Second, the WTO DSS may not be accessible to all WTO members because it is costly and lacks an enforcement mechanism. While the DSS provides WTO members with recommendations following a ruling, it does not have a sanctioning power and relies on complainants to implement retaliatory measures, when necessary. Therefore, WTO members who lack legal capacity may not be able to recognise and complain against an inconsistent measure before the WTO DSS. Similarly, members who lack retaliatory capacity may perceive WTO adjudication as worthless since they will not be able to enforce the dispute settlement (DS) body’s recommendations in cases in which respondents do not voluntarily conform to rulings. This “accessibility” argument, highly debated among researchers, is the subject of the first chapter of this dissertation and is further explained in Section 0.1.

Third, the WTO has limited human and capital resources. A main drawback of the legal procedure resides in the amount of time necessary to settle disputes. According to the timetables set by the WTO, it should take one year to settle a dispute without appeal and one year and three months to settle a dispute with appeal. These targets are, in practice, rarely reached. The average duration of disputes is 1,277 days, the equivalent of three and a half years (see Chapter 1). While this lengthy process occurs, some economic agents may be left hurting in the wait of the formal resolution of a dispute. This may lead some agents to circumvent trade regulation and engage in illicit trade. We further develop this issue in Section 0.2, as the second chapter of this dissertation focuses on the welfare consequences of illegal trade that emerges from the non-resolution of trade conflicts.

Finally, the DSS is a multilateral solution to trade conflicts. It imposes constraints on WTO members with regard to their trade policies (e.g. following the WTO’s recommendations or following the most-favoured-nation (MFN) rule) and limits their sovereignty in trade policy decisions. As a result, members may depart from this process and decide to implement unilateral (and sometimes discriminatory) trade policies to

manage their trade conflicts. This is the case of the United States, who seems dissatisfied by the WTO DSS, and recently found in unilateral action a potential remedy to its international trade disputes. Section 0.3 expands on this concern and introduces the third chapter of this dissertation, which investigates the welfare consequences of unilateral remedies to trade disputes.

The rest of this introduction proceeds as follow. The first section provides an overview of trade dispute resolution at the WTO DSS and presents the foundations of the analysis developed in the first chapter of this dissertation. The second section defines the notion of smuggling, explains why it emerges from trade disputes, and provides the conceptual framework surrounding our investigation presented in chapter two of this dissertation. The third section develops on the role of unilateral protectionist trade policies in trade dispute resolution. In particular, it demonstrates how the United States recently used unilateral protectionist measures to force its trading partners to negotiate. It also presents the principle of strict reciprocity in international trade relations, supported by Donald J. Trump, which is further studied in the third chapter of this dissertation. Finally, the fourth section presents an overview of the objectives, methodology and results of each chapter composing this thesis.

0.1 The WTO and its Dispute Settlement Mechanism

The WTO DSS was created at the same time as the WTO, in 1995, subsequent to the Uruguay round of negotiations. It allows WTO members to initiate trade disputes against trading partners who have supposedly violated WTO agreements.

Once a dispute is filed before the WTO DSS, litigants have sixty days to negotiate and settle the dispute without seeking WTO intervention. If consultations fail, the complaining country can ask for the establishment of a panel of experts that will provide conclusions on the case and help the DS body make rulings or recommendations. The complainant and/or the respondent may appeal the panel's findings. In such a case, the appellate body hears the appeal and either upholds, modifies, or reverses the panel's findings. In 93 percent of the cases, the panel or appellate body's report favours the complainant.³ The respondent is therefore asked to bring its policy in compliance with the DS body's recommendations. If the defendant does not bring its measures into compliance, the complainant may ask the DS body, and be authorised, to impose retaliatory measures. The DS body cannot,

³Author's calculations based on data from the WTO.

however, impose sanctions on non-cooperative respondents.⁴

Compared to the previous system, which was based on the General Agreement on Tariffs and Trade (GATT) of 1947, the current system is based on the Dispute Settlement Understanding (DSU) of 1994 and introduces three major innovations: i) automatic establishment of panels; ii) automatic adoption of panel and appellate body's reports;⁵ and iii) appellate review of panel reports (World Trade Organisation, 2018c). The new procedure also sets timetables for settling disputes at each stage of the dispute settlement process (World Trade Organisation, 2019a).

The WTO DSS is considered by many as the central pillar of the multilateral trading system. The high number of cases brought to the DSS reveals WTO members' trust in the WTO adjudication system (World Trade Organisation, 2015e). As previously mentioned, the WTO DSS has received 574 official disputes from 1995 to 2018 (World Trade Organisation, 2018b). Furthermore, WTO data shows that the DS body authorised a member to retaliate in only ten percent of all litigated disputes (World Trade Organisation, 2015e). Sacerdoti (2017) also argues that the success of the DSS lies in the participation of both major trading powers and small countries.

While small countries have participated in the DSS, and sometimes successfully complained about large countries' trade policies, close examination of WTO members' participation in the DSS reveals a different story. First, low-income countries have never participated in the DSS, either as complainants or respondents to a dispute. Second, high-income countries initiated 64 percent of disputes filed from 1995 to 2014 and appeared as respondents in 71 percent of these disputes. Third, the United States and the European Union have been the most active participants in dispute settlement, appearing as complainants in 32 percent and as respondents in 44 percent of all initiated cases.⁶

These participation statistics cast doubt on the access of the WTO DSS to developing countries. Previous studies have shed light on a potential bias in the DSS. Horn et al. (1999) provide a first analysis of the system and find that trade diversity and the value of exports appear as main determinants of dispute initiation. Following studies contradict this result. Bown (2005) emphasises the role that a country's retaliatory capacity plays in its decision to file an official dispute. Reinhardt (2000) argues that the political regime of a country affects its participation in the DSS. These studies, however, rely on limited

⁴For a complete description of the DSS, see Chapter 1.

⁵Prior to 1995, the establishment of panel and the adoption of panel and appellate body's reports required a positive consensus in the GATT council (i.e. agreements by all contracting parties to the decision, including litigants).

⁶Author's calculations based on WTO data.

samples of observations and provide results that may be sensitive to the model employed by their authors. In the first chapter of this dissertation, we intend to improve upon both these aspects.

The “accessibility” of the WTO DSS is, however, not the only issue concerning this dispute settlement mechanism. A lengthy procedure and the practical reality of international trade lead to the emergence of smuggling, which is analysed in the following section.

0.2 Smuggling: a Practical Way to Circumvent Disputed Measures

Economic agents who are constrained in their trade practices due to the implementation of an inconsistent measure may resort to illegal trade. Illegal trade, or smuggling, refers to international trade by firms or individuals that fully or partially evades trade regulations and border duties. Illegal traders either avoid official border crossing posts (full evasion) or resort to illegal means like under-invoicing, misclassification, underpricing, etc. (partial evasion). In this sense, smuggling differs from illicit trade (trading of illicit products such as drugs or counterfeits) and from informal trade (unorganised, small-scale trade generally conducted by self-employed traders to avoid import duties, bribes, administrative paperwork, etc. (Bouët et al., 2018)). When illegal trade emerges, the WTO-inconsistent policy, which is the subject of the dispute, remains and the conflict is not resolved, but trade continues.

Another option for the home country would be to accept the imposition of a WTO-inconsistent policy by one of its trading partners and trade with other partners whose trade policies follow WTO rules. This situation may, however, not be optimal to neither the country that imposes the restrictive measure nor to the affected country. The country imposing the measure may protect home producers in specific industries, but may harm domestic producers in other industries and/or domestic consumers. The affected country may have, for instance, to export its products to smaller markets or at a lower price. Both countries may thus experience a decrease in welfare following the implementation of the inconsistent measure. The effects of such trade diversion may differ depending on the type of measure (import tariff, production subsidy, etc.) and its application (discriminatory or non-discriminatory measure), but smuggling may appear as a better option.

Theoretical studies on illegal trade provide diverging results with regard to its welfare effects. Most analyses rely on Bhagwati and Hansen (1973)'s model of illegal trade. This general equilibrium model integrates smuggling within the traditional framework of international trade theory and finds that when legal and illegal trade coexist, smuggling reduces the welfare of the country imposing the tariff. Pitt (1981) contradicts this result. According to the author, some agents may conduct legal trade at a loss since it serves as a camouflage activity for illegal trade, in which case, smuggling may be welfare-improving. Finally, other studies find ambiguous results with regard to the welfare consequences of smuggling (Martin and Panagariya, 1984; Sheikh, 1989; Lovely and Nelson, 1995).

These studies make several assumptions that may affect their results. In chapter two of this dissertation, we provide a simple model of illegal trade, dropping such hypotheses, to evaluate the welfare consequences of smuggling. Moreover, we apply our theoretical model to a real case.

If smuggling improves a country's welfare following the implementation of an inconsistent trade policy, economic agents may have incentives to continue trading with the affected country through illegal channels. The implementation of trade barriers would thus not only lead to an initial decrease in the country's welfare, but also to an increase in the country's criminal activities to partially offset the welfare loss. Illegal trade appears as inherent to restrictive trade policies as it reduces the negative impact of such policies and avoids going through potentially lengthy and costly conflict resolution at the WTO DSS.

Smuggling is, however, not the only way that a country may choose to circumvent an inconsistent measure or express its dissatisfaction with the WTO DSS. A reflection on 2018 trade-related events reveals that countries may decide to act outside of the WTO scheme to solve their trade issues by unilaterally implementing retaliatory measures.

0.3 Unilateralism: An Alternative to the WTO DSS

In 2018, the United States unilaterally imposed additional import duties on products from several of its trading partners. Not only did one of the largest trading nations unilaterally impose additional tariffs, but the reasons invoked to justify these measures were unusual. For example, the United States introduced an additional tariff on its imports of steel and aluminum products equal to 25 percent and 10 percent, respectively, for national security reasons. Although Article XXI of the GATT allows for security

exceptions,⁷ countries generally invoke this article in time of war or embargo (Bellora et al., 2018).

Furthermore, the United States imposed additional import duties on products originating from China worth US\$ 250 billion, starting in July 2018. These measures appear as retaliatory measures against Chinese policies on the protection of intellectual property rights. Interestingly, the United States also filed an official dispute at the WTO against certain Chinese measures concerning the protection of intellectual property rights, on March 23, 2018 (World Trade Organisation, 2019c). As of January 16, 2019, the panel was composed but had not yet released its findings. The United States sends diverging signals: on one side, it seems to follow WTO governance, but on the other side, it imposes unilateral retaliatory measures outside of the WTO framework to settle its trade disputes.

The implementation by the United States of unilateral measures may continue as President Donald J. Trump supports the principle of strict reciprocity in trade relations. Strict reciprocity entails the imposition of the same tariff on the United States imports of any product from any country than the tariff applied by that same country on the United States exports of the same good. For example, in June 2018, the United States threatened to impose additional import duties on automobiles from the European Union because the latter imposes higher tariffs on its imports of US automobiles than the US tariffs on imports of European automobiles. The European Union taxes automobiles imported from the United States at 10 percent whereas the United States taxes automobiles imported from the European Union at 2.5 percent. In the United States' perspective, such threat, and its potential application, should force its trading partners to the negotiating table.

The principle of strict reciprocity contradicts the founding principle of the GATT/WTO. The Preamble to the GATT 1947 states that the organisation promotes "reciprocal and mutually advantageous arrangements directed to the substantial reduction of tariffs and other barriers to trade" (World Trade Organisation, 2019d). The term "reciprocal" refers to "first-difference" reciprocity, defined by Bhagwati and Irwin (1987) as mutual concessions from initial conditions. In the WTO framework, reciprocity does not refer to the levelling out of tariffs across countries but to a mutual exchange of

⁷"Nothing in this Agreement shall be construed [...] (b) to prevent any contracting party from taking any action which it considers necessary for the protection of its essential security interests (i) relating to fissionable materials or the materials from which they are derived; (ii) relating to the traffic in arms, ammunition and implements of war and to such traffic in other goods and materials as is carried on directly or indirectly for the purpose of supplying a military establishment; (iii) taken in time of war or other emergency in international relations."

concessions between trading partners. If the United States were to apply the principle of strict reciprocity in trade relations, it would act outside of the scope of the WTO, which would ultimately undermine the credibility of the organisation.

Moreover, if the United States were to follow this principle, it could, for example, increase its tariffs on imports from China in ten sectors: animals and animal products, chemical, rubber and plastic products, crops, fishing, machinery and equipment, manufactures, meat and dairy products, motor vehicles and parts, petroleum and coal products, and processed food. The United States average level of protection vis-à-vis China would increase by 80 percent.⁸ Similar numbers may be computed for other trading partners of the United States. Consequences in terms of economic welfare for the United States and for potentially affected countries may be significant.

The third chapter of this dissertation tests whether the United States may benefit from the threat and/or application of reciprocal taxes against its main trading partners, with a focus on China and the European Union.

0.4 An In-Depth View of the Dissertation

In the **first chapter** of this dissertation, we investigate whether the WTO DSS is accessible to developing countries. We thus develop an econometric model to identify the determinants of countries' participation in the WTO DSS. Having collected data on all trade complaints filed to the WTO DSS from 1995 to 2014, we perform a statistical analysis of trade conflicts. This statistical analysis provides us with great insight into the characteristics of trade disputes filed before the DSS (parties involved, subjects and agreements cited in the dispute, duration, etc.). We then implement our econometric model to understand the causal relationship between selected determinants of country participation in the DSS and both the probability of filing a dispute before the DSS and the number of cases filed by a country to the DSS. The analysis builds on three different models to determine country i 's probability of initiating a dispute against country j . Either it depends on the two countries' structure of trade (the rules-based model), or it is also affected by country i 's or country j 's specific characteristics (the unilateral power-based model), or it is also affected by bilateral economic and trade relations between countries i and j (the bilateral power-based model).

We find that country i 's structure of trade with j plays an important role in

⁸Calculations are based on the MacMap data set of the CEPII.

explaining the probability that i initiates a dispute against j before the DSS. We also find clear evidence with regard to the importance of two independent variables: first, the legal capacity of i (a variable related to the unilateral power-based model) and second, the trade retaliatory capacity of i against j (a variable related to the bilateral power-based model). Almost all these results hold when testing for both the likelihood of initiating a dispute and the number of disputes initiated before the WTO.

In the **second chapter**, we aim to determine the impact of smuggling on economic welfare. We focus on Costa Rica's recent prohibition of avocados imported from Mexico, dating from May 5, 2015. We chose this particular case study because the Mexican government filed a formal dispute against Costa Rica before the WTO DSS on March 8, 2017 (World Trade Organisation, 2017a). Two years and two months later, the dispute was not solved, but a panel of experts was composed. Interestingly, illegal trade emerged before Mexico initiated the complaint. In May 2016, Costa Rican customs authorities seized 4,100 kilograms of Mexican avocados that had been smuggled through Panama.

Since we focus on the avocado market in Costa Rica, we build a partial equilibrium model of trade, in which we integrate illegal trade. Moreover, we drop two important assumptions made in previous literature on such issue, and apply our model to a real situation. We solve important data needs through empirical analysis and make our assumptions explicit for unavailable data. Such a model fulfils our expectations, in particular with regard to its transparency and the traceability of our welfare analysis. Although the model is new, we provide enough details for understanding our method and for replicating or/and adapting it into other contexts.

Using unique data on trade, production, and the price of Costa Rican and Mexican avocados, we find that the quantity of avocados smuggled into Costa Rica on an annual basis ranges from 4,668 to 10,232 metric tons, representing up to four times the quantity of locally produced avocados. Furthermore, we demonstrate that smuggling is necessarily welfare-improving compared to the "no-smuggling situation". Compared to the "free-trade situation", smuggling does not always compensate for the negative effects arising from the restrictive trade measure. In most cases, welfare is lower after the prohibition and smuggling than prior to the implementation of the prohibition. In some cases, however, smuggling results in a gain in the terms of trade that offsets the harmful effects associated with the trading cost of smuggling. We find that such situations occur when the trading cost of smuggling is low, and thus when enforcement of the prohibition by public authorities is weak.

In the **third chapter**, we test whether the United States may benefit from the threat and/or application of strict reciprocity against its main trading partners. As previously mentioned, the United States may use the threat of unilateral strict reciprocity to manage its trade disputes and force its trading partners to negotiate.

In this chapter, we focus on a global issue that requires using a general equilibrium model of trade. In particular, we use a well-known computable general equilibrium (CGE) model of international trade, MIRAGRODEP. The model comprises several regions and sectors as we are interested in the effects of the implementation of a unilateral trade policy based on strict reciprocity by the United States on affected countries and the world's welfare. Furthermore, we need a model that provides results at the sectoral level since one of the important aspects of the “new”, or strict, reciprocity is its sectoral characteristic (Cline, 1983). Using new quantitative trade models (NQTMs) would not be coherent in our case since these models provide few results on welfare, production by sector, final consumption by sector or trade by sector (Bouët and Laborde, 2018). Using MIRAGRODEP, we compare the trade and welfare consequences of two scenarios: either the United States' trading partners reduce their trade barriers on US products (by fear of US retaliation), or the US increases its tariffs on its imports from its trading partners on a reciprocal basis. In addition to the model, we provide a statistical analysis of tariffs applied by the United States and countries of interest, at both the sectoral and HS6 product line levels.

We find that while the threat of retaliation through reciprocal taxes generates global gains equal to 0.2 percent, its effective application lowers the United States and the world's welfare by 0.1 percent and 0.02 percent, respectively. Moreover, we demonstrate that, for most of the United States trading partners, the threat of retaliation through reciprocal taxes does not appear as credible. We conclude that by threatening its trading partners with reciprocal taxes, the United States may create additional tension in trade relations that may hinder negotiations and provoke counter-retaliation from its trading partners, rather than lead to freer trade.

Chapter 1

Is the Dispute Settlement System, “Jewel in the WTO’s Crown”, Beyond Reach of Developing Countries?¹

1.1 Introduction

On January 24, 1995, Venezuela requested consultations at the World Trade Organisation (WTO), alleging that a US gasoline regulation discriminated against Venezuela’s producers. The WTO Dispute Settlement System (DSS) established a panel that released its findings on January 29, 1996. The panel’s report found the US regulation to be inconsistent with the General Agreement on Tariffs and Trade (GATT) Article III:4, “National Treatment on Internal Taxation and Regulation.”² On August 19, 1997, the US government announced implementation of the recommendations of the DSS. Since then, other developing countries, including Brazil, Chile, Guatemala, Honduras, India, Mexico, Pakistan, Peru, Philippines, and Thailand, have successfully complained via the DSS about measures implemented by either the European Union (EU) or the United States and have obtained withdrawal of a trade measure or an adjustment to a measure to conform with WTO law.

¹This chapter is a revised version of the paper written with Antoine Bouët (GREThA, University of Bordeaux and IFPRI), which has been published in the *Review of World Economics*.

² “The products of the territory of any contracting party imported into the territory of any other contracting party shall be accorded treatment no less favourable than that accorded to like products of national origin in respect of all laws, regulations and requirements affecting their internal sale, offering for sale, purchase, transportation, distribution or use.”

The WTO DSS is considered by many to be one of the great achievements of the multilateral trading system, but is the DSS beyond reach of developing countries? We construct a database on trade disputes initiated through the WTO DSS between 1995 and 2014, and conduct an econometric estimation to determine whether the DSS is rules-based (that is, litigations are open to all countries and settlements are based only on rules) or power-based (that is, litigations are not open to all countries and settlements are based not only on rules but also on economic power).

What could be the reasons for a power-based DSS?

First, litigations are costly. Guzman and Simmons (2002) stressed the importance of the real financial cost implied by the wages of diplomats and lawyers participating in DSS activities. Besson and Mehdi (2004) mentioned that in the Japan—Photographic Film case, lawyers claimed remuneration for US\$ 10 million in services. Despite progressive reforms for greater inclusion of developing countries in the formal DSS, the possibility for both litigants to appeal a panel report could increase the duration of disputes and thus their costs (Reinhardt, 2000; Busch and Reinhardt, 2002; Petersmann, 1997), an augmentation that could penalise poor countries. Hoekman and Mavroidis (2000) pointed out the cost of access to the information needed for the litigation. Horn et al. (1999) reported that legal proceedings can last up to three years. Michalopoulos (1999) explained that a certain level of institutional development is needed for full participation in litigation under the DSS. Besson and Mehdi (2004) likewise mentioned that the US Trade Representative employs more than 30 lawyers specialised in international trade disputes and adds other lawyers specialised in specific areas for specific disputes.

Second, no institutional arrangement so far has addressed the issue of the DSS's power to enforce its rulings. Each WTO member ultimately keeps its sovereignty in terms of applied trade policy, and the multilateral institution cannot oblige one of its members to adopt a DSS ruling. If a respondent does not put its legislation in conformity with the DSS ruling, the complainant may be authorised to implement retaliatory measures. Some authors (Busch and Reinhardt, 2000, 2002) have emphasised that in fact, the system relies on the ability of the complainant to implement retaliatory measures. A lack of retaliatory capacity may prevent a country from complaining. That a large country often wins against a small country in a trade war is well accepted in the economic literature (Johnson, 1953; Conybeare, 1987). Consequently, it could be easier for large countries to complain, because the threat of significant retaliation is an efficient way to push respondents to follow rulings whereas for small countries, the procedure is costly and may not result in any change in

partners' policies.

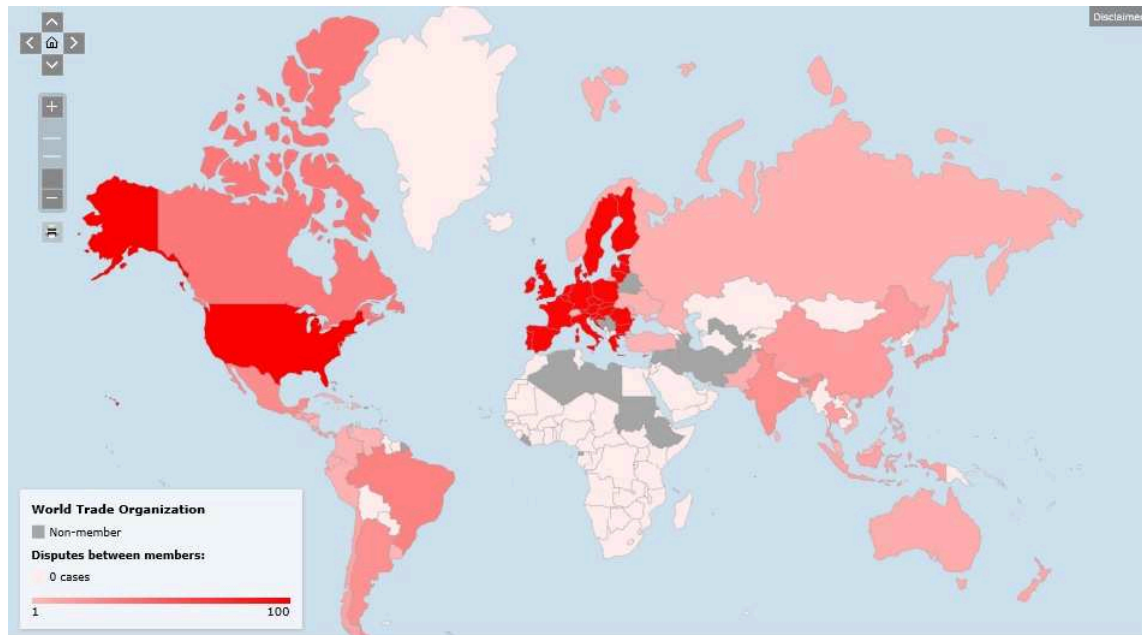
A third concern for developing countries may arise from unbalanced bilateral relations. Consider a rich country called *A* being an important destination for a poor country (called *B*)'s exports: *B*'s government may consider that complaining about *A*'s trade policy may endanger economic activity in *B* if following the complaint, *A*'s government exerts reprisals on imports from *B*. Or consider that *A* gives either a trade preference, or financial or development-related aid to *B*: in either case the threat of expected retaliation may prevent *B* from complaining about *A*'s trade policy (Besson and Mehdi, 2004). Therefore the respondent's capacity to exert (trade or financial) retaliation may prevent countries from complaining.

However, some may argue that describing the WTO DSS as a power-based system is flawed. The emergence of a trade litigation procedure, implemented with the birth of the WTO, corresponds to a long-term desire for structural reform, "the central pillar of the multilateral trading system" which "is also an important guarantee of fair trade for less powerful countries" according to Renato Ruggiero, the WTO's first director general (quoted by Horn et al. (1999)).

Concerning the cost of these actions, the Advisory Centre on WTO Law (ACWL) was established by a group of developed and developing WTO Members that were concerned about the lack of legal capacity of developing countries to access the DSS and the consequent effects on the fairness and effectiveness of the system: it is now a separate international organisation which offers, freely or at a low cost, legal assistance to poor countries.³ It is worth noting that, since its inception in 2001, the ACWL has been involved in about 20 percent of all disputes initiated at the WTO. Concerning the threat of retaliation, it may not seem plausible that rich countries today opt for a systematically unilateral international strategy under which they do not respect multilateral constraints. The multilateral trading system is a long-term public good that is accepted by most countries and openly rejected by only a minority of politicians. Pressure on governments to respect multilateral commitments may also come from nongovernmental organisations

³Let us remind that the WTO gives developing countries special rights, under an umbrella called Special and Differential Treatment (SDT). This includes: (i) longer time periods and augmented flexibility for the implementation of agreements and commitments; (ii) specific provision targeting the expansion of their trade opportunities and the safeguard of their interests; (iii) technical support (handling of disputes, implementation of technical standards...), and (iv) specific provisions for least-developed countries. It may be useful to differentiate between SDT under the "substantive" WTO Agreements that affects the rights and obligations of developing and least developed countries and SDT available to developing and least developed countries under the DSU. For the most part, these countries get little preferential treatment in formal disputes.

Figure 1.1.1: Number of disputes filed by each WTO member, 1995–2014



Source: World Trade Organisation, 2015.

(NGOs) during a period when communication matters.

Are trade litigations open to all countries? A preliminary test looks at the list of countries participating in the WTO DSS. Figure 1.1.1 shows the total number of disputes that each member country filed before the DSS from 1995 to 2014. A significant number of member countries have been absent altogether from formal trade litigation since the WTO's birth, including among others, Bolivia, Cambodia, Guyana, Jordan, Lao People's Democratic Republic, Mongolia, Myanmar, Nepal, Oman, Papua New Guinea, Paraguay, Saudi Arabia, Suriname, Yemen, and all WTO-member African states.

This simple observation may raise the question of bias in the litigation procedure itself. However, the predominance of rich countries as either complainants or respondents in trade dispute cases may simply reflect their predominance in international trade. According to our count, in 32 percent of all cases initiated between 1995 and 2014, either the EU or the United States appeared as either the complainant or the respondent. During the same period both countries represented around 25 percent of total world trade (World Bank, 2016).⁴ Thus, the prominent presence of the EU and the United States in WTO trade litigations may reflect only their share in world trade; conversely, the absence of certain poor countries from trade disputes may simply represent their relatively low level of trade.

⁴Intra-EU trade is excluded.

At this stage, two points are worth noting. First, the value of trade may not be the only factor explaining the probability of participating in a trade dispute. A complementary explanation may be the number of traded products and the number of trading partners. Imagine that country A exports the same value of goods to countries B and C, but trade from A to B consists of only 1 good whereas trade from A to C consists of n goods, with n being relatively large. There are n potential sources of trade disputes between A and C whereas there is only 1 between A and B.

Second, if a fixed cost is associated with trade litigation, then WTO members may not complain about unfair practices that hurt only small export flows. That is, below a certain threshold of trade value, it may not be worth complaining.⁵ Consequently the fact that the poorest countries are mainly involved with small flows (exports, imports, or both) may also be an important explanation for their apparent absence from WTO trade disputes. Bown (2010) found that the ACWL had enabled smaller developing countries to pursue disputes to protect trade flows that they would not have been able to protect had they had to pay normal legal costs to pursue the dispute.

Moreover, even if a bias exists in the WTO trade litigation procedure, this bias has to be qualified. Either it applies only to specific characteristics of the complainant or of the respondent, independent of the partner's characteristics (corresponding to what we call the unilateral power-based model), or it reflects a bilateral relation based on a difference in economic power, whereby either poor countries' lack of retaliatory capacity or the threat of retaliation from rich countries, targeting either trade concessions or financial aids may prevent poor countries from complaining about rich countries' trade policies (corresponding to what we call the bilateral power-based model).

This paper tests whether the WTO DSS is a rules-based or a power-based system, and if it is a power-based system, whether the bias is unilateral or bilateral. With this objective in mind, we construct a database of trade disputes litigated under the WTO DSS between 1995 and 2014, and provide detailed statistics on these disputes. We then test if the DSS is accessible to developing countries.

A preliminary test could have been conducted by a simple regression that would determine whether the result of a litigation settled by the DSS is biased in favour of rich, preference-giving, or aid-giving countries. Such a test would be inconclusive, however, because almost 93 percent of settlements support the complainant's position, regardless

⁵On the other hand, it may be that, whatever the value of trade flows at stake is, a country may complain in order to create a reputation effect. This is an interesting direction that we will not follow in this paper.

of its per capita gross domestic product (GDP) or its status in terms of preferences and international aid. Our interpretation is that because the procedure is costly, a country complains to the WTO only if the odds of winning are high enough.⁶

Consequently, we do not test for a potential bias in the outcome of WTO DSS litigations. Instead we regress the probability that each country files at least one complaint against another WTO member. If the DSS is rules-based, we expect that the only explanation of case initiation is the structure and importance of trade between countries i and j involved in the dispute. If the procedure is power-based with a unilateral bias, we expect that country-specific characteristics, such as country i 's legal capacity, also explain dispute initiation. Finally, if the procedure is power-based with a bilateral bias, we expect that other determinants, related to an economic relation between i and j , may play a role: retaliatory capacities of i against j , trade preferences conceded by j to i , financial aid given by j to i , and so on.

Some studies have already explored issues related to the access of developing countries to the WTO DSS (see Section 3), but only on small samples of observations, which weakens their conclusions. We think our article is an improvement on what literature has done so far.

First, we propose three different models explaining the existence of a trade dispute between two trading countries. Either trade disputes are only explained by the importance and structure of bilateral trade, or they are also explained by power, this power being related to a single country or related to a relationship between two countries. Second, in empirical tests conducted until today, estimations are based on limited samples of observations whereas our estimation is based on a relatively large dataset. For instance, the database used by Horn et al. (1999) covered only four years (1995–1998) of the settlement procedure, whereas our database covers 20 years. Not only is Horn et al. (1999) time coverage limited, but there is suspicion that it is flawed: during this period (the WTO ruling against the EU on a complaint about bananas filed by the United States was handed down in 1997—see below), the United States and the EU were overrepresented in trade disputes because these two trading partners were playing a “tit for tat” game, with a complaint by the United States about EU trade policy being followed by a complaint by the EU about US trade policy, and so on. Other studies have

⁶Another potential explanation was suggested by an anonymous reviewer: issues that proceed to formal disputes are also cases where, for political or other reasons, such as the domestic influence of the stakeholder benefiting from the WTO-inconsistent measure, it is very difficult for the respondent to change its measure without the pressure of a WTO panel ruling.

also conducted tests on limited datasets: Bown (2005) on 1995–2000, Besson and Mehdi (2004) on a database of only 40 cases.

Third, in empirical tests conducted until today, methodologies may be considered as faulty. In these studies, only the number of cases between countries i and j is regressed and the test is sometimes based on a sensitive specification. In our study we estimate not only the number of cases brought between i and j , but also the probability that country i initiates a WTO dispute against country j . We start with the latter because testing whether country i has initiated at least one dispute against country j provides much information about potential bias in the trade dispute participation of developing countries. This test has never been conducted to the best of our knowledge. Moreover we take advantage of our expanded dataset by creating a panel, looking at 5-year time periods, to better analyse changes over time. With a panel we account for significant changes that could have taken place over the entire period under study. For example the formation of the ACWL in 2001 may have significantly reduced the cost of participation in the WTO DSS for developing countries. Finally, to estimate the number of cases between country i and country j , we adopt the test designed by Horn et al. (1999), improving its implementation: whereas the results were criticised for being sensitive to the specification of the authors' predictive model,⁷ we adopt a specification particularly adapted to databases containing many 0s, a zero-inflated Poisson (ZIP) model.

Fourth, we also improve the measurement of different explanatory variables and take into account new regressors. For instance, we use several indicators for the complainant's legal capacity. We also suppose that the level of democracy may impact countries' participation in the DSS (see below) and we include several indicators of democracy. Finally, we conduct various robustness checks: exclusion of certain products (raw energy and mineral products), exclusion of the 1995–1999 period (see above), among others.

The rest of this paper proceeds as follows. Section 2 explains the details of the WTO DSS. Section 3 proceeds to a review of literature. Section 4 describes the construction of the database and provides various statistics. Section 5 presents the economic model of participation in the WTO DSS. Section 6 presents the econometric estimation and the sensitivity analysis. Section 7 presents the economic model of the number of trade disputes between two countries and the econometric estimation. Section 8 concludes.

⁷Horn et al. (1999) used a binomial model and assumed that the expected number of bilateral complaints is proportional to the number of products exported to the respondent.

1.2 The Dispute Settlement System

The aim of this section is to provide an overview of the DSS. In order to be brief, we include only the main characteristics of this complex process. Previous studies have already provided a detailed description of the DSS (Sevilla, 1998; Bütler and Hauser, 2000; Guzman and Simmons, 2002; Besson and Mehdi, 2004).

The whole process may be presented in three phases.

(i) *Initial phase*. To initiate the dispute settlement process, a member country must first file a request for consultation before the WTO. During the consultation stage, litigating parties negotiate among themselves. If they fail to reach an agreement, the WTO's director general can intervene upon request of either party. In this scenario, the dispute settlement (DS) body creates a panel of experts who is then responsible for mediating the dispute. Subsequently, the selected panelists produce a report containing their rulings and recommendations for both of the litigating parties as well as all other WTO members.⁸

(ii) *Appeal phase*. In most cases, the DS body adopts the panel's report.⁹ Either party, or both together, have the right to appeal the panel's report to the DS body. The appellate body, responsible for considering the appeal(s), either upholds, reverses, or modifies the findings of the panel's report.

(iii) *Implementation phase*. Once the panel's report or the appellate body's report is adopted, different situations can emerge. If the final report favours the respondent, no further action is required. If the final report favours the complainant, the DS body requires the respondent to bring its measure(s) into conformity with WTO law. If it does not, the complainant can ask the DS body for authorisation to retaliate against the respondent. It is important to note, however, that at any stage of the process the parties can reach a mutually acceptable solution.

⁸The consultations phase is different from the panel phase and it may be considered separately. In particular, it is not subject to multilateral supervision and frequently leads to a settlement. This remark could lead to split this initial phase into two phases: consultations phase and panel phase.

⁹To the authors' knowledge, there has never been a litigation case in the history of the WTO in which the DS body has rejected the final panel report. For this to happen, all member states involved must reach a consensus to reject the panel's recommendations, which seems unlikely because both the respondent and the complainant are involved.

1.3 Review of Literature

The literature on the WTO DSS is abundant, bringing together different disciplines, such as law, political science, and economics. Although from various fields, authors agree on the main issues concerning the DSS, including its utility in an evolving environment (with the increasing number of regional trade agreements and preferential trade agreements), its lack of enforcement power, and its potential sources of bias against developing countries.

This last issue, which is of particular interest for us, has been empirically examined from three main perspectives. A first approach focuses on potential bias in the effective outcome of disputes in terms of trade liberalisation: developed countries may not implement DS body's recommendations when facing complaints from developing countries. A second approach focuses on bias in the rulings provided by the mandated panels of experts. A third approach argues in favour of a global bias in the DSS, resulting in lower participation by developing countries. Although our study focuses on countries' participation in the DSS (the third approach), this section also briefly discusses the literature on the first two perspectives.

1.3.1 The Effective Application of WTO Rulings

The main criticism that has emerged against the DSS emphasises its lack of enforcement power. Once the panel or appellate body report is adopted, the role of the DS body is extremely limited. It cannot impose sanctions on respondents. The DS body can only grant complainants with the authorisation to retaliate against offenders. As a result, rulings may have only a "modest direct influence" on the outcome of disputes (Busch and Reinhardt, 2000).

Supporting this idea, several studies have demonstrated that respondents are more prone to implement the DSS's recommendations if they fear retaliation from complainants (Bown, 2004b,a; Bown and Reynolds, 2017). Moreover, other analyses have shown that the loss of reputation emerging from noncompliance with the DSS's recommendations is not high enough to restrain respondents from keeping illicit policies in place (Busch and Reinhardt, 2000; Bown, 2004b). Busch and Reinhardt (2003) have observed that as a result, complainants' per capita income is a major determinant of the outcome of disputes.

Although these studies discuss historical patterns of trade disputes and provide some empirical evidence of bias against developing countries, they rely on small samples of disputes occurring within the WTO. For example, Reinhardt (2000) provided large-scale

statistical analysis of trade disputes from 1948 to 1999, but only five years of the study's data were from after the inception of the WTO. In contrast, our investigation relies on new data, collected from the inception of the WTO to 2014, providing a 20-year time span. Working with WTO data, and not GATT data, is important because as we discussed in the introduction, the new DSS is supposed to be a major achievement of the WTO.

We also notice that bias in the effective outcome of disputes at the WTO may lead to bias in countries' participation in the procedure. If developing countries do not trust developed respondents to follow the recommendations of the DS body, they may not find costly trade litigations worthwhile and consequently, may not initiate disputes against developed countries, but only against developing countries (South–South disputes). Between 1995 and 2004, 8.7 percent of disputes brought before the DSS opposed two developing countries, a figure that doubled between 2005 and 2014, reaching 16.4 percent.

1.3.2 A Bias in WTO Rulings

Are rulings provided by the WTO's panel of experts biased against developing countries? To our knowledge, only one study, by Besson and Mehdi (2004) addresses this specific topic. In their investigation, the authors tested whether a credible threat of trade retaliation, legal capacity asymmetries among dispute participants, the threat of economic retaliation and asymmetric political power influence DSS rulings.

Besson and Mehdi (2004) found that although the threat of retaliation appears insignificant, countries' legal capacity plays a major role in the outcome of panel reports. In particular, the DSS seems to discriminate against developing countries because of their lack of legal representatives. Moreover, settling a dispute can be a long process (from a few years to decades), and some developing countries may lack financial resources to face litigation costs. Hence, asymmetries in legal capacity, in terms of both human capital and financial wealth, restrict developing countries from winning cases equitably. Furthermore, complainants relying on developed countries for bilateral assistance see their chances of winning disputes diminish. Consequently, Besson and Mehdi (2004) concluded that WTO rulings are influenced by economic, political, and military dependence between countries.

Results from Besson and Mehdi (2004) should be used with caution because no other analysis either confirms or refutes their validity. Furthermore, one issue that arises with testing the fairness of rulings is the extremely high number of observations for which rulings favour plaintiffs¹⁰ and the limited size of sample used in this study (40 observations).

¹⁰In 93 percent of cases that have been ruled between 1995 and 2014, the panel of experts has favoured

Moreover this study does not consider the participation of developing countries to the ACWL, participation which may have a significant impact on rulings. Finally, even if the link between legal capacity and political power on one side and the outcome of a WTO ruling on the other side is clear, it is not clear why the threat of economic or financial retaliation would determine the outcome of a ruling: rather it would seem more likely to affect participation in the procedure and the effective application of the ruling.¹¹

Again we notice that bias in WTO rulings may lead to bias in countries' participation in the procedure. If developing countries do not believe in the fairness of the procedure, they may not find trade litigations worthwhile and consequently may hesitate to initiate disputes at the WTO.

1.3.3 Participation in the WTO DSS

Is the participation of WTO members in the DSS biased? Studies by Reinhardt (2000) and by Bown and Hoekman (2005) have demonstrated that high transaction costs remain a barrier dissuading developing countries from entering WTO litigation.¹² Bown and Hoekman (2005) included a unique discussion of the role of different actors (among which are NGOs, law schools, development organisations, and the private sector) in helping developing countries at different stages of the WTO litigation process. However, their study was very specific as it focused on costs associated with WTO litigation and did not offer any empirical test.

According to Bown (2005), developed countries are able to use trade retaliation threat, or other forms of intimidation¹³ against developing countries to restrain the latter from participating in the DSS. Although this analysis is based on a short time period (5 years) and does not include variables such as the export diversity of complainants, it provides interesting empirical results on the determinants of nonparticipation.

Reinhardt (2000) went further in exploring the determinants of participation by testing additional variables. The political regime of a country for instance explains to some extent its willingness to initiate disputes. Countries with greater levels of democracy are more involved in trade litigation, whether as complainants or respondents. One of the main explanations resides in the political pressure that producers in the private sector are able

the complainant.

¹¹Let us also mention that results from this study question the impartiality of an international organisation such as the WTO and therefore, should be used with caution.

¹²This phenomenon is mostly due to the complexity and the duration of disputes.

¹³Based on the reliance of poor countries on bilateral aid and preferential trade arrangements.

to exercise on politicians in such countries, leading the latter to favour producers. As a result, “democracy disproportionately favours business” (Reinhardt, 2000). As previously mentioned, this study is based on many cases initiated under GATT, whereas our analysis studies cases initiated under the WTO.

Davis (2008) broadened the debate by investigating the same issue from a political science approach, focusing on the influence of the political environment on dispute initiation within the WTO.

Another determinant of bias in the DSS is the relationship between the public and the private sectors (Bown and Hoekman, 2005). This relationship is primordial because governments have control over the cases to be selected for WTO adjudication. Bohanes and Garza (2012) examine, from a legal point of view, the role of many factors that can inhibit the participation of developing countries in WTO litigation. They conclude that the most important inhibiting factor is domestic: lack of information on trade barriers and of coordination between the private and the public sectors.

Our analysis brings together previous investigations and offers a comprehensive perspective on potential determinants of WTO members’ participation in the DSS. It provides both a statistical analysis of WTO cases initiated from 1995 to 2014 and an empirical analysis of potential determinants of participation. Moreover, it offers a theoretical background on dispute initiation, based on the study by Horn et al. (1999).

Horn et al. (1999) developed a simple model that predicts the number of complaints each country should file based on its export diversity. According to these authors, countries with a larger number of traded products and trading partners should face a greater number of WTO-inconsistent policies and therefore should file a greater number of complaints. Thus, trade diversity appears to be one of the main determinants of dispute initiation (Horn et al., 1999; Holmes and Rollo, 2003). However, the results obtained by Horn et al. (1999) may be sensitive to the specification of their predictive model, and their empirical analysis is limited to cases filed from 1995 to 1998. We intend to improve upon both of these aspects by using different model specifications as well as a larger dataset.

1.4 A Few Statistics

We construct our database from the WTO website, which provides an updated list of all disputes initiated since 1995 (World Trade Organisation, 2015a).

We have observations from 1995 to 2014. We follow Horn et al. (1999) and Busch

and Reinhardt (2002, 2003) by dividing disputes involving more than one plaintiff into as many bilateral cases as there are complainants. Indeed, this process increases precision in the measurement of certain explanatory variables such as capacity for trade and financial retaliation.

We suppressed three types of cases from our database: first, cases that were not specific to a Harmonised System six-digit (HS6) product classification (because our analysis requires that a case be specific to one or several products); second, cases that corresponded to “second requests” as classified by the WTO, i.e. same product, same complainant and respondent, same violation and when necessary, same panel or appellate body’s report, (i.e. replication of the same case); and third, cases whose topic was an export restriction (because we expect this type of complaint to require a specific analysis).¹⁴

1.4.1 Trade disputes, by income level of participants

We count 345 initiated trade disputes, of which 218 had been settled by December 31, 2014. Each trade dispute may be allocated to either the year of initiation or the year of settlement. Figure 1.4.1 represents the number of initiated cases by start date and of settled¹⁵ trade disputes by settlement date.

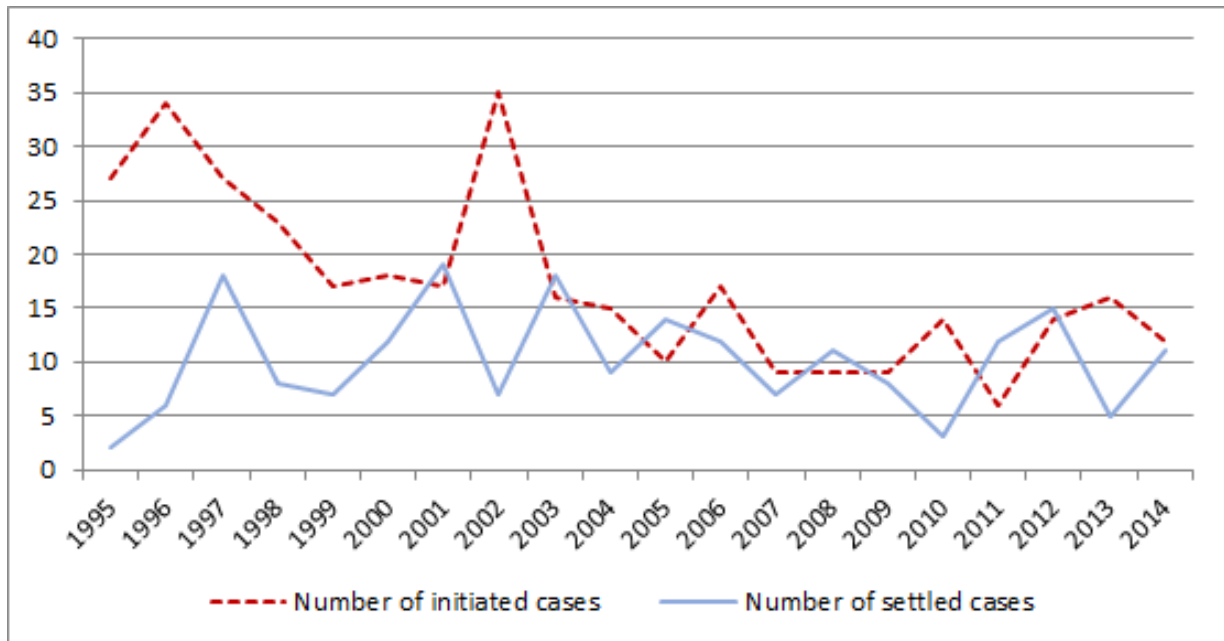
From 1995 to 2014, an average of 17.2 cases have been initiated each year and 10.2 settled, with more dispersion among those initiated: the number of initiated cases may vary with macroeconomic forces, business cycles, the number of WTO members, and other factors, whereas the number of settled cases depends mainly on WTO resources.

The number of initiated cases per year from 1995 to 2002 is on average higher than from 2003 to 2014. Two reasons may explain this phenomenon. First, many trade disputes not settled under GATT were reinitiated to the DS body in 1995, 1996, and 1997. Second, after the “banana wars” under which Guatemala, Honduras, Mexico, and the United States complained about the European regime for the importation, sale and distribution of bananas, many trade disputes involving the United States and the EU

¹⁴We suppressed a total of 155 cases, among which 128 were not specific to an HS6 line (these include cases related to services, tax measures, copyrights, and so on), 23 were renewals, and 4 cases were related to export restrictions.

¹⁵Settled disputes are cases classified under the following categories from the WTO’s website: (i) reports adopted, no further action required; (ii) implementation notified by respondents; (iii) compliance proceedings completed without findings of non-compliance; (iv) authorisation to retaliate granted; (v) withdrawn (measure withdrawn, other reasons); (vi) mutually terminated; and (vii) mutually agreed solution.

Figure 1.4.1: Number of initiated and settled cases per year, 1995–2014



Source: Authors.

occurred in apparent rounds of retaliation and counterretaliation. In 2003 and after 2005, this number was significantly reduced.

Our analysis of updated WTO trade dispute data reveals some important trends from 1995 to 2014. Table 1.4.1 indicates the percentage of total complaints filed by the income level of the complainant. Countries are classified according to World Bank revenue categories: high-income countries, upper-middle-income countries, lower-middle-income countries, and low-income countries (World Bank, 2016).¹⁶ The last column indicates the share of each group of countries in total exports of merchandise by all WTO members over the 1995–2014 period (exports are the correct benchmark because the table displays disputes by complainant).

On the one hand, low-income countries have never initiated a dispute, but they only represent 0.2 percent of total WTO exports. On the other hand, among the countries observed, high-income countries have filed the greatest number of complaints (63.5 percent). Despite a notable decrease in this number (by approximately 20 percent from the first period under study to the last one), there is still a considerable gap compared with all other countries (see columns 2 and 5 of Table 1.4.1). In a sense, however, the share of high-income countries in the total number of disputes might be considered low

¹⁶For the design of this table we used the 2014 income classification.

Table 1.4.1: Percentage of total complaints filed, by income level of the complainant, 1995–2014

	1995– 1999	2000– 2004	2005– 2009	2010– 2014	1995– 2014	Share in WTO exports
HI	70.3%	61.4%	64.8%	51.6%	63.5%	79.2%
UMI	17.2%	24.8%	25.9%	17.7%	20.9%	16.2%
LMI	12.5%	13.9%	9.3%	30.6%	15.7%	4.4%
LI	0.00%	0.00%	0.00%	0.00%	0.00%	0.2%

Source: Authors' calculations using data from United Nations (2015).

Note: The share in WTO exports is here defined as the share of a group of countries in total exports (merchandises) by all WTO members over the 1995–2014 period. HI = high-income countries; LI = low-income countries; LMI = lower-middle-income countries; UMI = upper-middle-income countries; WTO = World Trade Organisation.

Table 1.4.2: Percentage of complaints filed by the United States and the European Union by time period, 1995–2014

	1995– 1999	2000– 2004	2005– 2009	2010– 2014	1995– 2014	Share in WTO exports
EU	17.2%	11.9%	14.8%	14.5%	14.6%	11.7%
US	21.1%	12.9%	14.8%	14.5%	17.4%	9.5%
Total	38.3%	24.8%	29.6%	29.0%	32.0%	21.2%

Source: Authors' calculations using data from United Nations (2015).

Note: The share in WTO exports is here defined as the share of a group of countries in total exports (merchandises) by all WTO members over the 1995–2014 period. EU = European Union. US = United States. WTO = World Trade Organisation.

because this group of countries represents 79.2 percent of total WTO exports.

Table 1.4.2 focuses only on the United States and the European Union,¹⁷ further showing that both countries together have filed the largest number of complaints in the entire period under study (32 percent), confirming that these two trading countries have been the main drivers of the high participation of high-income countries in the DS system. Comparing these shares with the share of each country in WTO members' total exports, we conclude that both countries are significantly overrepresented as DSS complainants.

Table 1.4.3 indicates the percentage of total WTO complaints filed, by the income level of the respondent. The last column indicates the share of each group of countries in total imports of merchandise by all WTO members over the 1995–2014 period. Because

¹⁷This includes the European Community before 2010.

Table 1.4.3: Percentage of total complaints filed, by income level of the respondent, 1995–2014

	1995– 1999	2000– 2004	2005– 2009	2010– 2014	1995– 2014	Share in WTO imports
HI	80.5%	73.3%	66.7%	51.6%	71.0%	79.4%
UMI	13.3%	19.8%	24.1%	29%	19.7%	15.1%
LMI	6.3%	6.9%	9.3%	19.4%	5.2%	5.2%
LI	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%

Source: Authors' calculations using data from United Nations (2015).

Note: The share in WTO exports is here defined as the share of a group of countries in total exports (merchandises) by all WTO members over the 1995–2014 period. HI = high-income countries; LI = low-income countries; LMI = lower-middle-income countries; UMI = upper-middle-income countries; WTO = World Trade Organisation.

Table 1.4.3 presents disputes by respondent, imports are the correct benchmark. Notice that low-income countries have never been the respondent of any trade dispute initiated before the WTO. There may be different explanations for this fact, either complementary or substitute. First, low-income countries are not destination markets sufficiently large to cover the fixed cost associated with a WTO complaint. Second, there could exist a kind of *positive discrimination* under which WTO members commit themselves not to complaint about low-income countries' trade policy. Third, the numbers of products and of origin trading partners defining the structure of low-income countries' imports are relatively low, and these countries' share in total WTO imports is only 0.3 percent.

Table 1.4.4 indicates the percentage of total complaints filed, by the income level of both complainant and respondent, over the period 1995–2014, showing that almost 80 percent of trade disputes involved high-income and upper-middle-income countries (the upper-middle-income country group includes in particular Brazil, China, Mexico, South Africa and Turkey). More precisely, in 84.4 percent of all cases, the complainant is either a high-income or an upper-middle-income country while in 90.7 percent of all cases, the respondent belongs to one of these two groups. However, over the whole period, these two groups realised 95 percent of WTO members' trade. In a sense, then, high-income and upper-middle-income countries may be considered as underparticipating in the DSS whereas lower-middle-income countries may be considered as overparticipating because with only 4.8 percent as a share in total WTO trade, they participate in 15.7 percent of all disputes as a complainant and 9.3 percent as a respondent.

Table 1.4.4: Percentage of total complaints filed, by income level of participants, 1995–2014

Complainant	Respondent					Share in WTO trade
	HI	UMI	LMI	LI	Total	
HI	45.8%	11.0%	6.7%	0.0%	63.5%	79.3%
UMI	15.7%	4.1%	1.2%	0.0%	20.9%	15.7%
LMI	9.6%	4.6%	1.4%	0.0%	15.7%	4.8%
LI	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Total	71.0%	19.7%	9.3%	0.0%	100.0%	100.0%
Share in WTO trade	79.3%	15.7%	4.8%	0.2%	100.0 %	n.a.

Source: Authors' calculations using data from United Nations (2015).

Note: The share in WTO exports is here defined as the share of a group of countries in total exports (merchandises) by all WTO members over the 1995–2014 period. HI = high-income countries; LI = low-income countries; LMI = lower-middle-income countries; UMI = upper-middle-income countries; WTO = World Trade Organisation; n.a. = not applicable.

1.4.2 Objects, sectors and duration of disputes

Turning our attention to the objects of disputes, we find that these are principally conflicts of interest regarding GATT principles (cited 268 times in the 345 cases studied). More specifically, Articles I and III of GATT, respectively referring to the general most-favoured-nation treatment and to the national treatment on internal taxation and regulation, were the most employed objects of trade disputes. In addition to these agreements, many disputes emerged regarding trade remedy instruments. These include antidumping measures, safeguard duties and countervailing duties. Article VI of GATT, regarding antidumping duties, appeared as a conflict in 83 cases, while the Agreement on Subsidies and Countervailing Measures and the Agreement on Safeguards were cited in 69 and 38 disputes, respectively. These disputes involve mainly high-income countries as both complainant and respondent. High-income countries are complainant in 54 percent of antidumping cases and respondent in 71 percent of these cases. Similarly, they are complainant in 62 percent of disputes regarding countervailing measures and respondent in 65 percent of these cases. Finally, they appear as complainant in 47 percent of cases involving safeguard duties and as respondent in 68 percent of these disputes. The imposition of trade remedy measures by WTO members may thus significantly affect the probability that a country files a dispute before the DSS. We test this hypothesis in Section 1.6. Moreover, although GATT principles remained the most cited object of dispute over the entire period under study, the number of cases involving them decreased over time. This trend could be explained by the declining total number of complaints

filed over time as well as by the rising share of disputes that emerged in regard to trade remedy regulations, notably after 2000.

The subjects of disputes are concentrated, both in terms of agreements cited, as previously analysed, and in terms of sectors. The sector most represented in trade disputes is the textile industry (HS2 codes 50 to 63), specifically articles of apparel and clothing accessories (HS2 codes 61 and 62).

This sector encompasses 35.9 percent of all WTO trade litigation. Animals and animal products appears as the second-most-represented sector, with 23.2 percent of all disputes. Many complaints referred to other food products (HS2 codes 06 to 24). Metals is also one of the most affected sectors: 15.4 percent of all cases. Finally, the transportation sector (HS2 codes 86 to 89) represents 12.8 percent of all initiated cases. Sectors such as stone and glass (HS2 codes 68 to 71) or mineral products (HS2 codes 25 to 27) are rarely the subject of a trade dispute.¹⁸

Disputes last on average 1,277 days,¹⁹ the equivalent of three and a half years (see Table 1.4.5). This average duration is partly explained by a few disputes, which were very long: DS26 between the US and the European Union on meat products treated with certain hormones (6,653 days), DS27 on bananas between the European Union on one side, the US and a few Central American countries on the other side (6,251 days), DS58 on shrimps between the US on one side, India, Malaysia, Pakistan and Thailand on the other side (5,522 days). Without these three disputes, the average duration is 1,049 days. The median of the entire set of disputes is 911 days. We observe dispersion in the duration of disputes depending on the level of income of both participants, especially the per capita income of the respondent: when the respondent is a high-income country, the duration of the dispute is 1,436 days, yet it is only 827 days when the respondent is a lower-middle-income country. A potential simple explanation is that litigation takes more time when the respondent has more legal capacity.

1.5 Economic Model

The goal of this paper is to identify factors influencing the probability that countries participate in the WTO DSS, and thus to determine whether the WTO DSS is rules-based or power-based.

¹⁸Services (HS2 codes 98 and 99) are not included in our analysis.

¹⁹We calculate the average duration of disputes based on the 218 settled cases.

Table 1.4.5: Duration of disputes, in days, by income level of participants

Complainant	Respondent				
	HI	UMI	LMI	LI	Total
HI	1,205	1,010	854	n.a.	1,135
UMI	1,783	380	898	n.a.	1,566
LMI	1,952	878	577	n.a.	1,463
LI	n.a.	n.a.	n.a.	n.a.	n.a.
Total	1,436	888	827	n.a.	1,277

Source: Authors' calculations.

Note: HI = high-income countries; LI = low-income countries; LMI = lower-middle-income countries; UMI = upper-middle-income countries; n.a. = not applicable.

Let us suppose that we have a perfect knowledge of the distribution of disputable trade measures (DTMs), defined by Horn et al. (1999) as “trade or trade-related measures that potentially violate a provision of the WTO agreement”. If we had access to data on all DTMs, we could compare the distribution of DTMs with the distribution of the actual number of complaints and draw conclusions about the DSS. However, since these data are not available, we have to rely on different methodologies.

Let y_{ijt} be a dummy variable equal to 1 if country i filed at least one complaint against country j at time period t , 0 if not. We denote $P(y_{ijt} = 1|x)$ as the response probability, conditional on the value of a set of explanatory variables, x . We propose three models of this response probability: (1) the rules-based model; (2) the unilateral power-based model; and (3) the bilateral power-based model.

Different econometric models are available to estimate this response probability. The linear probability, in particular, is simple to interpret but has a major drawback: for certain values of independent variables, the prediction for response probability can be either negative or greater than 1. For that reason, instead of the linear model, we use the probit and logit models.²⁰ The remainder of the paper discusses results for the logit model, based on a logistic function. Results for the probit model, based on a normal density

²⁰Individual (exporter) fixed effects are not included in the model because the dependent variable, y_{ij} , always equals zero for a set of exporters. Exporter fixed effects associated with countries that have never filed a complaint before the DSP perfectly predict failure (i.e. dependent variable equal to zero). As a result, these observations are dropped from the regression. When adding exporter fixed effects, the model uses only 19,655 observations, compared to 67,161 without exporter fixed effects. Moreover, results obtained from the model that includes exporter fixed effects are similar to results obtained from the model that does not include exporter fixed effects. The only difference resides in the share of agricultural products in a country's total exports to the partner country, $AGRI_{ij}$, which is no longer significant.

function, are not presented here and may be requested from the authors; they confirm the results from the logit model.

1.5.1 Rules-Based Model

According to the rules-based model, there is no bias in the DSS and the probability that country i initiates a complaint against country j at time period t depends only on the structure and importance of trade between both countries. The response probability is

$$P(y_{ijt} = 1|x) = G(\beta_0 + \beta_1 x_{1ijt} + \beta_2 x_{2ijt} + \dots + \beta_k x_{kijt}), \quad (1.1)$$

where G is the logistic cumulative distribution function (standard normal cumulative distribution function in the case of the probit model). $(x_{1ijt}, \dots, x_{kijt})$ is a vector of variables related to the structure of trade between country i and country j at time period t . This vector is composed of four variables. The first independent variable in this baseline model, n_{ijt} , is calculated as the number of products exported by each complainant to each respondent at time period t . We expect this variable to have a positive impact on the dependent variable; that is, an increase in the number of exported products should lead to an increase in the probability that i complains about j and of the number of complaints filed, inasmuch the probability that an exporter will encounter a WTO-inconsistent policy increases with the number of exported products. Second, v_{ijt} represents the logged value of exports (in thousands US\$) from each complainant to each respondent at time period t . We also expect this variable to have a positive impact on the dependent variable. Countries that trade more with each other should have more opportunities for trade conflicts. Third, given that agricultural issues often encounter strong interest group pressure in many member countries and are the object of more technical, sanitary and phyto-sanitary regulations, we consider the possibility that a country with a larger share of agricultural products in its total exports to the partner country will be more likely to initiate trade disputes at the WTO. This variable is represented by $AGRI_{ijt}$ and is expressed as a percentage. Fourth, FTA_{ijt} is a dummy variable equal to one if country i and j belong to the same reciprocal trade agreement in time period t . We expect this variable to have a negative effect on the probability that i (or j) complains about j (respectively i) before the DSS: these agreements have their own dispute-settlement mechanism. Even if the efficiency of these mechanisms is criticised

(Bagwell et al., 2016), the probability of i and j having a trade dispute litigated at DSS should be decreased when i and j belong to the same reciprocal trade agreement.

Indeed there are two types of preferential trade agreements: either they are reciprocal (free trade areas or custom unions), or they are non-reciprocal (preferences granted by a rich country to a developing one). Both agreements may increase trade between member countries but this effect should be taken into account by the trade variable. Reciprocal trade agreements have their own mechanism of dispute settlement as mentioned earlier: trade flows under these agreements may not lead to potential dispute litigated under the WTO DSS. It may even lead to a negative impact of such an agreement between two countries i and j on the probability of i complaining at WTO about j , or j about i . Non-reciprocal trade agreements are different because they take the form of preferences given by a rich country to a developing one, and may create power asymmetries between pairs of countries. Therefore, such agreements may lead to a bias in the DSS. Indeed, some preferences, like the African Growth Opportunity Act, may be suspended at any time. To test if a preference given by i to j decreases the probability that j complains about country i 's conduct before the DSS, we include a variable representing non-reciprocal trade preferences in the bilateral power-based model.

In the following models (unilateral and bilateral power-based), we include all four variables representing the structure of trade between i and j . These four variables (n_{ijt} , v_{ijt} , $AGRI_{ijt}$, and FTA_{ijt}) appear as important determinants of dispute initiation and unilateral or bilateral characteristics may be complementary explanations of the likelihood of dispute initiation. As a robustness check, we test in Section 1.6 for an additional variable, TR_{jt} , representing trade remedies imposed by respondents. This variable also appears as a main determinant of dispute initiation.

1.5.2 Unilateral Power-Based Model

According to the unilateral power-based model, a potential bias may arise from the characteristics of country i , independent of country j 's characteristics, or of country j 's characteristics, independent of country i 's characteristics.²¹ In this model, the response probability is

²¹This model may be called the unilateral power-based model or the unilateral model. Explanatory variables are systematically related to the characteristics of a single country, either the complainant or the respondent. These variables may be the expression of an economic power, like the legal capacity of the complainant, or a structural feature like the degree of democracy.

$$P(y_{ijt} = 1|x) = G(\beta_0 + \beta_1 x_{1ijt} \dots + \beta_k x_{kijt} + \beta'_1 x_{1it} + \dots + \beta'_k x_{kit} + \beta''_1 x_{1jt} + \dots + \beta''_k x_{kjt}) \quad (1.2)$$

$(x_{1it}, \dots, x_{kit})$ is a vector of variables related to country i at time period t , $(x_{1jt}, \dots, x_{kjt})$ to country j at time period t .

The first characteristic that may affect this probability is the legal capacity of the potential complainant country. Testing for the importance of this capacity seems necessary to explain the absence of low-income and some lower-middle-income countries from the DSS. We expect this variable to have a positive impact on the number of initiated disputes: complainants with greater legal capacity should easily detect WTO-inconsistent policies and may have better chances of winning disputes. As a result, they would be expected to get involved in more trade litigations than countries with lower legal capacity.

The second characteristic is the level of democracy in country i . Democratic governments may be more efficient at defending interests of economic sectors. In a democracy, voices of economic groups can be more easily heard and taken into consideration. We hence expect countries with greater levels of democracy to initiate more disputes before the DSS.

The third characteristic is the level of democracy in country j , the respondent. The interpretation of this variable is ambiguous. On the one hand, authoritarian regimes may not follow WTO rules as much as democratic countries. Consequently, they may implement DTMs more often than democratic governments and therefore be the target of more complaints, making the probability of i initiating a complaint against j higher if j is not democratic.

On the other hand, countries with authoritarian regimes may not follow WTO rulings: country i , whose exports toward country j , with an authoritarian regime, are the object of a DTM, may anticipate a relatively high probability that country j will not follow WTO rulings on litigation. The probability of i 's initiating a complaint against j would thus be lower if j is not democratic. Conversely, countries with democratic regimes may be more transparent about trade measures in general and DTMs in particular. Country i , whose exports are concentrated toward country j , with a democratic regime, may then be more likely to detect a DTM.

The fourth characteristic is the past experience a country may have in trade adjudication. We expect a country that has previously participated in WTO trade

litigation to possess more experience with the DSS and hence to have a higher probability of initiating a case against one of its trading partners. Bohanes and Garza (2012) explain that “there is evidence from some countries that defensive postures in the early WTO years lead to experience and reforms that facilitate subsequent offensive cases”. They cite the case of Argentina, Brazil and Pakistan adopting such reforms.

1.5.3 Bilateral Power–Based Model

According to the bilateral power–based model, potential bias may arise from the characteristics of the economic relationship between country i and country j at time period t . In this model the response probability is

$$P(y_{ijt} = 1|x) = G(\beta_0 + \beta_1 x_{1ijt} + \dots + \beta_k x_{kijt} + \beta_1''' x_{1ijt}' + \dots + \beta_k''' x_{kijt}'), \quad (1.3)$$

$(x_{1ijt}', \dots, x_{kijt}')$ is a vector of variables related to the economic relationship between country i and country j .

The concept of economic relationship involves trade and financial aspects. In particular we test the influence of four variables:

- Country i 's capacity to retaliate may have a positive influence on the number of filed complaints. A complainant i with large retaliatory capacity should have better chances of a respondent j 's following of a WTO ruling and thus i would be expected to initiate more disputes.
- Respondents' retaliatory capacity may have a negative influence on the number of complaints filed against them, due to fear of trade retaliation. Respondent j , with large trade retaliatory capacity toward country i , should have a lower chance of being sued by country i .
- When country i receives financial aid or development–related aid from country j , it is less likely that country i will initiate a complaint against a DTM implemented by country j on country i 's exports, due to the fear of canceled aid. When i receives more financial aid from j , the probability that i will complain about j is reduced.
- When country i has been granted a non–reciprocal trade preference by country j , it is less likely that country i will initiate a complaint against a DTM implemented

by country j on country i 's exports due to the fear of withdrawn preferences. This variable may have additional influence because a trade preference may imply more exports from country i to country j and thus more potential disputes. This last effect should, however, be captured by the trade variable.

The importance of trade retaliatory capacity of both complainants and respondents has been highly commented. Let us first consider the case of the complainant's retaliatory capacity. In a WTO dispute, if a respondent loses and does not bring the incriminated measure into conformity with WTO law, retaliation by the complainant against the respondent, in the form of suspended concessions, may be authorised. Trade theory explains that in a trade war, a small country has no retaliatory power (Johnson, 1953), whereas big countries win tariff wars (Kennan and Riezman, 2013), i.e. big countries may inflict an economic damage to small countries. As a logical outcome, because it does not influence world prices, a small country does not have an interest in exerting retaliation: imposing additional duties may only harm a small and less developed country and may not hurt its large and rich partner. Busch and Reinhardt (2003) bring evidence of developing countries being less successful than their developed counterparts in early settlements of cases, i.e. prior to the implementation of a panel (early settlements of cases are generally beneficial for complainants). They consider that a lack of trade capacity to retaliate may be the reason of this failure. Bohanes and Garza (2012) also point out the fact that developing countries are increasingly prone to complain about other developing countries and not developed countries (see *supra*) and conclude that this may reflect a lack of retaliatory capacity.

Second, let us consider the case of the respondent's retaliatory capacity. This case is different from the previous one. If country i is hurt by a measure implemented by country j , measure that i considers as inconsistent with WTO law, it may hesitate to file a dispute against j based on potential trade retaliation by j . This retaliation may not take the form of direct reprisals like additional duties which would be inconsistent with WTO law, but the form of less visible non-tariff or administrative measures implemented by j , or suspension of trade negotiation concerning a potential trade agreement between i and j . In this interpretation, the respondent j 's retaliatory capacity against i may have a negative impact on the probability that i files a dispute against j .

There exists, however, an alternative interpretation with regard to the respondent's capacity to retaliate. A complaint is costly and as mentioned earlier, it may be worth, or not, to file it. The respondent j 's retaliatory capacity against i is measured by the share

of destination j in total exports of i . The greater this share is, the larger the potential benefits from the dispute litigation are. In this interpretation, the respondent j 's retaliatory capacity may have a positive impact on the probability that i files a dispute against j .

1.6 Empirical Analysis

Three models are presented in this section. For all models, the dependent variable, y_{ijt} ,²² is a binary variable coded 1 if country i has filed at least one complaint against country j at time period t , and 0 otherwise. Each time period lasts five years, for a total of four periods.²³ As previously mentioned, a time component is added to the model to reflect changes that took place over the entire 20-year time frame: the formation of the Advisory Centre on WTO Law in 2001, the accession of China to the WTO in 2001, the accession of Russia to the WTO in 2012, among other things.

We obtain 81,252 bilateral observations from the 153 countries and four time periods included in the analysis.²⁴ Although we obtain 81,252 bilateral observations, only those representing trading partners are included in the analysis. Countries that do not trade with each other should, by definition, not face any DTM. In 0.3 percent of all potential cases, at least one bilateral dispute was initiated between WTO members during the period under study (Table 1.6.1). The data for the dependent variable contain a high number of 0s, but that is expected because we are considering bilateral cases. Some countries, for instance, have never initiated disputes, and others have initiated many disputes against the same respondent. For example, over the entire period under study, the EU filed 14 complaints against the United States, and the United States filed 12 complaints against the EU.

1.6.1 Rules-Based Model

The first model, that we propose to call “rules-based”, tests whether the structure of trade of WTO members is the only determinant of their participation in the DSS.

Data for n_{ijt} , v_{ijt} , and $AGRI_{ijt}$ were collected from the BACI Database for International Trade Analysis (Centre d'Etudes Prospectives et d'Informations Internationales, 2017) and

²²Throughout the analysis section, i represents the complainant and j the respondent.

²³The first time period lasts from 1995 to 1999, the second from 2000 to 2004, the third from 2005 to 2010, and the fourth from 2010 to 2014.

²⁴Seven countries were not included in the analysis due to a lack of data: Botswana, Lesotho, Liechtenstein, Luxembourg, Montenegro, Namibia, and Swaziland. Furthermore, Afghanistan, Kazakhstan, Liberia, and Seychelles were not included since they became members of the WTO after 2014.

Table 1.6.1: Summary statistics for the estimation variables: Rules-based model

Variables	N	Mean value	Standard deviation	Minimum	Maximum
Dependent variable					
y_{ijt}	81,252	0.003	0.055	0	1
Explanatory variables					
n_{ijt}	69,658	511.479	940.367	1	4929
v_{ijt}	69,658	9.343	4.083	0	21.393
$AGRI_{ijt}$	69,658	12.65	24.51	0	100
FTA_{ijt}	77,874	0.104	0.305	0	1
TR_{jt}	14,797	1.697	3.706	0	23.264

Source: Authors' calculation based on CEPII (2017).

are measured at the six-digit Harmonised System level. Data on FTAs are from the gravity database of the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales, 2018).

The second column of Table 1.6.2 reports the estimated odds ratios obtained from the rules-based model. Although the size of the odds ratio associated with the number of products exported by the complainant to the respondent is small,²⁵ it is statistically significant and reflects a positive relationship between the number of products exported from i to j and the dependent variable. The implied size of the estimate for v_{ijt} is difficult to interpret since it is defined in logs, however, it is also significant and implies, as expected, a positive relationship between the value of trade and the dependent variable. A one-unit increase in v_{ijt} increases the odds that the exporter will file a complaint against the importer by a factor of 1.665. An exporter with a large share of agricultural commodities in its total exports to its trading partner will be more likely to initiate a trade dispute. A one-unit increase in the exporter's share of agricultural products in its total exports to the partner country increases the odds that the exporter will become a complainant by a factor of 1.016. Lastly, two countries members of the same reciprocal trade agreement (FTA_{ijt}) are less likely to initiate a trade dispute. These results confirm our expectations.

In the next column, we run the same model excluding the 1995–1999 period, during which countries, notably the United States and the EU, may have over-exploited the DSS (Figure 1.4.1). Over this period, approximately 25 complaints were filed each year, whereas this number falls to 14 for the period from 2000 to 2014. Results obtained from

²⁵A one-unit increase in the number of products exported from i to j at time period t increases the odds that the exporter will become a complainant by a factor of 1.0004.

Table 1.6.2: Odds ratios: Rules-based model

Ind. var.	Baseline model (1)	Excluding 1995–1999 (2)	Excluding raw minerals and energy products (3)	Including trade remedy measures (4)
n_{ijt}	1.0004*** (0.0001)	1.0004*** (0.0001)	1.0005*** (0.0001)	1.0006*** (0.0001)
v_{ijt}	1.665*** (0.086)	1.800*** (0.116)	1.666*** (0.086)	1.519*** (0.089)
$AGRI_{ijt}$	1.016*** (0.004)	1.018*** (0.005)	1.016*** (0.004)	1.031*** (0.005)
FTA_{ijt}	0.395*** (0.112)	0.536* (0.178)	0.396*** (0.112)	0.533** (0.167)
TR_{jt}				1.072*** (0.024)
Obs.	67,161	54,304	67,161	13,405
AIC	1,742.457	1,164.285	1,742.529	1,114.703

Source: Authors' calculation based on CEPII (2017).

Note: In parentheses are robust standard errors adjusted for clusters in $Dyads_{ij}$. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% threshold levels, respectively. Specification estimated with a constant term whose estimates are suppressed. AIC = Akaike information criterion.

specification (2) are similar to those obtained from specification (1). The odds ratios for all four variables are of equivalent size and remain statistically significant.

We also want to explore why many countries that export raw energy and mineral products have never participated in the DSS. These types of products may not be subject to DTMs because they are commodities necessary for the domestic production process. To test this hypothesis, we exclude raw energy and mineral products²⁶ from the list of exported products used to calculate the explanatory variable, n_{ijt} . Results are displayed in the fourth column of Table 1.6.2. The odds ratio associated with all variables are statistically significant, and close to that of specification (1). The AIC statistic of specification (3) is slightly higher than that of specification (1).

Finally, we test for the impact of the imposition of trade remedy measures by a respondent on the probability that another WTO member files a dispute against the former. The fact that a large number of WTO members are not subject to trade remedy measures, and that such measures give rise to about half of the total number of dispute,²⁷

²⁶We exclude all products classified under HS2 codes 25 to 27.

²⁷Recall from Section 1.4 that about 55 percent of disputes included in our dataset concerns trade remedies implemented by respondents.

would seem to have a significant effect on the probability of certain countries filing disputes against other WTO members. To test this assumption, we add an explanatory variable to our model, TR_{jt} , which represents the stock of the respondent's imports subject to temporary trade barriers (TTBs) by count, expressed as a percentage (Bown, 2011, 2014).²⁸ We expect the coefficient associated with TR_{jt} to be positive since as the share of the respondent j 's imports subject to trade remedy measures increases, the probability that a country i files a dispute against this country j increases. The fifth column of Table 1.6.2 reports the results. The coefficient associated with TR_{jt} is positive, as expected, and significant at a 1 percent threshold level. Moreover, all other results hold under this new specification of the model. In subsequent sections, we use specification (1) as our baseline model and do not include the variable TR_{jt} because data on this variable is available for only 16 percent of all observations included in our sample. Using specification (4) thus reduces the number of observations included in our model from 67,161 to 13,405. We have, however, performed all subsequent regressions including the variable TR_{jt} in our model. Most results hold for both the unilateral and bilateral power-based model.²⁹

We conclude from this subsection that the structure and importance of trade between countries i and j affect country i 's probability of initiating a dispute against country j before the WTO DSS. In the following section, we test for both countries i and j specific characteristics, in particular for their legal capacity, which may affect their access to the WTO DSS.

1.6.2 Unilateral Power-Based Model

The model presented in this section tests for diverse country-specific characteristics that may be sources of bias in the DSS. Descriptive statistics of additional independent variables included in this model are summarised in Table 1.6.3.

First, we attempt to measure complainants' legal capacity ($LEGAL_{it}$). To do so, we

²⁸We have tested other indicators of trade remedies provided by Bown (2011, 2014), such as the stock of the respondent's imports subject to TTBS weighted by the HS6 product-level value of import, the flow of the respondent's imports affected by TTBS by count, and the flow of the respondent's imported subject to TTBS weighted by the HS6 product-level value of import. Results obtained from these models confirm our main conclusions. We do not report these results, but they may be requested from the authors.

²⁹In the unilateral power-based model, $POLITY_{jt}$ is no longer significant, as is the case in the robustness analysis. In the bilateral power-based model, PTA_{jit} is no longer significant whereas $RETAL_{jit}$ becomes significant as is also the case in various robustness checks. Otherwise, coefficients associated with all other variables remain significant and of comparable values.

Table 1.6.3: Summary statistics for the estimation variables: Unilateral power-based model

Variables	N	Mean value	Sta. dev.	Minimum	Maximum
Dependent variable					
y_{ijt}	81,252	0.003	0.055	0	1
Explanatory variables					
$LEGAL_{it}$ (ACWL)	77,874	0.104	0.305	0	1
$LEGAL_{it}$ (UNESCO)	42,045	35.506	11.121	0	80.845
$POLITY_{it}$ (POLITY IV)	72,712	4.69	5.73	-10	10
$POLITY_{it}$ (FH sum)	80,118	3.096	1.782	1	7
$POLITY_{it}$ (FH CL)	80,118	3.101	1.631	1	7
EXP_{it}	81,252	0.237	0.425	0	1

Source: Authors' calculation.

Note: Sta. dev. = Standard deviation.

use two alternative proxies.³⁰ First we include ACWL membership as a dummy equal to 1 if country i becomes a member of ACWL in the first two years of time period t , 0 otherwise.³¹ We expect this proxy to have a positive impact on the dependent variable. In a second specification, we create a new proxy for the legal capacity of the complainant by collecting data on the percentage of graduates from tertiary education in social science, business, and law programs for each complainant (UNESCO, 2016). This number is then averaged for each time period.

Second, the political regime of WTO members could have an impact on their participation in the DSS. To verify this hypothesis, we collect the polity score of each potential complainant and each time period ($POLITY_{it}$). Polity scores capture the degree of authority of a regime, ranging from -10 (“hereditary monarchy”) to +10 (“consolidated democracy”) (Polity IV, 2016). On average, WTO members obtained a polity score of 4.69, and both extreme regimes are represented. For example, Saudi Arabia has a polity score of -10, whereas Australia reached a score of +10 during all four time periods.

We also take into account the political regime of respondents, $POLITY_{jt}$, calculated as the polity score of each respondent.

Finally, we include a dummy variable, EXP_{it} , coded 1 if the complainant has previously been involved in a trade conflict either as complainant or respondent. As shown by Davis

³⁰The logged value of the exporter’s per capita GDP has been used in previous literature as a proxy for the complainant’s legal capacity. See, for example, Sattler and Bernauer (2008), Guzman and Simmons (2005), Horn et al. (1999). We think this is not a right proxy for legal capacity: for illustration countries with high per capita GDP may have a religious legal system, which may not be adapted to the WTO DSS.

³¹We thank the ACWL staff for rapidly providing data on membership.

Table 1.6.4: Odds ratios: Unilateral power-based model

Ind. Var.	Baseline using ACWL for $LEGAL_{it}$ (1)	Legal capacity using % grad. (2)	DEMOC Freedom House (sum) (3)	DEMOC Freedom House (CL) (4)	EXPi (5)
n_{ijt}	1.0004*** (0.0001)	1.0006*** (0.0002)	1.0005*** (0.0001)	1.0005*** (0.0001)	1.0004*** (0.0001)
v_{ijt}	1.697*** (0.110)	1.577*** (0.145)	1.680*** (0.096)	1.672*** (0.093)	1.679*** (0.108)
$AGRI_{ijt}$	1.015*** (0.005)	1.018*** (0.006)	1.016*** (0.004)	1.016*** (0.004)	1.015*** (0.004)
FTA_{ijt}	0.303*** (0.094)	0.277*** (0.099)	0.338*** (0.104)	0.357*** (0.109)	0.305*** (0.097)
$LEGAL_{it}$	2.004** (0.563)	1.040** (0.013)	2.065*** (0.576)	1.970** (0.546)	1.888 (0.532)
$POLITY_{it}$	1.089*** (0.025)	1.022 (0.034)	0.943 (0.049)	1.007 (0.057)	1.087*** (0.024)
$POLITY_{jt}$	1.073*** (0.024)	1.081** (0.030)	0.918 (0.052)	0.963 (0.057)	1.073*** (0.024)
EXP_{it}	0.686 (0.165)	0.996 (0.315)	0.723 (0.170)	0.732 (0.170)	0.789 (0.202)
Obs.	55,571	30,590	65,192	65,192	55,571
AIC	1,689.492	1,117.944	1,717.058	1,719.447	1,691.321

Source: Authors.

In parentheses are robust standard errors adjusted for clusters in $Dyads_{ij}$. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% threshold levels, respectively. Specification estimated with a constant term whose estimates are suppressed. DEMOC = democracy; CL = civil liberties; EXP = past experience in WTO adjudication. AIC = Akaike information criterion.

and Bermeo (2009), past experience in trade adjudication, as either a complainant or a defendant, may increase the likelihood of dispute initiation. We include a similar measure to capture such dynamics.

Specification (1) of Table 1.6.4 is referred as the baseline model, while specifications (2) to (5) are referred as a sensitivity analysis of the unilateral power-based model.

First, focusing on the baseline model, results concerning the four variables already included in the rules-based model (n_{ijt} , v_{ijt} , $AGRI_{ijt}$, FTA_{ijt}) are confirmed.

Second, the odds ratio associated with $LEGAL_{it}$, measured by ACWL membership, is statistically significant. Legal capacity of exporters does appear as a determinant of dispute initiation. When the complainant is member of ACWL, it is more likely to initiate a dispute at DSS.

Third, the odds ratio of the complainant's political regime variable is statistically significant and reflects an expected positive relationship between the probability of

initiating a dispute and the complainant’s level of democracy. A one–unit increase in the Polity Score of the complainant increases the odds that the exporter will file a complaint against the importer by a factor of 1.089. Regimes that are more democratic initiate significantly more disputes.

Fourth, the odds ratio of $POLITY_{jt}$ is statistically different from 0 and also reflects a positive relationship between the probability of initiating a dispute and the respondent’s political regime. A one–unit increase in the Polity Score of the defendant increases the odds that the exporter will become a complainant by a factor of 1.073. Countries with greater levels of democracy are targeted more often than countries with authoritarian regimes in trade litigation. Our interpretation is that democratic regimes are more transparent about trade measures and that complainants may expect democracies to better follow the DSS’s recommendations and, as a result, initiate more disputes against democratic states.

Finally, past experience in trade adjudication does not seem to play a role. The estimated odds ratio associated with EXP_{it} is not statistically significant.

We next run a sensitivity analysis on three variables presented in the baseline model (specifications (2) to (5) of Table 1.6.4). First, we develop another proxy of the legal capacity of the complainant, presented in specification (2) of Table 1.6.4. We also expect a positive relationship between the dependent variable and this new proxy.

Second, instead of using the polity score of each potential complainant to measure their level of democracy, we use the Freedom House (FH) Index (Freedom House, 2016). The FH Index includes a polity rights score and a civil liberties score. The polity rights indicator consists of three elements: electoral process, political pluralism and participation, and functioning of the government. The civil liberties score comprises four elements: freedom of expression and belief, associational and organisational rights, rule of law, and personal autonomy and individual rights. We hence create four variables: $DEM - sum_{it}$, $DEM - sum_{jt}$, $DEM - CL_{it}$, and $DEM - CL_{jt}$. $DEM - sum_{it}$ is measured as the sum of the polity rights and civil liberties scores of the complainant, averaged over each time period. Likewise, we calculate the level of democracy of the respondent, $DEM - sum_{jt}$. $DEM - CL_{it}$ and $DEM - CL_{jt}$ take into account only the civil liberties scores (averaged over each time period) of the complainant and of the respondent, respectively. Both indicators are measured on a scale from 1 (free) to 7 (not free). If previous results are confirmed, we expect a negative impact of variables $DEM - sum_{it}$ and $DEM - CL_{it}$ on the dependent variable since the Freedom House Index reverses countries’ rank. We also expect a negative impact associated with $DEM - sum_{jt}$ and $DEM - CL_{jt}$.

Third, we test for the impact of past experience in WTO trade adjudication as complainant only. To do so, we create a dummy variable coded 1 if the complainant has previously filed at least one complaint before the WTO, regardless of the defendant; 0 otherwise.

Specification (2) of Table 1.6.4 tests the robustness of the variable $LEGAL_{it}$, using the percentages of graduates from tertiary education in social science, business, and law programs for each complainant. Under this specification, previous findings are all confirmed, except for the political regime of the complainant, which is no longer statistically significant. The impact of the legal capacity of the complainant is confirmed as a positive influence on participation.

Specifications (3) and (4) present the results from the sensitivity analysis carried out on the political regime of both exporters and importers. The odds ratios associated with both the complainant and the respondent's political regimes, based on the FH Index, are not statistically different from 0. While in specification (3) the odds ratios associated with these two variables are less than one (implying, as expected, a negative relationship with the dependent variable), in specification (4), the odds ratio associated with complainant's political regime is greater than one (implying a positive relationship with the dependent variable). These results contrast with previous findings. This difference may be explained by the distinct methodologies used to compute the Polity Score and the Freedom House Index. Consequently, we cannot conclude on the impact of the political regimes of both complainants and respondents on the likelihood of dispute initiation.

Specification (5) reports the odds ratio associated with the variable EXP_{it} , representing past experience of complainants in trade litigation as complainants only. Once again, this variable is not statistically significant. Past experience in trade adjudication, either as a complainant or respondent, or solely as a complainant, does not have an impact on the likelihood of dispute initiation.

We conclude from this subsection that, in addition to the structure and importance of trade between countries i and j , the legal capacity of country i influences its probability of initiating a dispute against country j at the WTO DSS. In the subsequent section, we consider the role of bilateral asymmetries between countries i and j on their access to the DSS.

1.6.3 Bilateral Power–Based model

The main objective of the bilateral model is to test whether power asymmetries among WTO members could lead to bias in their participation in the DSS.

In this model, we attempt to measure the impact of retaliatory capacities of both complainants and respondents. To this purpose, we create four variables: $RETAL_{ijt}$, ODA_{jit} , PTA_{jit} , and $RETAL_{jit}$. Let us keep in mind that the DSS does not have any enforcement power. Instead, in the case of a ruling supporting the complainant, if the respondent does not put its policy into conformity with WTO law, the complainant may be authorised to retaliate. The absence of retaliatory capacity against the respondent may prevent a country from complaining.

Complainants' capacity to retaliate is calculated as the share of respondents' total exports sent to complainants, averaged for each period under study. Data were collected from the BACI database (Centre d'Etudes Prospectives et d'Informations Internationales, 2017), and are expressed as percentages. Complainants' capacity seems on average relatively low, even though we observe dispersion in the data (Table 1.6.5). On the one hand, some countries send a quasi–null share of their exports to others. For example, Nicaragua sends 0.0015 percent of its total exports to Australia. As a result, if Australia were to initiate a dispute against Nicaragua, Australia's retaliatory capacity against Nicaragua would be low. On the other side, some countries seem to be at a great disadvantage. For example, Haiti sends 83.6 percent of its total exports to the United States. Consequently, Haiti would significantly suffer from retaliatory measures implemented by the United States.

We expect this variable to have a positive impact on countries' participation in the DSS. As previously mentioned, the DSS lacks enforcement power, relying on complainants to implement retaliatory measures against respondents. As a result, complainants with high retaliatory capacities can use their power to ensure that respondents will follow the DSS's recommendations. Hence, we should find that they initiate more disputes.

Moreover, developing countries may not initiate disputes for fear of enduring economic consequences resulting from retaliatory measures potentially implemented by respondents. Respondents could use different forms of retaliation: suppression or reduction of bilateral official development aid (ODA), modification of preferential trade arrangements (PTA), or implementation of protectionist trade policies. The last three variables, ODA_{jit} , PTA_{jit} , and $RETAL_{jit}$, respectively were constructed to take these effects into account.

The first of these, ODA_{jit} , is measured either in level or as a binary variable, coded

Table 1.6.5: Summary statistics for the estimation variables: Bilateral power-based model

Variables	N	Mean value	Sta. dev.	Minimum	Maximum
Dependent variable					
y_{ijt}	81,252	0.003	0.055	0	1
Explanatory variables					
$RETAL_{ijt}$	69,658	0.008	0.035	0	0.890
ODA_{jit} (Level)	81,252	1.588	19.425	-689.648	1,562.882
ODA_{jit} (Binary)	81,252	0.224	0.417	0	1
PTA_{jit} (WTO)	81,252	0.049	0.215	0	1
PTA_{jit} (CEPII)	27,762	0.177	0.381	0	1
$RETAL_{jit}$	69,658	0.008	0.036	0	0.890

Source: Authors.

Note: ODA = official development assistance; PTA = preferential trade agreement; Sta. dev. = Standard deviation.

1 if respondents provide complainants with ODA and 0 otherwise. ODA includes grants, soft loans, and the provision of technical assistance. In 22 percent of all cases, respondents provide ODA to complainants (Table 1.6.5). In the regressions that follow, we use both the value of ODA_{ji} in level and ODA_{jit} as a binary variable.

The second variable, PTA_{jit} , is a binary variable coded 1 if respondents applied non-reciprocal PTA with complainants at time period t , and 0 otherwise. We use two types of databases for this variable. In a first estimation, data come from the WTO website. In only 5 percent of all potential bilateral conflicts do respondents apply non-reciprocal preferential trade measures with complainants (Table 1.6.5). In a second estimation, data come from the CEPII website: observations, however, stop in 2005. Its mean value is greater than that of the previous one.

The third variable, $RETAL_{jit}$ measures respondents' retaliatory capacity. This variable is calculated as the averaged share of complainants' total exports sent to respondents for each time period (Centre d'Etudes Prospectives et d'Informations Internationales, 2017).

We expect all three variables, ODA_{jit} , PTA_{jit} , and $RETAL_{jit}$, to have a negative influence on countries' participation in the DSS. Let us, however, remind that there is a second interpretation where $RETAL_{jit}$ has a positive influence on this participation.

Five findings are worth noting.

- First, all four variables representing the structure of trade between i and j remain significant at a 1 percent threshold level with expected positive impacts on the dependent variable.

Table 1.6.6: Odds ratios: Bilateral power-based model

Ind. Var.	Baseline Model (1)	ODA Binary (2)	PTA CEPII (3)
n_{ijt}	1.0004*** (0.0001)	1.0005*** (0.0001)	1.0006*** (0.0001)
v_{ijt}	1.97*** (0.707)	1.468*** (0.068)	1.369*** (0.0855)
$AGRI_{ijt}$	1.011*** (0.0042)	1.014*** (0.004)	1.013*** (0.0065)
FTA_{ijt}	0.553*** (0.1657)	0.358*** (0.107)	0.310*** (0.1244)
$RETAL_{ijt}$	1.003*** (0.0097)	1.002** (0.001)	1.003*** (0.0010)
ODA_{jit}	0.999 (0.0017)	0.642 (0.173)	0.997 (0.0019)
PTA_{jit}	1.862*** (0.0018)	3.340*** (1.217)	0.789 (0.2920)
$RETAL_{jit}$	0.999 (0.7626)	1.005*** (0.0008)	1.003 (0.0020)
Obs.	66,606	67,161	23,916
AIC	1,501.875	1,709.884	651.5817

Source: Authors' calculation.

In parentheses are robust standard errors adjusted for clusters in $Dyads_{ij}$. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% threshold levels, respectively. Specification estimated with a constant term whose estimates are suppressed. Variables $RETAL_{ijt}$, and $RETAL_{jit}$ were scaled up by 1,000. AIC = Akaike information criterion.

- Second, the odds ratio associated with the variable $RETAL_{ijt}$ is significantly different from 0. Thus, retaliatory capacity of complainants may affect positively, as it was expected, the likelihood of dispute initiation.
- Third, suppression or reduction of bilateral official development aid (ODA) does not appear as a credible retaliatory threat. The odds ratio associated with the variable ODA_{jit} is not significant. This result is confirmed in specification (2), using this variable as a binary variable instead as in level.
- Fourth, in specification (1), the odds ratio associated with variables PTA_{jit} is significantly different from 0 and reflect positive relationships between these variables and the dependent variable. According to the bilateral power-based model, these relationships were expected to be negative. However, when data from CEPII are included to measure the PTA variable, it becomes non-significant.
- Fifth, the odds ratio associated with $RETAL_{jit}$ is not significantly different from 0. In specification (2) it is significant and implies a positive impact on participation to DSS: this may reflect that when the respondent's market represents an important share of the complainant's total exports, the complainant is more likely to complain. However, in specification (3), the variable $RETAL_{jit}$ is not significant. Consequently is difficult to conclude on this variable.

We conclude from this subsection that the retaliatory capacity of the complainant is an important determinant of the probability that a country participate in the WTO DSS. In the following section, we verify whether factors affecting the probability of filing a dispute are similar to those influencing the number of complaints filed by a country before the WTO DSS.

1.7 Estimating the Number of Disputes between Two Countries

In order to test the sensitivity of our results we apply the three models (rules-based, unilateral power-based and bilateral power-based) to estimate the number of disputes between two countries, i and j . The dependent variable, y_{ijt} , is now a count variable of bilateral disputes initiated by country i against country j for each time period. This was the methodology used by Horn et al. (1999) who based their estimation on a model in which

disputes between two countries are proportional to the diversity and value of exports and where the probability of observing n_{ij} disputes between countries i and j is binomially distributed.

Since we observe many pairs of countries with 0 dispute, we use a zero-inflated Poisson (ZIP) distribution. Recall that the ZIP model is particularly appropriate for random events containing many 0-count data and that it employs two components: a Poisson count model and a logit model for predicting excess 0s. A ZIP model assumes that there are two types of individuals: those who have a zero count with a probability of one (“always-zero” group), and those who have counts predicted by a standard Poisson model (“not always-zero” group). While it is evident that our data set includes the latter group, we argue that it also includes the “always-zero” group. Although we removed pairs of countries that did not trade during a specific time period (i.e. country pairs which would have, otherwise, been included in the “always-zero” group), some pairs of countries in our data set may never file a dispute against one another, either because trade flows between them are small and/or do not include products that are prone to disputes, or because they settle their trade conflicts without reaching to the WTO DSS (they use a dispute-settlement mechanism implemented within a reciprocal trade agreement). The use of the ZIP model is recommended in such a case. Furthermore, there is an overdispersion problem in the data: the ZIP model is therefore better than the Poisson model.^{32,33}

Table 1.7.1 reports the estimated average marginal effects from the rules-based model with the ZIP method.³⁴

Specification (1) of Table 1.7.1 reports the results from the baseline model. The average marginal effects associated with all four variables have the expected sign and are significant at a 1 percent threshold. In specifications (2) and (3) of Table 1.7.1, we also test whether either excluding the 1995–1999 period, or excluding raw mineral and energy products from

³²A Poisson distribution assumes that the mean and the variance of the count variable are the same. In this case, detailed descriptive statistics of the dependent variable, y_{ijt} , demonstrate that the variance (0.009) is more than two times larger than the mean (0.004). The distribution of y_{ijt} thus displays signs of overdispersion. Furthermore, we run a negative binomial regression that provides a test of the overdispersion parameter. In this case, the overdispersion parameter is significantly different from zero, which reinforces that the Poisson distribution is not the most appropriate.

³³We also use the Poisson model to estimate the three models. A Vuong test was conducted to identify the best model, and systematically the ZIP model is better, which looks consistent, given the overdispersion in the data. We ran the same tests based on the negative binomial model. Results are similar to those obtained with the ZIP model. We present in this paper only the results from the ZIP model. Results from the Poisson and Vuong tests and from the negative binomial model may be requested from the authors.

³⁴Throughout this section, we report the average marginal effects rather than the odds ratio since we are estimating the determinants of the number of disputes initiated by i against j , rather than the probability that i files a complaint against j .

the dataset modifies the results. All four variables are significant and affect the dependent variable as it was expected, except FTA_{ijt} in specification (2) which does not have a significant impact on the number of disputes. In specifications (4), we test whether trade remedy measures implemented by a respondent on its imports affect the number of disputes filed against this specific respondent. The coefficient associated with TR_{jt} is positive and significant at a 5 percent threshold level. Coefficients associated with all other variables are significant and of expected sign, except the coefficient associated with FTA_{ijt} , which is no longer significant.

As in Section 1.6, we do not include TR_{jt} in the subsequent regressions due to the lack of data regarding this variable and thus, to the lower number of observations included in the model. We have, however, performed the following regressions adding TR_{jt} in the model. All results hold in both the unilateral power-based model and in the bilateral power-based model, except $LEGAL_{it}$ and $POLITY_{jt}$, which are no longer significant in the unilateral power-based model, as in other robustness checks, and $RETAL_{ijt}$ which is no longer significant in the bilateral power-based model. This latter result suggests that the retaliatory capacity of the complainant may not affect the number of disputes initiated by WTO members before the DSS, when accounting for trade remedies.

Specification (1) of Table 1.7.2 reports the results from the baseline estimation of the unilateral power-based, while specifications (2) to (5) present the results of the sensitivity analysis of the unilateral power-based model, both using the ZIP method.

Results associated with all four variables representing the structure of trade between i and j (n_{ijt} , v_{ijt} , $AGRI_{ijt}$, FTA_{ijt}) are confirmed in all specifications of this model. Consequently, the structure of trade affects the likelihood of dispute initiation as well as the number of disputes initiated.

In specification (1) of Table 1.7.2, the coefficient associated with the variable measuring the complainant's legal capacity remains statistically significant and positive. This result is confirmed in specification (2). Again, the $POLITY$ variables for both complainant and respondent are positive and significantly different from 0, indicating that country i is more likely to initiate disputes against country j if i and j are both democratic. However, this is not confirmed in specifications (3) and (4). Finally, past experience in adjudication appears as not significant in specification (1), but significant and positive, as expected in specification (5). It is also difficult to conclude on this variable.

Table 1.7.3 presents the results from the estimation of the bilateral power-based model with the ZIP method. This model identifies the same determinants of the number of

Table 1.7.1: Average marginal effects: Rules-based model (zero-inflated Poisson method)

Ind. var.	Baseline model (1)	Excluding 1995–1999 (2)	Excluding raw minerals and energy products (3)	Including trade remedy measures (4)
n_{ijt}	1.27e-06*** (3.22e-07)	8.07e-07*** (2.90e-07)	1.31e-06*** (3.31e-07)	7.89e-06*** (1.62e-06)
v_{ijt}	0.002*** (0.0002)	0.001*** (0.0002)	0.002*** (0.0002)	0.005*** (0.001)
$AGRI_{ijt}$	0.00005*** (0.00001)	0.00004*** (0.00001)	0.00005*** (0.00001)	0.0004*** (0.00001)
FTA_{ijt}	-0.002*** (0.0009)	-0.001 (0.0008)	-0.002*** (0.0009)	-0.006 (0.004)
TR_{jt}				0.0006** (0.0002)
Obs.	67,161	54,304	67,161	13,405
AIC	2,013.369	1,347.221	2,013.373	1,341.426

Source: Authors' calculation.

Note: In parentheses are robust standard errors adjusted for clusters in $Dyads_{ij}$. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% threshold levels, respectively. We use the value of exports from i to j as the explanatory variable of the logit model. Countries with a low value of exports should not face many disputable trade measures. AIC = Akaike information criterion.

complaints filed as of the probability of filing a dispute: retaliatory capacities of both the complainant and the respondent, through either trade, preferences or financial aid (again using the same methodology as in the previous section).

The coefficient associated with the complainant's trade retaliatory capacity is significant and positive in all specifications. The respondent's financial retaliatory capacity does not have a significant influence on the number of disputes. This latter results is, however, not confirmed when using the variable ODA_{jit} as a binary variable (specification (2) of Table 1.7.3). Concerning the respondent's capacity to retaliate through the suspension of non-reciprocal preferences, the marginal effect is significantly different from 0 but positive, when taking data from the WTO, and not significant when considering data from CEPII. The variable respondent's trade retaliatory capacity is significant in only 2 specifications. Again, it is difficult to conclude.

Table 1.7.2: Average marginal effects: Unilateral power-based model (zero-inflated Poisson method)

Ind. Var.	Baseline Model (1)	Legal capacity using % grad. (2)	DEMOC Freedom House sum (3)	DEMOC Freedom House (CL) (4)	EXPi (5)
n_{ijt}	1.27e-06*** (3.70e-07)	2.27e-06*** (7.23e-07)	1.28e-06*** (3.19e-07)	1.36e-06*** (3.26e-07)	1.28e-06*** (3.73e-07)
v_{ijt}	0.002*** (0.0003)	0.002*** (0.0006)	0.002*** (0.0003)	0.002*** (0.0003)	0.002*** (0.0003)
$AGRI_{ijt}$	0.00005*** (0.00002)	0.00007*** (0.00003)	0.00005*** (0.00001)	0.00005*** (0.00001)	0.00005*** (0.00002)
FTA_{ijt}	-0.004*** (0.0012)	-0.005*** (0.0017)	-0.003*** (0.001)	-0.003*** (0.0010)	-0.004*** (0.0011)
$LEGAL_{it}$	0.002* (0.0009)	0.0001** (0.00005)	0.002** (0.0007)	0.002 (0.0008)	0.001 (0.0009)
$POLITY_{it}$	0.0003*** (0.00007)	0.00002 (0.00002)	-0.0003** (0.0001)	-0.002 (0.002)	0.0003*** (0.00007)
$POLITY_{jt}$	0.0002*** (0.00008)	0.0003*** (0.0001)	-0.0003** (0.0002)	-0.0003 (0.0002)	0.0002** (0.00008)
EXP_{it}	0.0007 (0.0007)	0.002** (0.0011)	0.0006 (0.0006)	0.0005 (0.0006)	0.001*** (0.0007)
Obs.	55,571	30,590	65,192	65,192	55,571
AIC	1,946.694	1,298.897	1,977.051	1,981.626	1,944.379

Source: Authors' calculation.

In parentheses are robust standard errors adjusted for clusters in $Dyads_{ij}$. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% threshold levels, respectively. We use the value of exports from i to j as the explanatory variable of the logit model. Countries with low value of exports should not face many disputable trade measures. AIC = Akaike information criterion.

Table 1.7.3: Average marginal effects: Bilateral power-based model (zero-inflated Poisson method)

Ind. Var.	Baseline Model (1)	ODA Binary (2)	PTA CEPII (3)
n_{ijt}	1.92e-06*** (5.99e-07)	1.60e-06*** (3.43e-07)	1.91e-06*** (4.87e-07)
v_{ijt}	0.001*** (0.0004)	0.001*** (0.0002)	0.0009*** (0.0002)
$AGRI_{ijt}$	0.00005*** (0.00002)	0.00005*** (0.00001)	0.00004*** (0.00002)
FTA_{ijt}	-0.004** (0.0017)	-0.004*** (0.0011)	-0.004*** (0.0013)
$RETAL_{ijt}$	4.60e-06** (2.27e-06)	3.69e-06** (1.88e-06)	6.24e-06*** (2.27e-06)
ODA_{jit}	-0.00002 (0.00001)	-0.001** (0.0006)	-6.43e-06 (8.19e-06)
PTA_{jit}	0.004*** (0.0014)	0.004*** (0.0009)	-0.0005 (0.0009)
$RETAL_{jit}$	9.95e-06*** (3.43e-06)	8.64e-06*** (1.87e-06)	1.48e-06 (9.62e-06)
Obs.	67,161	67,161	23,916
AIC	1,968.086	1,969.621	716.9811

Source: Authors' calculation.

In parentheses are robust standard errors adjusted for clusters in $Dyads_{ij}$. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% threshold levels, respectively. The variable ODA_{jit} is scaled down by 1,000. We use the value of exports from i to j as the explanatory variable of the logit model. Countries with low value of exports should not face many disputable measures. AIC = Akaike information criterion.

1.8 Conclusion

In this article we construct a database of trade disputes litigated at the WTO from 1995 to 2014. We provide a few descriptive statistics about these disputes: low-income countries are never involved in these disputes, either as complainant or as respondent. Between 80 and 90 percent of all disputes involve either at least one high-income country or at least one upper-middle-income country. More than 60 percent of all disputes concern three sectors: animals and animal products, vegetable products, and foodstuffs. A dispute lasts on average three and a half years, longer when the respondent is a high-income country.

We also test the determinants of both the probability that country i files a complaint against country j and of the number of disputes between the two countries. These two series of tests give partially convergent results. The structure of trade between country i and j is an important determinant: the number of products exported by i to j , the value of exports from i to j , the share of agricultural commodities in i 's total exports to j , the existence of a reciprocal trade agreement between i and j and the share of j ' imports subject to trade remedies are significant determinants of the probability of i complaining about j 's trade policy and of the number of complaints filed. These results are confirmed in almost all specifications and estimated odds ratios/marginal effects of these five variables are remarkably stable.

Concerning the existence of a potential bias in the DSS, we obtain two important conclusions: first, legal capacity is an important determinant of the probability of initiating disputes, and it is likely that the ACWL plays an important role in this matter. Second, the trade retaliatory capacity of the complainant also matters. This result is verified in all specifications, except when considering the number of disputes filed and integrating trade remedies in the equation. This conclusion confirms earlier studies like Bown (2004b), Bown (2004a), Bown (2005), and Bown and Reynolds (2017).

Consequently, the DSS appears first as a rules-based dispute settlement system where the small share of lower-middle-income and low-income countries participating in the DSS is explained by their low participation in international trade. This result confirms findings from the statistical analysis of Section 1.4: in almost 85 percent of all cases, the complainant is either a high-income or an upper-middle-income country, but these two groups realised 95 percent of WTO members' trade. On the contrary, we had found that lower-middle-income and low-income countries participated in 15.7 percent of all disputes whereas they represented only 4.8 percent of total WTO trade. This result also confirms conclusions by Horn et al. (1999). A country is, however, more likely to complain against

the trade policy of a partner, if it has its own legal resources or if it is member of the ACWL, and if it has sufficient trade retaliatory capacity.

The WTO may face a new challenge: providing a DSS accessible to all countries under the constraint of a growing number of initiated cases. As stated by current director general Roberto Azevêdo, “the system is in very high demand”, with both the number of disputes and the complexity of each dispute rising (Azevêdo, 2014). At a time when more and more policy makers are tempted to support protectionist measures or even willing to contest WTO decisions,³⁵ a strong WTO that can guarantee the fairness of trade litigation could represent a key element of the world trading system.

³⁵According to the 2017 US president’s trade policy agenda report, “it is important to recall also that Congress had made clear that Americans are not directly subject to WTO decisions” (Office of the United States Trade Representative, 2017).

1.9 Appendix

Appendix A. World Bank categories of revenue

High-income	Upper-middle-income	Lower-middle-income	Low-income
Antigua and Barbuda	Albania	Armenia	Benin
Argentina	Angola	Bangladesh	Burkina Faso
Australia	Belize	Bolivia	Burundi
Austria	Bostwana	Cabo Verde	Cambodia
Bahrain	Brazil	Cameroon	Central African Republic
Barbados	Bulgaria	Congo, Rep.	Chad
Belgium	China	Côte d'Ivoire	Congo, Dem. Rep
Brunei Darussalam	Colombia	Djibouti	The Gambia
Canada	Costa Rica	Egypt, Arab Rep.	Guinea
Chile	Cuba	El Salvador	Guinea-Bissau
Croatia	Dominica	Georgia	Haiti
Cyprus	Dominican Rep.	Ghana	Madagascar
Czech Republic	Ecuador	Guatemala	Malawi
Denmark	Fiji	Guyana	Mali
Estonia	Gabon	Honduras	Mozambique
Finland	Grenada	India	Nepal
France	Jamaica	Indonesia	Niger
Germany	Jordan	Kenya	Rwanda
Greece	Kazakhstan	Kyrgyz Rep.	Sierra Leone
Hong Kong, China	Macedonia, FYR	Lao PDR	Tanzania
Hungary	Malaysia	Lesotho	Togo
Iceland	Maldives	Mauritania	Uganda
Ireland	Mauritius	Moldova	Zimbabwe
Israel	Mexico	Morocco	
Italy	Mongolia	Myanmar	
Japan	Montenegro	Nicaragua	
Korea, Rep.	Namibia	Nigeria	
Kuwait	Panama	Pakistan	
Latvia	Paraguay	Papua New Guinea	
Liechtenstein	Peru	Philippines	
Lithuania	Romania	Samoa	
Luxembourg	South Africa	Senegal	
Macao, China	St. Lucia	Solomon Islands	
Malta	St. Vincent and the Grenadines	Sri Lanka	
Netherlands	Suriname	Swaziland	
New Zealand	Thailand	Tajikistan	
Norway	Tonga	Ukraine	
Oman	Tunisia	Vanuatu	
Poland	Turkey	Vietnam	
Portugal		Yemen, Rep.	
Qatar		Zambia	
Russian Federation			
Saudia Arabia			
Singapore			
Slovak Rep.			
Slovenia			
Spain			
St. Kitts and Nevis			
Sweden			
Switzerland			
Taiwan, China			
Trinidad and Tobago			
United Arab Emirates			
United Kingdom			
United States of America			
Uruguay			
Venezuela			

Chapter 2

Is Smuggling Welfare–Improving? Evidence from Avocados in Costa Rica.¹

2.1 Introduction

In May 2016, Costa Rican customs authorities seized 4,100 kilograms of Mexican avocados that had been smuggled through Panama. One year earlier, the Ministry of Agriculture and Livestock of Costa Rica had suspended the issuing of phytosanitary import certificates for avocados from several of its trading partners, including Mexico. Within a few months of the ban, the local price of avocados in Costa Rica doubled. Thus, the restrictive trade measure imposed by the Costa Rican government created an opportunity for smugglers (The Economist, 2016).

Smuggling is defined as international trade by firms or individuals that either partially or fully evades trade regulations and border duties, either by avoiding official border crossing posts (full evasion) or by resorting to illegal means like under-invoicing, misclassification, underpricing, etc. (partial evasion). In this paper, we focus on the full-evasion type of smuggling, also called the Bhagwati–Hansen type of smuggling (Martin and Panagariya, 1984). Throughout the paper, we use the terms “smuggling” and “illegal trade” to refer to trade in products between two countries that forbid such trade. We do not use these terms to refer to illicit trade (trading of illicit products, such as drugs or counterfeits) or to informal trade (unorganised, small-scale trade generally conducted by self-employed traders to avoid import duties, bribes, administrative

¹This chapter is an extended version of the paper written with Antoine Bouët (GREThA, University of Bordeaux and IFPRI), which has been submitted to Open Economies Reviews.

paperwork, etc. (Bouët et al., 2018)).

Smuggling occurs when a price disparity that is not caused by natural trading costs exists for the same good sold at two different locations. When governments implement a trade prohibition, smuggling may arise due to the difference between the price at which smugglers can buy a good and the price at which consumers are willing to buy that good, the latter not being an official market price. As a consequence, policies hampering trade, such as tariffs, quantitative restrictions, administrative regulations, and sanitary and phytosanitary rules, are key determinants of the emergence of smuggling. Therefore, smuggling activities prevail in many countries worldwide and throughout economic history.

In this paper, we build a simple method for evaluating the trade and welfare consequences of smuggling. Such an evaluation may be difficult due to a lack of data. Furthermore, we propose a direct application of our model to the smuggling of avocados occurring in Costa Rica. We contribute to both the theoretical and empirical literature on illegal trade in several ways. First, while previous researchers have mostly considered the welfare effects of smuggling on economies in which a tariff has been imposed, either on exports or on imports,² we focus on the welfare consequences of smuggling arising after the implementation of a ban on imports. To the best of our knowledge, this perspective has never been analysed.

Second, all theoretical analyses of illegal trade so far conducted apply general equilibrium models.³ We build a partial equilibrium model to study the welfare effects of smuggling. A partial equilibrium model appears to be the most appropriate tool with which to conduct our analysis for several reasons. First, it allows us to focus on a specific market by assuming that other markets are in equilibrium throughout the analysis. We are therefore able to isolate the impact of smuggling of a specific commodity on domestic welfare. Second, thanks to its theoretical simplicity, a partial equilibrium model offers greater tractability and transparency than a general equilibrium model. Finally, our model permits a more detailed analysis of complex policy instruments, such as a prohibition on imports or sanitary and phytosanitary norms (Bouët, 2008).

Third, results from previous models are all based on certain restrictive assumptions. Among others, Bhagwati and Hansen (1973), Sheikh (1977), Pitt (1981), and Martin and

²With the exception of Falvey (1978), who assumes that a home country implements a quantitative restriction on imports from all sources. Falvey (1978), however, adopts a model similar to that presented by Bhagwati and Hansen (1973).

³Except Sheikh (1977), who adopts a partial equilibrium model; however, the author uses restrictive assumptions that we relax in this investigation.

Panagariya (1984) assume that the country under study is small and that legally and illegally traded goods are homogeneous. In this paper, we relax both assumptions to provide a more generalisable model.

Finally, this paper contributes to the theoretical literature on smuggling, as well as to the empirical literature on illegal trade (see Section 2.2), by providing an empirical estimation of the quantity of avocados smuggled in Costa Rica (see Section 2.6). Furthermore, it also contributes to the literature on agricultural economics by specifying an empirical estimation of price elasticities of demand and supply of avocados produced in, and imported to, Costa Rica (see Section 2.5). Avocado presents an interesting commodity, as its trade is becoming very lucrative in some countries, especially in Latin America. The data collected in this paper may thus prove useful for future research on this good.

The rest of this paper develops as follows. Section 2.2 proceeds to the review of the literature. Section 2.3 explains the context in which smuggling occurs in Costa Rica. Section 2.4 thoroughly describes the theoretical model used in this analysis. Section 2.5 presents the estimation of the parameters used in the model. Section 2.6 reports the results obtained from the empirical application of our model. Section 2.7 considers two additional aspects of the analysis: potential substitution effects and the inelasticity of local supply in the short-term. Section 2.8 concludes.

2.2 Review of Literature

Through empirical analyses of illegal trade, researchers have revealed the presence of this phenomenon in many economies worldwide. Although these studies may suffer from a lack of accurate data on smuggling, they provide rough estimates of its magnitude.

Bhagwati (1974) carries out one of the first empirical studies on smuggling and under-invoicing of imports. He compares the f.o.b. values of exports recorded by Turkey's main trading partners to the c.i.f. values of imports recorded by Turkey in 1960 and 1961. The author finds strong evidence supporting under-invoicing of imports in manufactures. Although these results are limited in scope, Bhagwati (1974) provides a methodology to estimate illegal trade, called the "reconciliation" approach.

Using this methodology, many researchers have assessed the magnitude of illegal trade in various countries (Smith (1969); Simkin (1970); Sheikh (1974b); Connolly et al. (1995); Van Dunem and Arndt (2009); Jean and Mitaritonna (2010); Bouët and Roy (2012); Levin

and Widell (2014), among others). These studies, however, estimate the partial–evasion type of smuggling (e.g. under–invoicing, misclassification, under–pricing, etc.).

Few recent empirical studies evaluate the full–evasion type of smuggling (i.e. avoidance of official border crossing posts). These include statistical investigations and surveys (Golub and Mbaye, 2009; INSAE, 2012).

Finally, one study econometrically explores the determinants of illegal trade. Bensassi et al. (2016a) find that agricultural products, goods facing higher tariffs or an import ban, and time–sensitive products are mainly smuggled, while other goods are legally traded. Bensassi et al. (2016b) confirm these results in the case of Benin, Togo and Nigeria.

Empirical studies can be useful in showing that illegal trade forms a major component of the economy in many parts of the world. However, due to difficulties in compiling data on contraband products, researchers have produced a wide range of estimates of the quantities and values smuggled. In addition, compared to theoretical studies, these investigations do not analyse the welfare effects of smuggling activities.

Early theoretical studies highlight the willingness of trade theorists to integrate smuggling activities within the traditional framework of international trade theory. Bhagwati and Hansen (1973) propose a general equilibrium model based on the Hicks–Samuelson value framework to evaluate the welfare effects of smuggling. Bhagwati and Hansen (1973)’s model (BH model) assumes that smuggling imposes a terms of trade loss due to the real cost involved with smuggling. Bhagwati and Hansen (1973) conclude that when legal and illegal trade coexist, smuggling results in a decrease in welfare (due to the loss in the terms of trade).⁴ However, this result depends largely on the strong assumption previously stated.⁵ Modifying some assumptions of the BH model, Kemp (1976), Sheikh (1974a) and Deardorff and Stolper (1990) obtain results that oppose those found in Bhagwati and Hansen (1973).

Despite suffering from other imperfections,⁶ the BH model has provided the basis for many other investigations into the theory of smuggling. For example, Bhagwati and Srinivasan (1973) and Ray (1978) exploit the BH model to explore diverse questions related to illegal trade from a policy–oriented perspective, while Falvey (1978)

⁴This proposition holds true regardless of the market structure of smuggling activities (monopolistic or perfect competition).

⁵Cooper (1974), among others, questions the assumption that illegal trade is socially more costly than legal trade, even when smuggling occurs at illegal entry points.

⁶The BH model does not assume risk premium compensations from smuggling activities, does not consider welfare implications of induced shifts in income distribution, and relies only on two goods (Gray and Walter, 1975).

investigates the welfare effects of smuggling resulting from quantitative restrictions. We also analyse the welfare impact of smuggling in the context of more modern forms of protectionism, such as a prohibition on imports for sanitary and phytosanitary (SPS) reasons, but build our own model of illegal trade.

Another important contribution to the theoretical literature on smuggling is that of Pitt (1981). According to this author, legal trade may be conducted at a loss if it serves as a camouflage activity for smuggling. In this sense, Pitt (1981) provides an explanation for the coexistence of both legal and illegal trade and of price disparity, which was not explained by the BH model.⁷ Pitt (1981) concludes that smuggling may be welfare improving and that smuggling is “unambiguously welfare increasing” if the cost of smuggling corresponds to fines and confiscations.

Finally, reconciling previous results, Bhagwati (1981) models different configurations of smuggling in order to account for the fact that illegal trade may take place at both legal and illegal entry points. The models used are based on the BH model but reach diverse outcomes regarding the welfare effects of smuggling.

As emphasised by the above-mentioned studies and by the work of Bhagwati (1981), smuggling represents a complex phenomenon that can take various forms. Theoretical analyses of smuggling within the traditional international trade theory do not lead to clear and systematic conclusions regarding the welfare consequences of illegal trade. As a result, economists have developed new approaches through which to investigate the theory of smuggling.

Martin and Panagariya (1984) model the uncertainty associated with smuggling by introducing a probability of detection. The authors confirm Pitt (1981)’s results in regard to price disparity, however, their results in terms of welfare are ambiguous. We build on Martin and Panagariya (1984), as we also introduce a probability of detection in our model. However, since we do not permit legal trade in our model, this rate of detection is exogenous.

Lovely and Nelson (1995) model smuggling as a directly unproductive, profit-seeking activity (DUP) since it produces pecuniary returns but does not produce goods or services that enter a conventional utility function directly. Contrary to Bhagwati and Hansen (1973), Lovely and Nelson (1995) demonstrate that smuggling does not necessarily decrease welfare, even when smuggling is considered a resource-using activity.

Following Martin and Panagariya (1984), Norton (1988) integrates risk in the analysis

⁷Price disparity is defined by Pitt (1981) as the difference between domestic market price and the tax-inclusive world price of an exported commodity.

of smuggling and introduces transport costs, which were assumed to equal zero in the BH model and in Pitt (1981)'s model. Norton (1988) validates Pitt (1981)'s conclusion that smugglers located within a certain distance from the frontier use legal trade as a cloaking activity for illegal trade.⁸

Sheikh (1989) provides a more realistic application of risk in the analysis of smuggling. Understanding that smugglers are not risk-neutral, as assumed in all previous studies, Sheikh (1989) models risk-averse smugglers by applying Tobin (1958)'s analysis of risk. Sheikh (1989) confirms the results of Martin and Panagariya (1984), stating that the presence of smuggling may increase or reduce welfare if there are real resource costs associated with smuggling. Smuggling is welfare-increasing only if custom officials are bribed or if the government ignores the illegal activity. Finally, Sheikh (1989) shows that smuggling through legal entry points (e.g. under-invoicing of imports) may lead to smaller welfare losses than smuggling through illegal entry points.

Our analysis brings together previous research and offers an original perspective on the impact of illegal trade on welfare. We provide both a theoretical analysis of illegal trade emerging from a prohibition on imports (rather than tariffs) and an empirical application of this theory to an existing case. In the theoretical analysis, we present a simple and transparent model of illegal trade, rather than a more complex general equilibrium model, as those developed in previous literature.

Our model is based on the study by Sheikh (1977), who presents the first and, to our knowledge, only partial equilibrium model of smuggling.⁹ In his model, he assumes that consumers of illegally traded goods face a risk. We relax this assumption in our model, as it was unrealistic in the case examined.¹⁰

Furthermore, producers of smuggled goods face a real resource cost and a risk cost. Sheikh (1977) finds that smuggling results in a "two tier price system", as the price of the smuggled good in the domestic market is inferior to the legal price (tariff-inclusive price). His results in terms of welfare are ambiguous. Although Sheikh (1977) provides a simple model of smuggling, he assumes that the smuggled and legally imported products are homogeneous and that the country in which illegal trade occurs is small. In our analysis,

⁸Norton (1988) also provides an empirical test of his model, using data on illegal trade of cattle and pigs from 1974 to 1982 and of barley from 1978 to 1982 between the Republic of Ireland and Northern Ireland. The author provides evidence that legal trade has been used as a camouflage activity for illegal trade.

⁹All previous models on the theory of smuggling consist of general equilibrium models.

¹⁰Discussions with customs authorities from Costa Rica confirmed that consumers of smuggled avocados are not punished by law.

we relax both assumptions.

2.3 Background

On May 5, 2015, the State Phytosanitary Service of the Ministry of Agriculture and Livestock of Costa Rica submitted a notification of emergency measures to the Committee of Sanitary and Phytosanitary Measures (SPS Committee) of the WTO. The notified document temporarily suspended the issuing of phytosanitary import certificates of avocados from the following eight countries: Australia, Spain, Ghana, Guatemala, Israel, Mexico, South Africa and Venezuela.¹¹ On May 12, 2015, Costa Rica submitted an addendum to the SPS Committee that added the U.S. State of Florida to the list of countries affected by the measure (World Trade Organisation, 2015c).

With this precautionary measure, Costa Rica officially aims to prevent the spread of plant pests and disease to protect human, animal, and plant health and food safety. Costa Rican authorities seem particularly worried about the presence of *avocados Sunblotch Viroid* in various avocados-producing countries (World Trade Organisation, 2015b). Costa Rica is, however, the only country that has implemented a sanitary and phytosanitary measure prohibiting the importation of avocados from the above-mentioned countries.¹² Moreover, Costa Rica does not have convincing scientific evidence that justifies the imposition of a temporary import ban.¹³ Thus, it appears that the Costa Rican government implemented this prohibition for protectionist rather than pest-risk avoidance motives.

Costa Rica's local production of avocados is not sufficient to satisfy local demand. Prior to the implementation of the import ban, Costa Rica imported more than 90 percent of its avocados from Mexico (United Nations comtrade, 2017).¹⁴ After the implementation of the ban, the price of avocados grown in Costa Rica went up.¹⁵ The price per kilogram of Hass

¹¹Resolution DSFE 03-2015 on phytosanitary measures applicable to imports of *Persea americana* Mill.

¹²Disdier et al. (2008) suppose that the number of countries that implement sanitary and phytosanitary (SPS) or technical barriers to trade (TBT) measures reveals the magnitude of risks for health or safety. Such criterion may thus be used to distinguish between SPS and TBT measures that are implemented for protection of health from those implemented for trade protection.

¹³In November 2015, Costa Rica has circulated a revised pest risk analysis (PRA) to the WTO. Since Mexico disagreed with the findings and measures established by the revised PRA, Costa Rica decided to include extensive work at the laboratory level in the PRA (World Trade Organisation, 2015d). This work has yet to be concluded.

¹⁴Other suppliers include Guatemala, Peru and Chile, although to an almost negligible extent.

¹⁵It is difficult to estimate the increase in local production due to the ban. According to data from the Ministry of Agriculture and Livestock (Sistema de Información del Sector Agropecuario Costarricense

avocados grown in Costa Rica averaged 2.12 constant 2010 US\$ in July 2014, compared to 3.74 constant 2010 US\$ in July 2015.¹⁶ As a result of this rapid and large increase in the price of locally produced avocados, illegal trade of avocados emerged in Costa Rica. In May 2016, the State Phytosanitary Service of the Ministry of Agriculture and Livestock of Costa Rica reported that customs authorities had seized 4.1 metric tons of Hass avocados illegally imported through Panama (Cortes, 2017).¹⁷ As another solution to face the shortage of avocados, Costa Rica also started to legally import avocados from Peru and Chile. Costa Rican imports of avocado from Peru equaled US\$ 196,874 in 2014, US\$ 3.5 million in 2015 and US\$ 7.8 million in 2016, representing 0.96 percent, 19 percent and 42 percent of Costa Rican total imports of avocados in 2014, 2015 and 2016, respectively. Similarly, Costa Rican imports of avocados from Chile equaled US\$ 3.7 million in 2015 and US\$ 10 million in 2016, representing 20 percent and 55 percent of Costa Rican total imports of avocados in 2015 and 2016, respectively.¹⁸ Avocados originating from these countries are, however, of lower quality than Mexican avocados (The Economist, 2016).

In addition to these economic consequences, this precautionary measure had legal consequences. In July 2015, Mexico and Guatemala raised a specific trade concern (STC) about it, arguing that it halts trade and is not justified by scientific evidence (World Trade Organisation, 2015d). Ghana, Venezuela, South Africa and the United States of America (USA) supported Mexico and Guatemala. Costa Rica indicated that a risk assessment was under way and that it would remain open to dialogue with its trading partners. However, faced with inertia on the part of the Costa Rican government, the complaining countries reiterated their STC in October 2015, March 2016, June 2016, and October 2016 to ask for a withdrawal of the measure.

On March 8, 2017, Mexico requested consultations with Costa Rica regarding measures

from Direcciones Regionales del Ministerio de Agricultura y Ganadería), local production of avocados rose from 1 metric tons in 2014 to 12 metric tons in 2015 and to 12.042 metric tons in 2016. This swift increase does not only reflect an increase in local production of avocados but also reflects changes in data collection. Prior to 2015, data from the Ministry of Agriculture and Livestock only included the area of Los Santos, rather than all avocado-producing areas in Costa Rica. Moreover, estimation of average local yield was established at four tons per hectare, which is rather low compared to the world average of approximately 10 tons per hectare (Ministry of Agriculture and Livestock, 2017).

¹⁶We focus the price analysis on Hass avocados since this represents the most produced variety of avocados in Costa Rica. 75 percent of avocados grown in Costa Rica are of the Hass variety, while the remaining 25 percent includes several varieties such as Simmonds, Catalina, Booth, etc. (Secretaría Ejecutiva de Planificación Sectorial Agropecuaria, 2017).

¹⁷Interestingly, exports of Hass avocados from Mexico to Panama increased by 893 percent from 2013 to 2015, and by 231 percent from 2015 to 2016 (United Nations comtrade, 2017).

¹⁸Data is from UN COMTRADE. Data on imports of avocados from Chile into Costa Rica were not available for 2014.

it had implemented to restrict or prohibit the importation of avocados from Mexico (World Trade Organisation, 2017a). These policies appear to be inconsistent with several articles of the SPS Agreement and of the GATT 1994.¹⁹ As of June 2019, the dispute led by Mexico against Costa Rica remains unsolved.

2.4 Theoretical Model

In this paper, we aim to investigate the welfare effects of smuggling arising from the implementation of a restrictive trade measure, specifically a prohibition on imports. In this section, we develop a simple partial equilibrium model with one sector and two trading partners: Home (H) and the rest of the world (ROW) i.e. Mexico. The model includes only two trading partners since Costa Rica imported over 90 percent of its avocados from Mexico prior to the prohibition. Moreover, we cannot take into account any substitution effect between avocados legally imported from Mexico prior to the ban and avocados legally imported from Chile and Peru following the import ban since we lack data on prices and quantities of Chilean and Peruvian avocados sold in Costa Rica.²⁰ We thus cannot compute price and cross-price elasticities of demand and supply for avocados originating from Chile and Peru required to run a model that would include these two countries. We explain in Section 2.7.1 how including Chile and Peru in the analysis could affect our results.

We relax two assumptions from Sheikh (1977): (i) the home country is not a small country; and (ii) legally and illegally traded goods are not homogeneous, but are differentiated by their country of origin. Although our case study focuses on Costa Rica, which might be thought of as a small country in the market for avocados, we wish to develop a model that can be generalised and applied to other contexts. For this reason, we remove the small country assumption included in Sheikh (1977), which may not always be realistic. As a result, local demand and supply of avocados may thus affect the world price, and terms of trade effects may occur in our model. In the case of Costa Rica, these effects remain small. Second, we wish to develop a model in which goods are not

¹⁹Articles 2.1, 2.2, 2.3, 3.1, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 6.1, 6.2, 7, 8, and paragraphs 2, 5 and 6 of Annex B and paragraph 1 of Annex C to the SPS Agreement; and articles I:1, III:4, X and XI of the GATT 1994.

²⁰Although data on prices and quantities of Chilean and Peruvian avocados sold in Costa Rica is available through UNCOMTRADE, it cannot be exploited in an econometric analysis as the number of observations remains too low. Data is available on an annual basis starting in 1996 for Peru and in 1998 for Chile until 2017, providing only 22 and 20 observations for Peru and Chile, respectively. Data is also available on a monthly basis starting in 2010 for Peru and Chile but is not available for all months, providing only 35 and 31 observations for Peru and Chile, respectively.

homogeneous since this assumption may not always be verified. In the case of Costa Rica, legally and illegally traded goods differ by quality. While both Costa Rican and Mexican avocados under study are of the Hass variety, Mexican avocados are of higher quality than Costa Rican avocados.²¹

Throughout the paper, the first stage of the model represents a situation in which free trade exists between the home country and the rest of the world. In the second stage, the home country imposes a restriction on imports from the rest of the world in the sector under study. This simple step is necessary to identify the welfare effects of smuggling and to compare welfare gains and losses associated with a ban without smuggling, and a ban with smuggling. It is worth mentioning that when computing welfare effects throughout the different stages of the model, we do not account for the potential sanitary and phytosanitary effects of consuming avocados imported from Mexico.²² As previously mentioned, we assume that the Costa Rican government implemented this measure for protectionist reasons rather than to address market failures. Finally, the third stage of the model introduces illegal trade.

We successively present the full equations of the model for each stage. Throughout the description of the model, each variable is associated with a subscript, from 1 to 3, representing each stage of the model. For example, pl_t represents the local price computed at stage t of the model. Variables computed at stage t of the model serve as initial data for stage $t+1$. We adopt standard notations for elasticities, with η for demand elasticities, and ϵ for supply elasticities.

Stage 1: Situation of free trade

We start from a situation of free trade between the home country and the ROW (Equations (2.1) through (2.6)).

$$Apm_1^{-\eta_m} pl_1^{\eta_{ml}} = K_{md} + md_1 \quad (2.1)$$

$$Bpl_1^{-\eta_l} pm_1^{\eta_{lm}} = K_{ld} + ld_1 \quad (2.2)$$

$$K_{ms} + ms_1 = Cpm_1^{\epsilon_m} \quad (2.3)$$

²¹This difference is further documented in stage 1 of the model.

²²First, the presence of *avocados Sunblotch Viroid* in Mexico has not been scientifically proven and thus remains highly contested. Second, we lack knowledge regarding the potential health effects of Costa Ricans consuming avocados imported from Mexico.

$$ls_1 = Dpl_1^{\epsilon_l} \quad (2.4)$$

$$md_1 = ms_1 \quad (2.5)$$

$$ld_1 = ls_1 \quad (2.6)$$

Equations (2.1) and (2.2) determine the quantity of the imported good demanded in stage 1 (md_1) and the quantity of the locally produced good demanded in stage 1 (ld_1), respectively. A constitutes the scale parameter of the demand function for the legally imported good, pm_1 is the world price, η_m is the constant price elasticity of demand of the imported good, pl_1 is the price of the locally produced good, η_{ml} is the constant cross-price elasticity of demand of the imported good, K_{md} is a constant associated with the demand of the legally imported good, and md_1 is the quantity of the legally imported good demanded in the home country in stage 1.

Similarly, in Equation (2.2), B is the scale parameter of the demand function for the locally produced good, η_l is the constant price elasticity of demand of the locally produced good, η_{lm} is the constant cross-price elasticity of demand of the locally produced good, K_{ld} is a constant associated with the demand of the locally produced good, and ld_1 is the quantity of the locally produced good demanded in stage 1.

In Equations (2.1) and (2.2) we add a constant associated with the demand for the imported good (K_{md}) and a constant associated with the demand for the locally produced good (K_{ld}) in order to allow for positive prices of locally produced and imported goods when the quantity of the imported good demanded and the quantity of the locally produced good demanded, respectively, equal zero.

To estimate K_{md} and K_{ld} , we make the following assumptions:

- If the price of the imported good is tripled, then imports equal zero. This is equivalent of a prohibitive tariff of 200 percent. We conduct a sensitivity analysis on this assumption.
- If the price of the imported good equals the price of the locally produced good, then domestic demand for the locally produced good equals zero. We suppose a vertical differentiation, with the imported avocados having higher quality. This assumption is actually reflected in the price of Mexican Hass avocados, which is higher than the

price of Costa Rican Hass avocados.²³ Vertical differentiation can be explained by the fact that when two vertically differentiated goods are presented at the same price, sales of the lower quality good are zero.

Using these two assumptions in combination with the initial data, we are able to estimate K_{md} and K_{ld} . By including these parameters, we can maintain the same specification across all stages of the model.

Next, Equation (2.3) defines the quantity of the imported good supplied by the ROW to the home country in stage 1, ms_1 . K_{ms} is a constant associated with the supply of the imported good, C is the supply function parameter of the imported good, and ϵ_m is the constant price elasticity of supply of the imported good. Moreover, we add a constant, K_{ms} , to the equation so that when imports equal zero due to the prohibition on imports implemented by the home country, the price of imports remains positive. To estimate K_{ms} , we assume that when imports become zero, the world price decreases from 2.04 to 2.0 constant 2010 US\$. We also conduct a sensitivity analysis on this assumption.

Equation (2.4) defines the quantity of the locally produced good supplied domestically in stage 1, ls_1 , in which D is the scale parameter of the supply function of the locally produced good and ϵ_l is the constant price elasticity of supply of the locally produced good.

Finally, Equations (2.5) and (2.6) represent price equations and define the price of the imported good (pm_1) and the price of the locally produced good (pl_1), respectively obtained in stage 1.

In this first stage, we can compute all variables of interest, such as quantities of locally produced and imported goods demanded and local and world prices, under a situation of free trade. This first stage establishes a background situation from which we will be able to compare the results obtained in stages 2 and 3 of the model.

Stage 2: Situation of prohibition on imports prior to any smuggling

In stage 2, we model a situation in which the home country implements a ban on imports coming from the ROW in the sector under study. In this stage, the ban does not yet lead to any smuggling activity. As a result, the home country becomes an autarky in this sector since legal imports equal zero and illegal trade does not yet occur.

$$Bpl_2^{-\eta} pm_f^{\eta m} = K_{ld} + ld_2 \quad (2.7)$$

²³Discussions with Costa Ricans also confirmed that Mexican Hass avocados are of higher quality than Costa Rican Hass avocados.

$$pm_2 = \left(\frac{K_{ms}}{C}\right)^{\frac{1}{\epsilon_m}} \quad (2.8)$$

$$ls_2 = Dpl_2^{el} \quad (2.9)$$

$$ld_2 = ls_2 \quad (2.10)$$

Equation (2.7) defines the quantity of the locally produced good demanded in stage 2, ld_2 , in which pl_2 is the price of the locally produced good in stage 2 and pm_f is a parameter derived from Equation (2.1) with $md_1 = 0$. We want to estimate the impact of the prohibition on imports and on domestic demand using the same specifications across all stages of the model. Therefore, we adapt the model in stage 2 so that the quantity of the locally produced good demanded depends on the parameter pm_f rather than on the world price, since imports equal zero in stage 2. We estimate parameter pm_f so that with a fixed price of the locally produced good, imports become zero.

Since imports equal zero, the world price in stage 2, pm_2 , is defined by Equation (2.8), which represents the ROW's supply function.

The local producers' supply function is defined in Equation (2.9), in which ls_2 is the quantity of the locally produced good supplied in stage 2.

Finally, the price equation is defined by setting the quantity of the locally produced good demanded (ld_2) equal to the quantity of the locally produced good supplied (ls_2).

After the implementation of the ban, imports equal zero. We thus expect the demand for the locally produced good to increase. Production of the locally produced good should also increase, as should its own-price. On the other hand, the prohibition implemented by the home country on goods imported from the ROW should decrease the world price. These effects on quantities and prices of the locally produced good should lead to a decrease in consumer surplus and to an increase in producer surplus.

Stage 3: Situation of prohibition on imports from which illegal trade emerges

In stage 3, smuggling activities emerge due to the prohibition on imports from the ROW implemented by the home country in stage 2.

$$Aps_3^{-\eta_m} pl_3^{\eta_{ml}} = K_{md} + sdt_3 \quad (2.11)$$

$$Bpl_3^{-\eta_l} ps_3^{\eta_{lm}} = K_{ld} + ld_3 \quad (2.12)$$

$$ls_3 = Dpl_3^{\epsilon_l} \quad (2.13)$$

$$\pi = (1 - \alpha)[(ps_3 - pm_3)ss_3 - K\frac{ss_3^2}{2}] - \alpha(pm_3ss_3 + K\frac{ss_3^2}{2}) \quad (2.14)$$

$$Kss_3 - (1 - \alpha)ps_3 + pm_3 = 0 \quad (2.15)$$

$$sst_3 = ss_3I \quad (2.16)$$

$$sst_3 = (1 - \alpha)md_3 \quad (2.17)$$

$$ms_3 + K_{ms} = Cpm_3^{\epsilon_m} \quad (2.18)$$

$$(1 - \alpha)ps_3ss_3 = pm_3ss_3 + K\frac{ss_3^2}{2} \quad (2.19)$$

$$sdt_3 = sst_3 \quad (2.20)$$

$$ld_3 = ls_3 \quad (2.21)$$

$$ms_3 = md_3 \quad (2.22)$$

We define the total quantity demanded of the smuggled good in Equation (2.11) in a similar manner as we define the quantity demanded of the legally imported good in Equation (2.1). In particular, ps_3 is the local price of the smuggled good in stage 3 and sdt_3 is the total quantity demanded of the smuggled good in stage 3.

Equations (2.12) and (2.13) respectively determine the quantity demanded and supplied of the locally produced good in stage 3, ld_3 and ls_3 . Here, we use the same approach as in stage 1.

When introducing smuggling in the model, we assume that:

- Smugglers, rather than consumers, face a cost.²⁴ This cost represents the real

²⁴Sheikh (1977) assumes that consumers of smuggled goods also face a cost because of the existence of

resource cost of smuggling discussed in Section 2.2 and the risk cost associated with smuggling.²⁵ The real resource cost of smuggling is introduced in the profit function of smugglers and in Equation (2.15) by the parameter K , while the risk cost of smuggling is represented in these equations by the parameter α . In particular, α is the probability that smugglers are caught by public authorities.

- There are I smugglers who are risk-neutral.
- Marginal cost of smuggling increases because of the rising real resource cost.

Note that the risk attached to smuggling is supported only by smugglers and not by consumers. If legal and illegal trade coexisted, the local price of smuggled avocados should be equal to the price of legally imported avocados. However, in this study, legal trade is prohibited and we do not know the local price of smuggled avocados.

The profit function of an individual smuggler is given by Equation (2.14), in which π is the profit of an individual smuggler, ps_3 is the local price of the smuggled good in stage 3, pm_3 is the world price in stage 3, and ss_3 is the quantity of the smuggled good supplied by an individual smuggler in stage 3. For the sake of simplicity, we assume that public authorities only penalise smugglers by confiscating the smuggled goods.

The first term of Equation (2.14) computes the profit of an individual smuggler, assuming that she or he is not caught by public authorities. In this case, total revenue equals the price differential between the price at which the smuggler sells the smuggled good in the local market and the price at which she or he buys the good (i.e. the world price) times the quantity of smuggled goods sold ($ss_3(ps_3 - pm_3)$). The total cost equals the total real resource cost of smuggling ($K\frac{ss_3^2}{2}$) and implies an increasing marginal cost of smuggling.²⁶

The second term of Equation (2.14) computes the profit of an individual smuggler, assuming that she or he is caught by public authorities. In this latter case, the individual smuggler's total revenue equals zero since she or he is not able to sell any smuggled good, and her or his total cost includes the cost of buying the goods (pm_3ss_3) plus the total real resource cost of smuggling ($K\frac{ss_3^2}{2}$). As in Martin and Panagariya (1984), we suppose that when smugglers are caught, all smuggled goods are confiscated.

law enforcement or because of the moral standards of society. This cost, however, appears to be negligible; law enforcement at the consumer level is generally weak or nonexistent. Moreover, moral standards of society may not play a role when it comes to agricultural, and thus necessary, products.

²⁵Following Sheikh (1977).

²⁶The cost of buying the goods is already included in the computation of an individual smuggler's total revenue.

Smuggling occurs as long as a smuggler earns a profit ($\pi \geq 0$). Using the first derivative of the profit function (Equation (2.14)), Equation (2.15) defines the supply function of an individual smuggler. The quantity supplied by all smugglers of smuggled good in stage 3, sst_3 , is given by Equation (2.16), in which I is the number of smugglers smuggling goods between Home and ROW.

The relationship between the total quantity supplied of smuggled good, sst_3 , and the world demand, md_3 , is defined by Equation (2.17). Aggregate supply of smuggled good at Home, sst_3 , represents the portion $(1 - \alpha)$ of the world demand that has not been seized by Home's public authorities.

Similarly to stage 1 of the model, Equation (2.18) determines the world supply of avocados in stage 3, ms_3 .

Equation (2.19) corresponds to the zero profit condition and allows us to compute the total number of smugglers, I .

Finally, Equations (2.20), (2.21), and (2.22) present price equations. Equation (2.20) sets the total quantity of the smuggled good demanded at Home (sdt_3) equal to the total quantity of the smuggled good supplied at Home (sst_3). Equation (2.21) sets the quantity of the locally produced good demanded (ld_3) equal to the quantity of the locally produced good supplied (ls_3). Similarly, Equation (2.22) sets the world supply of avocados (ms_3) equal to the world demand for avocados (md_3).

We expect the prohibition implemented by Home on the good imported from the ROW to lead to the emergence of smuggling activity. Consequently, we expect demand for the locally produced good to decrease. Production of the locally produced good should also decrease, as should its own-price. Since the ROW produces the good smuggled, the world price should increase. Therefore, we expect consumer surplus to increase between stage 2 and stage 3 and producer surplus to decrease between stage 2 and stage 3. Successful smugglers also earn a positive surplus.

2.5 Empirical Estimation of Parameters Used in the Model

The model presented in Section 2.4 comprises 16 parameters. First, we estimate four price elasticities and two cross-price elasticities: price elasticity of demand for the locally produced good (η_l), price elasticity of supply for the locally produced good (ϵ_l), price elasticity of demand for the imported good (η_m), price elasticity of supply for the

imported good (ϵ_m), cross-price elasticity of demand of the locally produced good (η_{lm}), and cross-price elasticity of demand of the imported good (η_{ml}). Second, we compute initial values of the price of the locally produced good (pl_0), the world price (pm_0), the quantities of locally produced good both demanded and supplied (ld_0 and ls_0), and imported goods (md_0 and ms_0). Finally, we need values for four smuggling parameters: the probability that smugglers get caught (α), the cost parameter of smuggling (K), the initial number of smugglers (I_0), and the initial quantity of avocados supplied by an individual smuggler (ss_0).

2.5.1 Price Elasticities of Demand and Supply of Locally Produced Avocados

Data on prices and quantities of avocados produced or consumed at the national level in Costa Rica remain scarce. The Food and Agriculture Organization of the United Nations does not have data on producer or consumer avocado prices that could be related to data on national production. The National Institute of Statistics and Census of Costa Rica provides monthly consumer price index for avocados; however, as previously mentioned, this institute has changed its methodology for estimating the local production of avocados since 2015.

Therefore, in order to estimate the price elasticities of demand and supply of the locally produced good, we collect data on prices and quantities of locally produced avocados sold at the main wholesale center in Costa Rica: el Centro Nacional de Abastecimiento y Distribución de Alimentos (CENADA) (National Center for Food Supply and Distribution) (Programa Integral de Mercadeo Agropecuario, 2017).^{27,28} In particular, we use the logged values of the average wholesale price (in constant 2010 US\$ per kg), $\ln p$, and of the total quantity (in kg), $\ln q$, of Costa Rican avocados sold at el CENADA each month from

²⁷Costa Ricans sell and buy fruits and vegetables at three main locations: el CENADA, BORBON (a market in Costa Rica), and the FERIAS del agricultor (farmers' trade fairs). We estimate that around 15 percent to 20 percent of domestic production of fruits and vegetables, including avocados and other main commodities produced in Costa Rica (such as banana, chayote, and papaya), is sold at el CENADA. Unfortunately, data on prices and quantities of avocados sold at the other two locations is not available.

²⁸Data on avocados sold and bought at el CENADA are disaggregated by varieties. To estimate price elasticities of demand and supply of locally produced avocados, we use data on Hass avocados. As previously mentioned, Hass avocados represent 75 percent of total avocado production in Costa Rica. Furthermore, Mexico only exports Hass avocados to Costa Rica. In the following subsection, we thus estimate price elasticity of imported Hass avocados from Mexico. Finally, previous estimations of price elasticities of avocados have also used data on Hass avocados (Carman and Green, 1993; Carman and Craft, 1998; Carman, 2006; Peterson and Orden, 2008).

January 2001 to April 2015 (prior to the implementation of the prohibition).²⁹ Our sample thus comprises 172 observations.

However, information on prices and quantities is not sufficient to identify both demand and supply price elasticities. We solve this identification problem by including additional variables in both the demand and the supply equations to help to identify the individual relations (Santeramo, 2014). In particular, we use instrumental variables.

In the estimation of the price elasticity of demand for locally produced goods, η_l , we include the log of the adjusted per capita net income (in constant 2010 US\$), $\ln y$ (World Development Indicators, 2017), and *Season*, a dummy variable. Costa Ricans consume more avocados on average from July to December than from January to July. The dummy variable thus takes on a value of 1 from July to December and 0 otherwise.³⁰ Furthermore, we account for the potential endogenous behavior of prices vis-à-vis quantities by using data on temperature in Costa Rica.³¹ In particular, in the demand equation, we include the log of the monthly average temperature in Costa Rica (in degree Celsius), $\ln T$ (The World Bank Group, 2017), as an instrumental variable for the log of the average wholesale price of Costa Rican avocados (Equation (2.23)). In agricultural economics, researchers commonly use weather variables as supply shifters. We verify the relevance of $\ln T$ as an instrumental variable in the first stage regression of the two-stage least squares (2SLS) and of the three-stage least squares (3SLS) estimations. Monthly average temperature in Costa Rica appears to be a strong instrument.³² We also believe it is exogenous since the demand for avocados in Costa Rica does not depend on the temperature.

$$\ln q_t = \beta_0 + \beta_1 * \ln p_t + \beta_2 * \ln y_t + \beta_3 * Season_t \quad (2.23)$$

In addition to data on prices and quantities, the supply equation of locally produced avocados comprises the log of the monthly average temperature in Costa Rica (in degree Celsius), $\ln T$, and the log of the monthly total quantity of Costa Rican avocados sold at

²⁹Data prior to 2001 is not available.

³⁰In another version of the model, we also included data on prices of potential complements or substitutes of avocados (viz. tomato, lemon, and lettuce) in the list of independent variables. These variables were not statistically significant so we dropped them from the analysis. These results are consistent with existing literature on avocados: no substitute nor complementary product for avocados has been identified as statistically significant (Carman and Craft, 1998; Carman, 2006; Van Zyl and Conradie, 1988).

³¹Prior to using this instrument, we have verified that the pattern observed regarding the consumption of avocados is not related to changes in temperature.

³²The R^2 , adjusted R^2 , and partial R^2 from the first stage regression equal 10.8 percent, 9.2 percent and 5.9 percent, respectively. Moreover, the F statistic associated with the first-stage regression based on the 2SLS estimator is significant at the 1 percent threshold level and equals 12.6 (Stock et al., 2002).

the CENADA (in kg), lagged by one month, $\ln q_{t-1}$. We use the log of the adjusted per capita net income (in constant 2010 US\$), $\ln y$, as an instrumental variable for the log of the average wholesale price of Costa Rican avocados (Equation (2.24)). The former variable shifts the demand curve but does not shift the supply curve. From the first-stage regression of the 2SLS and 3SLS estimations, this variable also appears as a strong instrument.³³ Furthermore, the per capita net income does not affect the quantity of avocados offered. Thus, it seems to be a valid instrument.

$$\ln q_t = \beta_4 + \beta_5 * \ln p_t + \beta_6 * \ln T_t + \beta_7 * \ln q_{t-1} \quad (2.24)$$

Table 2.5.1 summarises the results obtained for both price elasticities of demand and supply of the locally produced good, using 2SLS and 3SLS estimations.³⁴ We find that i) the price elasticity of demand of the locally produced good equals -1.22 and is significant at the 5 percent threshold level using 2SLS and equals -2.16 and is significant at the 1 percent threshold level using 3SLS; and ii) the price elasticity of supply of the locally produced good equal 1.98 and is significant at the 5 percent threshold level using 2SLS and equals 1.56 and is significant at the 1 percent threshold level using 3SLS. These results are consistent with economic theory.

Furthermore, all other variables included in either the demand or the supply equations are significant at the 1 percent threshold level (except $\ln T$, which is significant at the 5 percent threshold level in the 2SLS estimation and loses its significance in the 3SLS estimation). Moreover, coefficients associated with all other variables are of expected signs.

2.5.2 Price Elasticities of Demand and Supply of Imported Avocados

To estimate the price elasticity of demand for imported avocados, we gathered monthly data on prices and quantities of avocados from Mexico imported into Costa Rica. In particular, we use the logged values of the average unit price of imports of avocados from Mexico to Costa Rica (in US\$ per kg), $\ln pm$, and of the quantity (in kg), $\ln qm$, of

³³The R^2 , adjusted R^2 , and partial R^2 from the first stage regression equal 12.8 percent, 10.7 percent and 10 percent, respectively. The F statistic associated with the first-stage regression based on the 2SLS estimator is significant at the 1 percent threshold level and equals 10.5.

³⁴We did not use ordinary least squares (OLS), as $\ln p$ appears as endogenous. This was confirmed by Wooldridge (1995)'s post-estimation test.

Table 2.5.1: Estimation of price elasticity of demand and of supply of locally produced avocados

	η			ϵl	
	2SLS	3SLS		2SLS	3SLS
$\ln p$	-1.22** (0.499)	-2.16*** (0.646)	$\ln p$	1.98** (0.849)	1.56*** (0.548)
$\ln y$	6.32*** (0.359)	6.81*** (0.546)	$\ln T$	-4.98** (2.051)	-2.47 (1.678)
<i>Season</i>	0.46*** (0.076)	0.57*** (0.099)	$\ln q_{t-1}$	0.77*** (0.088)	0.88*** (0.071)
R^2	0.6756	0.3531	R^2	0.3442	0.5166
<i>Obs.</i>	171	169	<i>Obs.</i>	169	169

Source: Authors.

Note: In parentheses are robust standard errors. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% levels, respectively. Estimated constant parameters not reported.

Mexican avocados imported into Costa Rica each month from January 2001 to April 2015 (Secretaría Ejecutiva de Planificación Sectorial Agropecuaria). This dataset also comprises 172 observations.

In the demand equation, we include the log of the adjusted net national income in Costa Rica (in US\$), $\ln y$, and the log of the monthly quantity imported of Mexican avocados (in kg), lagged by one month, $\ln qm_{t-1}$. We use the log of the monthly average temperature in Mexico (in degree Celsius), $\ln Tm$, and the ad valorem tariff rates implemented by Costa Rica on avocados from Mexico as instrumental variables for the price of Mexican avocados.³⁵

These variables appear to be relevant since they influence the price of imported avocados and are exogenous since they do not directly affect the quantity of imported avocados demanded. We thus consider them to be valid instruments.³⁶

³⁵Data on the ad valorem tariff rates were collected from the World Trade Organisation Tariff Analysis Online facility. Although Costa Rica and Mexico have a free trade agreement since 1995, the ad valorem tariff imposed by Costa Rica on avocados from Mexico initially differed from zero. From 1995 to 2001, Costa Rica gradually decreased its ad valorem tariff on Mexican avocados from 19 percent to 11 percent. From 2002 to 2008, Costa Rica implemented tariff–rate quotas on its imports of avocados from Mexico. Finally, from 2009 to 2015, Costa Rica removed tariff–rate quotas and set the ad valorem tariff rate on avocados imported from Mexico to zero.

³⁶The R^2 , adjusted R^2 , and partial R^2 from the first stage regression equal 71.5 percent, 70.8 percent and 39.7 percent, respectively. The F statistic associated with the first–stage regression based on the 2SLS estimator is significant at the 1 percent threshold level and equals 59.2. Finally, these instrumental variables also pass Wooldridge (1995)’s robust score test of overidentifying restrictions.

Table 2.5.2: Estimation of price elasticity of demand for imported avocados

	η_m 2SLS	η_m OLS
$\ln pm$	-0.87*** (0.104)	-0.65*** (0.089)
$\ln y$	0.69*** (0.072)	0.53*** (0.053)
$\ln qm_{t-1}$	0.51*** (0.60)	0.62*** (0.054)
R^2	0.7144	0.8039
<i>Obs.</i>	171	170

Source: Authors.

Note: In parentheses are robust standard errors. ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% levels, respectively. Estimated constant parameters not reported. Column 3 reports Cochrane–Orcutt estimates.

$$\ln qm_t = \beta_8 + \beta_9 * \ln pm_t + \beta_{10} * \ln y_t + \beta_{11} * \ln qm_{t-1} \quad (2.25)$$

Table 2.5.2 summarises the results obtained for the price elasticity of demand for the imported good, using 2SLS and OLS estimations.³⁷ We find that the price elasticity of demand for the locally produced good equals -0.87 and -0.65, respectively, using 2SLS and OLS estimations and is significant at the 1 percent threshold level. These results are consistent with economic theory. The coefficients associated with all other variables are significant and of expected signs.

We were not successful in obtaining monthly data regarding exports of Mexican avocados into Costa Rica with which to estimate the price elasticity of supply of exported Mexican avocados in Costa Rica. We only collected data on total Mexican exports of avocados. This estimation is not common in the literature. In most models, the authors assume that the country is price-taker so that the export supply price elasticity is infinite and the world price is exogenous. In this study, we suppose that the export supply price

³⁷We also use OLS estimation for the price elasticity of demand for the imported good because it appears to be exogenous at the 5 percent threshold level of significance, based on Wooldridge (1995)’s post-estimation test. Since the Durbin–Watson statistic indicates significant serial correlation at the 5 percent threshold level, we perform a Cochrane–Orcutt transformation. Column 3 of Table 2.5.2 reports Cochrane–Orcutt estimates.

Table 2.5.3: Estimations of price elasticities of demand and of supply of locally produced and imported goods

Elasticities	OLS (1)	2SLS (2)	3SLS (3)
ηl	N.A.	-1.22**	-2.16***
ϵl	N.A.	1.98**	1.56***
ηm	-0.65***	-0.87***	N.A.
ϵm	N.A.	N.A.	N.A.

Source: Authors' calculation based on PIMA (2017).

Note: ***, **, and * denote variables statistically different from 0 at the 1%, 5%, and 10% levels, respectively.

elasticity equals 16 ($\epsilon_m = 16$) and conduct a sensitivity analysis on this parameter.

Table 2.5.3 summarises results found for price elasticities of demand and of supply of locally produced and imported goods, using different estimation methods.

Results are consistent with economic theory: price elasticities of demand are negative, while price elasticities of supply are positive. Estimates are of the same order of magnitude, except for ηl , which is slightly higher when using the 3SLS estimation. We perform robustness tests on those elasticities. Since the 2SLS method provides more estimations, we base our central estimation on elasticities provided by this method.

Previous studies have not estimated price elasticities of demand and supply of locally produced avocados in Costa Rica and of avocados imported from Mexico into Costa Rica. It is thus difficult to compare our results with previous estimations of price elasticities from the literature. Nonetheless, the price elasticity of avocados has been estimated for the California avocado industry. In particular, Carman and Green (1993) report a price flexibility of demand for the California avocado industry equal to -1.16, corresponding to a price elasticity of -0.86. Carman and Cook (1996) use a revised version of the Carman and Green (1993) model and find a price flexibility of demand for the California avocado industry of -1.53, corresponding to a price elasticity of demand of -0.65.

Carman and Craft (1998) estimate the annual and monthly price flexibilities of demand for the California avocado industry at -1.33 and -1.54, respectively, corresponding to an annual price elasticity of demand of -0.75 and a monthly price elasticity of demand of -0.65. The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) uses a price elasticity of demand of -0.86 in its 2001 and 2003

reports and of -0.57 in its 2004 study.³⁸ Carman (2006) derives a price elasticity of demand for California avocados of -0.387.

Finally, Peterson and Orden (2008) find a price elasticity of demand for Californian avocados of -2.06.³⁹ Estimates of price elasticity of demand for California avocados thus varies from -0.4 to -2.06. Our estimates of Costa Rican price elasticity of demand for Costa Rican and Mexican avocados are of the same order of magnitude.

2.5.3 Cross-price Elasticities of Demand of Locally Produced and Imported Avocados

Since we have already produced estimations of price elasticities of demand and of supply of locally produced and imported goods, we use Rousslang and Suomela (1985)'s methodology to compute cross-price elasticities of locally produced and imported goods. In particular, we define the cross-price elasticity of the locally produced good, η_{lm} , as follows:

$$\eta_{lm} = \frac{(\eta_l - \eta_m)V_m}{(V_l - V_m)} \quad (2.26)$$

in which η_{lm} is the cross-price elasticity of locally produced avocados, η_l is the own-price elasticity of locally produced avocados, η_m is the own-price elasticity of imported avocados, V_m is the value of imported avocados, and V_l is the value of locally produced avocados.

Similarly, we define the cross-price elasticity of the imported good as follows:

$$\eta_{ml} = \frac{(\eta_m - \eta_l)V_l}{(V_m - V_l)} \quad (2.27)$$

in which η_{ml} is the cross-price elasticity of imported avocados.

We respectively compute V_m and V_l as the quantity of imported Mexican avocados and of locally produced Costa Rican avocados times their respective price, on average, from May 2012 to April 2015.⁴⁰ We find V_m equal to 21,062,812 constant 2010 US\$ and V_l equal to 4,334,882 constant 2010 US\$.

³⁸U.S. Department of Agriculture and Service (2001, 2003, 2004).

³⁹As previously mentioned, price elasticities of demand estimated in the above-mentioned analyses are estimated for Hass avocados, similar to our study.

⁴⁰We believe that three-year averages allow for a sufficient amount of time to control for variations in quantities produced and consumed and provide a short enough amount of time to avoid the need to take trends in price, etc. into account.

Table 2.5.4: Estimated cross-price elasticities of demand for locally produced and imported avocados

Elasticities	Values
η_{lm}	0.441
η_{ml}	0.091

Source: Authors.

Table 2.5.5: Initial values of the variables of the model

Variables	Initial values
pl_0	1.8 constant 2010 US\$
pm_0	2.04 constant 2010 US\$
ld_0	2,506,180 kgs
ls_0	2,506,180 kgs
md_0	10,373,436 kgs
ms_0	10,373,436 kgs

Source: Authors.

Table 2.5.4 reports the estimated cross-price elasticities of demand of locally produced and imported avocados, using Rousslang and Suomela (1985)'s method.

2.5.4 Initial Values and Smuggling Parameters

We compute the initial values of the price of the locally produced good, the world price, and the quantity of locally produced and imported goods demanded and supplied by calculating their average values from May 2012 to April 2015 (three years prior to the implementation of the ban). Table 2.5.5 presents results obtained for these initial values.

In order to evaluate the consequences of smuggling, we need to compute four smuggling parameters: the probability of being caught (α), the smuggler's cost parameter (K), the initial quantity of smuggled avocados supplied by an individual smuggler (ss_0), and the initial number of smugglers (I_0).

With regard to the initial quantity of smuggled good supplied by an individual smuggler, we have anecdotal evidence regarding a police confiscation of 4,100 kgs of avocados smuggled from Mexico into Costa Rica in May 2016. We hence set $ss_0 = 4,100$ kgs. Since data on the three other parameters is not available, we calibrate the initial number of smugglers (I_0) based on different values of α and K . We run the model 3,900 times, allowing α to vary by 1 percent in a range from 1 percent to 39 percent and allowing K to vary by $1e-12$ in a range from $1e-12$ to $1e-10$. This allows us to obtain

results based on a large range of values of K and α rather than providing a single result based on an approximation of these two parameters.

2.6 Results

This section discusses results obtained at the end of the second and third stage of the model.

First, after the implementation of the ban but prior to the emergence of smuggling activity, the demand for Costa Rican avocados rises by 83 percent (from 2,506 metric tons to 4,590 metric tons). As a result, the price of Costa Rican avocados rises by 36 percent, from 1.8 to 2.44 constant 2010 US\$. The quantity of avocados imported from Mexico to Costa Rica equals zero, leading to a decrease in the quantity of Mexican avocados demanded and thus to a decrease in the world price (from 2.04 to 2.0 constant 2010 US\$). Total consumer surplus decreases by 89 percent (from about 41 million constant 2010 US\$ to 4.6 million constant 2010 US\$). This result is not surprising since, as previously mentioned, imports represent about 90 percent of the avocados consumed in Costa Rica. This loss is supported by consumers of imported avocados who now have to pay a greater price for lower quality, locally produced avocados.⁴¹ On the other side, the producer surplus increases by 149 percent (from approximately 1.5 million constant 2010 US\$ to 3.8 million constant 2010 US\$). The net welfare effect is negative. Costa Rican welfare decreases by 81 percent (from around 43 million constant 2010 US\$ to 8.4 million constant 2010 US\$), representing a loss of 0.06 percent of Costa Rican GDP in 2016.

Second, Table 2.6.1 presents the results obtained when we allow for some smuggling activity. As mentioned in Section 2.5.4, we run the model for a large number of values of the probability of being caught (α) and of the cost parameter of smuggling (K). While results are not sensitive to K , they vary with α . We thus present in Table 2.6.1 the results obtained for several values of α .

As expected, the number of smugglers, I , decreases with α : from 2,496 for α equal to 1 percent to 1,138 for α equal to 39 percent. The total quantity of avocados smuggled

⁴¹Variations in consumer surplus are calculated separately for both consumers of locally produced and imported goods. Just et al. (2004) demonstrate that in a multiple-price-change case, the order in which prices change does not affect the compensating and equivalent variations in consumer surplus. We thus compute total consumer surplus as the sum of consumer surpluses of locally produced and imported goods. We note, however, that due to a lack of data on income elasticities, these elasticities are not included in our calculations of total consumer surplus. We still expect the calculation error to be small since income elasticities of fruit and vegetable products are often less than one (Abler, 2010).

Table 2.6.1: Results (stage 3)

α (%)	I (count)	sst (kgs)	ps (constant 2010 US\$)	ls (kgs)	pl (constant 2010 US\$)
1	2496	10,232,060	2.06	2,520,773	1.81
10	2183	8,949,447	2.27	2,662,658	1.86
20	1829	7,500,896	2.55	2,846,894	1.92
30	1469	6,024,383	2.91	3,068,003	1.99
39	1138	4,668,032	3.33	3,309,887	2.07

Source: Authors.

decreases with α : from 10,232 metric tons for α equal to 1 percent to 4,668 metric tons for α equal to 39 percent. The price of smuggled good increases with α : from 2.06 constant 2010 US\$ for α equal to 1 percent to 3.33 constant 2010 US\$ for α equal to 39 percent. Thus, an increase in the probability of an individual smuggler being caught increases the price of the smuggled good; a higher risk brings more profitable activity.

On the other side, both the quantity of the locally produced good supplied and the price of that good increase with α : from 2,521 metric tons for α equal to 1 percent to 3,310 metric tons for α equal to 39 percent, and from 1.81 constant 2010 US\$ for α equal to 1 percent to 2.07 constant 2010 US\$ for α equal to 39 percent, respectively. Thus, an increase in the probability of being caught serves the interest of local producers.

Tables 2.6.2 and 2.6.3 present the changes in percentage for the different variables of interest. Specifically, Table 2.6.2 reports variations from stage 2 to stage 3, while Table 2.6.3 reports variations from stage 1 to stage 3 of the model.

As seen in Table 2.6.2, the emergence of smuggling activity decreases the demand for Costa Rican avocados from 45 percent to 28 percent as α increases from 1 percent to 39 percent. As a result, the price of locally produced avocados also decreases from 26 percent to 15 percent as α increases from 1 percent to 39 percent. Consumer surplus (CS) largely rises with the emergence of smuggling compared to the absence of smuggling under the import ban. Specifically, CS increases from 1004 percent to 585 percent as α increases from 1 percent to 39 percent.⁴² Consumers are now able to buy higher-quality avocados. On the other hand, producer surplus (PS) decreases from 59 percent to 39 percent as α increases from 1 percent to 39 percent.

At this stage, we compute two values of welfare: δ_{WEL_1} represents the variation in Costa

⁴²Although such an increase appears large, recall that consumer surplus decreases by 89 percent from stage 1 to stage 2 of the model. Thus, for an initial value of 100, consumer surplus equals 11 at stage 2 and equals $11(1 + 1004\%) = 121.44$ at stage 3, which results in an augmentation of only 21 percent between stages 1 and 3 of the model.

Table 2.6.2: Results (variations in percentage from stage 2 to stage 3)

α (%)	δ_{ld} (%)	δ_{pl} (%)	δ_{CS} (%)	δ_{PS} (%)	δ_{WEL_1} (%)	δ_{WEL_2} (%)
1	- 45	- 26	1004	- 59	526	527
10	- 42	- 24	923	- 56	482	494
20	- 38	- 21	821	- 51	429	451
30	- 33	- 18	705	- 45	367	399
39	- 28	- 15	585	- 39	304	340

Source: Authors.

Rican welfare between stage 2 and 3 of the model, assuming that smugglers are not Costa Ricans; δ_{WEL_2} represents the variation in Costa Rican welfare between stage 2 and stage 3 of the model, assuming that smugglers are Costa Ricans. Since smugglers earn a profit on goods that are successfully smuggled, their surplus is positive and δ_{WEL_2} is greater than δ_{WEL_1} . Both welfare variables increase after the emergence of smuggling. WEL_1 increases from 8.4 million to 52 million constant 2010 US\$ for α equal to 1 percent, representing a 526 percent increase, and increases from 8.4 million to 34 million constant 2010 US\$ for α equal to 39 percent, representing a 304 percent increase. Similarly, WEL_2 increases from 8.4 million to 52 million constant 2010 US \$ for α equal to 1 percent, representing a 527 percent increase, and increases from 8.4 million to 37 million constant 2010 US \$ for α equal to 39 percent, representing a 340 percent increase. Regardless of whether we include smugglers' welfare in the computation of Costa Rican welfare, we find a large and positive impact of smuggling on Costa Rican welfare.

Similarly, Table 2.6.3 reports the changes in percentage for the variables of interest from stage 1 to stage 3 of the model. Overall, the prohibition leads to an increase in the quantity of locally produced good demanded (by 1 percent to 32 percent, depending on the value of α), thus raising the price of locally produced avocados (by 0.3 percent to 15 percent, again depending on the value of α). The prohibition favours producers, as producer surplus increases by 1 percent for α equal to 1 percent and by 52 percent for α equal to 39 percent.

On the other side, the implementation of the prohibition with smuggling imposes a trading cost on consumers, who pay a higher price for Mexican avocados than they did prior to the prohibition. Thus, the consumer surplus generally decreases between stage 1 and stage 3 of the model. We observe a similar effect with regard to Costa Rican welfare.⁴³

⁴³Costa Rican welfare decreases by 21 percent when the probability that smugglers get caught equals 39 percent (high enforcement), representing a decrease in Costa Rican welfare roughly equal to 9.1 million

Table 2.6.3: Results (percentage change from stage 1 to stage 3)

α (%)	δ_{ld} (%)	δ_{pl} (%)	δ_{CS} (%)	δ_{PS} (%)	δ_{WEL_1} (%)	δ_{WEL_2} (%)
1	1	0.3	23	1	22	22
10	6	3	14	10	14	16
20	14	7	2	21	3	8
30	22	11	-11	36	-9	-3
39	32	15	-24	52	-21	-14

Source: Authors.

Therefore, while smuggling is welfare-improving compared to the “no-smuggling situation”, it does not always compensate for the harmful effects of the import prohibition.

It is, however, worth noting that for low levels of enforcement ($\alpha < 22\%$), the consumer surplus is greater in stage 3 than in stage 1 of the model.⁴⁴ As smugglers’ probability of being caught decreases, the risk premium associated with smuggling also decreases, resulting in lower prices for the smuggled good. Moreover, the prohibition with smuggling leads to a decrease in the world price compared to the free trade situation, which results in a gain in the terms of trade for Costa Rica. For low levels of enforcement ($\alpha < 22\%$), the terms of trade gain offsets the negative effects associated with the trading cost of smuggling.⁴⁵ Consequently, Costa Rican welfare may be greater under the prohibition with smuggling than under free trade.

This latter result is, however, unlikely in the case of Costa Rica, which remains a relatively small player in the market for avocados compared to countries such as Mexico and the United States. We expect the gain in the terms of trade resulting from smuggling to be small in the case of Costa Rica, and thus Costa Rican welfare to be greater under free trade than under the prohibition with smuggling. Nonetheless, it shows that in the case of a large country implementing this type of protectionist measure, the prohibition and smuggling may be beneficial.

We conclude that smuggling is welfare-improving when compared to the “no-smuggling situation”. The positive impact of smuggling on welfare may, however, not always offset the loss incurred from the implementation of the protectionist trade policy. Smuggling

constant 2010 US\$.

⁴⁴Welfare increases by 22 percent when the probability that smugglers get caught equals 1 percent (very low enforcement), representing an increase in Costa Rican welfare roughly equal to 9.4 million constant 2010 US\$.

⁴⁵If we include smugglers’ surplus in the calculation of Costa Rican welfare (WEL_2), the threshold value for α below which welfare is higher in the third than in the first stage of the model rises to 28 percent.

does offset these losses for lower levels of enforcement by public authorities and for an improvement in the terms of trade.

A sensitivity analysis reveals that our results are robust to changes in the values of K_{ms} , K_{md} , η_l , η_m , ϵ_l , ϵ_m . The only noticeable variation in our results comes from the fact that for small values of η_m , smuggling is always welfare-improving.⁴⁶

2.7 Discussion

In this section, we further discuss two important aspects of the analysis: potential substitution effects and the inelasticity of the local supply in the short-term.

2.7.1 Potential Substitution Effects

As previously mentioned, Costa Rica substituted avocados legally imported from Mexico for avocados legally imported from Chile and Peru, in addition to smuggled avocados.⁴⁷ Following *The Economist* (2016) and personal discussions with Costa Ricans, we assume that Chilean and Peruvian avocados are of lower quality than Mexican avocados. In this case, consumers would have the choice between buying low-quality, cheap avocados locally produced or legally imported from Chile or Peru, or buying high-quality, expensive avocados smuggled from Mexico. Consumer surplus would thus be higher than the value predicted by the model. Local producers of avocados would lose from this substitution effect i.e. producer surplus would be lower than the value predicted by the model. As a result, the price of locally produced avocados would also be lower than that predicted by the model. The effects of such substitution on the quantities demanded and supplied and on the price of illegally imported avocado are, however, uncertain since they depend on consumers' preferences. Data on price and cross-price elasticities of demand for legally imported avocados from Chile and Peru and for illegally imported avocados from Mexico are necessary to conclude on the potential substitution effect between smuggled avocados and legally imported avocados from Chile and Peru.⁴⁸ Including legal imports of avocados from Chile and Peru in the analysis would lead to a substitution effect between these legal imports and locally produced avocados, but may

⁴⁶Additional information may be requested from the authors.

⁴⁷Costa Rican total legal imports of avocados only dropped by 3 percent between 2015 and 2016 (Cámara de Comercio Exterior, 2016; United Nations comtrade, 2017).

⁴⁸As previously mentioned, this data is not directly available. Furthermore, data on quantities and prices of smuggled avocados required to compute such elasticities is limited.

not affect smuggled avocados since the latter are of higher quality than legally imported avocados from Chile and Peru and than locally produced avocados. Government revenues will not rise since Costa Rica has free-trade agreements with Chile and Peru, under which tariffs on avocados equal zero.⁴⁹ Finally, welfare effects are ambiguous. On one side, Costa Rican consumers would have access to less expensive, legally imported avocados. On the other side, local producers would suffer from increased competition in the market for avocados.

2.7.2 Inelasticity of Local Supply in the Short-Term

In our model, we assume that the quantity of locally produced avocados depends on its own price. As a result, an increase in the price of Costa Rican avocados leads to an increase in the local production of avocados (and vice versa). Since it takes three to four years to collect fruits from newly planted avocado trees, the above-mentioned reasoning corresponds to a middle term situation. Following the import ban, Costa Rican farmers plant additional avocado trees and production of locally produced avocados increases three to four years after the prohibition.⁵⁰

In the short-term, however, the quantity of locally produced avocados may be inelastic. In this section, we thus adjust our model so that the production of Costa Rican avocados does not vary with a variation in its own price. In particular, we substitute the equation defining the local supply of avocados as iso-elastic with an equation defining the local supply of avocados as constant, in each stage of the model.

Results from stage 1 to stage 2 of the model are similar to those obtained in Section 2.6. Following the implementation of the prohibition, total consumer surplus decreases by 94 percent, compared to 89 percent when local production is elastic. Producer surplus increases by 226 percent, compared to 149 percent when local production of avocados varies with its own price. The larger increase in producer surplus reflects the larger increase in the price of locally produced avocados: 49 percent when local production is constant, compared to 36 percent when production of locally produced goods varies. Finally, Costa Rican welfare decreases by 82 percent, compared to 81 percent in previous results.

Table 2.7.1 presents results obtained in the third stage of the model under our new

⁴⁹Costa Rica reduced its import duties on avocados originating from Chile from 0.9 percent ad valorem in 2014 to 0 percent ad valorem in 2015. Costa Rican's tariffs on avocados from Chile remained equal to zero since 2015 (World Trade Organisation, 2018d).

⁵⁰We assume that Costa Rican farmers buy young avocado trees from nurseries rather than grow trees from seeds, in which case they would have to wait ten to fifteen years prior to harvest the first fruits.

Table 2.7.1: Results (stage 3) - Inelastic local supply

α (%)	I (count)	sst (kgs)	ps (constant 2010 US\$)	ls (kgs)	pl (constant 2010 US\$)
1	2496	10,233,061	2.06	2,506,180	1.81
10	2185	8,959,314	2.27	2,506,180	1.87
20	1834	7,520,255	2.55	2,506,180	1.95
30	1476	6,052,741	2.91	2,506,180	2.05
39	1147	4,703,933	3.33	2,506,180	2.15

Source: Authors.

Table 2.7.2: Results (percentage change from stage 2 to stage 3) - Inelastic local supply

α (%)	δ_{ld} (%)	δ_{pl} (%)	δ_{CS} (%)	δ_{PS} (%)	δ_{WEL_1} (%)	δ_{WEL_2} (%)
1	0	- 33	1012	- 59	530	531
10	0	- 30	927	- 55	485	497
20	0	- 27	821	- 49	430	453
30	0	- 24	700	- 41	367	398
39	0	- 20	574	- 32	302	338

Source: Authors.

assumption, for different values of the probability of being caught (α). Results are similar to those presented in Table 2.6.1. As expected, the quantity of locally produced avocados (ls) no longer varies with its own price. Consequently, the price of locally produced avocados is slightly above the one previously found, regardless of the value of α . The price of the smuggled good remains the same, but the quantity of smuggled avocados increases due to a slightly greater number of smugglers. As previously mentioned, an increase in α benefits local producers.

Table 2.7.2 reports changes in the variable of interest from stage 2 to stage 3. As expected, variations in the demand for locally produced avocados equal zero. This modification, however, does not alter our results since these new results are similar to those presented in Table 2.6.2.

Finally, Table 2.7.3 reports changes in the variable of interest from stage 1 to stage 3 of the model. The variations in the price of locally produced goods are slightly higher than those found in Table 2.6.3, leading to higher variations in producer surplus. Variations in consumer surplus and both measures of welfare are virtually not affected by this modification.

We conclude that considering the supply of locally produced avocados as inelastic in the short-term does not affect our results.

Table 2.7.3: Results (percentage change from stage 1 to stage 3) - Inelastic local supply

α (%)	δ_{ld} (%)	δ_{pl} (%)	δ_{CS} (%)	δ_{PS} (%)	δ_{WEL_1} (%)	δ_{WEL_2} (%)
1	0	0.4	24	1	23	23
10	0	4	14	12	14	16
20	0	8	2	27	3	8
30	0	14	-11	46	-9	-3
39	0	19	-25	69	-22	-15

Source: Authors.

2.8 Conclusion

In this paper, we provide a transparent and simple theoretical model of trade with smuggling and heterogeneous goods. We empirically apply this model to the current situation of avocado smuggling in Costa Rica. To do so, we compute a number of parameters, including price elasticities of demand and of supply for locally produced and (legally or illegally) imported avocados, that may prove useful for future research.

In terms of welfare, we find that smuggling largely improves Costa Rican welfare compared to the “no-smuggling situation”.⁵¹ Our results converge with Deardorff and Stolper (1990), who conclude that smuggling is a “healthy reaction to bad situations caused by bad policies”.

This paper, however, goes one step further by demonstrating that smuggling may also be welfare-improving when compared to the “free-trade situation”. This peculiar situation occurs when the gain in the terms of trade following the prohibition with smuggling offsets the negative effects of the trading cost of smuggling.

However, these latter results do not mean that governments aiming to maximise their own country’s overall welfare should implement protectionist measures and let smugglers trade freely or that they should implement protectionist measures on foreign products for which the price elasticity of demand is very low. Indeed, implementing such restrictive measures may have political and judicial costs that are not included in the analysis. As previously mentioned, Mexico has established a complaint against Costa Rica at the WTO DSS. Settling such a trade dispute may turn very costly for Costa Rica, especially if the

⁵¹Recall, however, that our analysis does not take into account the potential sanitary and phytosanitary effects of consuming avocados imported from Mexico nor does it take into account the risk of contamination of local avocados by imported Mexican avocados. If such effects and risk proved to be real, smuggling could have a negative impact on welfare. Measuring potential sanitary and phytosanitary effects of consuming avocados imported from Mexico and measuring the risk of contamination would, however, require a fully-fledged investigation and is not the purpose of our analysis.

Costa Rican government decides to maintain the restrictive trade policy.

Chapter 3

Can the United States Benefit from Strict Reciprocity?¹

3.1 Introduction

On January 24, 2019, Republican Senator Sean P. Duffy introduced the United States Reciprocal Trade Act (USRTA) to Congress. This legislation aims to give additional power to the President of the United States (US), Donald J. Trump, with regard to trade policy. As its name suggests, this act would allow the President of the United States to impose strict reciprocity in US trade relations with its trading partners. In other words, the proposed bill would enable President Donald J. Trump to increase the tariff imposed by the US on its imports of any good from any country to the level of the tariff imposed by that same country on US exports of the same good.

The principle of strict, or full, reciprocity entails that reciprocity must be met in terms of market access at the sectoral level and, that trade balances assess the level of fairness in trade (Bhagwati and Irwin, 1987). This principle is particularly attractive to President Donald J. Trump since it justifies the recent imposition by the US of unilateral additional duties on its imports from several countries and in various sectors, to reduce US bilateral trade deficits. US President tweeted on March 2, 2018: “When a country Taxes our products coming in at, say, 50 %, and we Tax the same product coming into our country at ZERO, not fair or smart. We will soon be starting RECIPROCAL TAXES so that we will charge the same thing as they charge us. \$800 Billion Trade

¹This chapter has been submitted to International Economics.

Deficit–have no choice!” (Trump, 2018).²

Strict reciprocity has, however, never been a principle governing the international trading system. The US rather built the GATT on the principle of “first–difference” reciprocity. “First–difference” reciprocity, also called “marginal” reciprocity, defines reciprocity between trading partners as mutual concessions from the initial conditions (Bhagwati and Irwin, 1987). Under this principle, countries negotiate and find mutually acceptable trade–liberalising concessions. It is currently one of the main principles governing the World Trade Organisation (WTO), with the most–favoured–nation (MFN) rule.

Although the concept of strict reciprocity recently reappeared in President Donald J. Trump’s speeches, it is not new. Bhagwati and Irwin (1987) discuss the “return of the reciprocitarians” to refer to the movement that emerged in the US at the end of the twentieth century, and which had first been observed in Britain at the end of the nineteenth century. The authors explain that during these periods, both countries experienced domestic macroeconomic problems combined with a shrinking position in the world economy, leading some of their leaders and citizens to adopt skeptical views about free trade. “Reciprocitarians” claimed reciprocity in trade relations, and promoted the idea that foreign trade barriers could be reduced by threat of retaliation. While Britain endorsed free trade, by notably repealing the Corn Laws in 1846, the US never embraced the ideology of unilateral free trade. Axelrod (1984) even demonstrated the effectiveness of a reciprocal, or “tit–for–tat”, strategy in social and political relations to trigger cooperative behaviours. Political figures from both the Democratic party, such as Walter Mondale, and the Republican party, such as Ronald Reagan, later supported the principles of reciprocity and fair trade.³ From 1985 to 1988, US senators introduced over 300 trade bills in Congress that amended Section 301 of the Trade Act of 1974 and created the Super 301 and Special 301 provisions. Under these provisions, the US could impose trade sanctions on foreign countries that either violated trade agreements or engaged in unfair trade practices (International Trade Administration, 2018; Bhagwati and Patrick, 1990). The objectives of these provisions were both to address unfair foreign

²Since trade negotiations conducted on the basis of reciprocity require valuation of concessions, the concept of reciprocity only applies to tariff barriers. As Dell (1986) mentions, it is “virtually impossible” to consider non–tariff barriers, except quotas, on a reciprocal basis. Furthermore, President Donald J. Trump seems to only focus on import duties in his speeches on reciprocity. Consequently, we only treat the issue of reciprocal taxes in this article.

³Walter Mondale served as the forty–second vice–president of the US from 1977 to 1981. He lost in the US presidential election of 1984 to Ronald Reagan.

barriers to US exports and to open foreign markets (Bhagwati and Patrick, 1990). The 301 trade policy of the US thus appeared as a “weapon with which to negotiate trade barrier reductions” (Bhagwati and Patrick, 1990). Similarly, the USRTA would “give the President the tools necessary to pressure other nations to lower their tariffs and stop taking advantage of America” (Sean Duffy United States Representative, 2019). But, can the US benefit from the threat and/or application of reciprocal taxes?

“Reciprocitarians” offer two arguments in favour of strict reciprocity. First, applying reciprocal tariffs would help the US reduce its bilateral trade deficits (see Section 3.3). “Reciprocitarians” adopt a mercantilist vision of trade relationships: they perceive imports as bad and exports as good.⁴ They also consider international trade as a zero–sum game, rather than as a positive–sum game, in which a gain for a country necessarily leads to a loss to another nation. Under this perspective, a trade deficit thus represents a loss to the country facing the deficit, and fair trade is achieved when the terms and conditions of trade are strictly reciprocal (Chow and Sheldon, 2018). Accordingly, the US should unilaterally raise its tariffs to reduce its bilateral trade deficits, and to play on a “level playing field” with its trading partners. Second, “reciprocitarians” who are less concerned with simple equity in trade, believe that reciprocity would lead to free trade as it would provide incentives to US trading partners to reduce their trade barriers. Under this view, the US may use strict reciprocity as a threat to force its trading partners to lower their tariffs on US exports.

On the contrary, those who oppose strict reciprocity perceive it as another form of protectionism (Bhagwati and Irwin, 1987; Irwin, 2017). First, they argue that an increase in import tariffs will not be efficient to reduce the US trade deficit: this deficit is related to structural factors like demography and public and private net savings. They explain that net capital flows into the US, rather than trade policies, determine the trade deficit. Consequently, to reduce its trade deficit, the US should either raise domestic savings or reduce “national investment” (Irwin, 2017). Second, opponents of strict reciprocity argue that it may lead to losses to the country imposing the sanctions rather than to reductions in foreign trade barriers, since affected countries could implement retaliatory measures that would harm the tariffs–imposing country. Irwin (2017), based on data from the US Department of Commerce, emphasises that US exports supported 11.5 million jobs in the US, in 2016. Retaliatory measures against the US could substantially jeopardise these jobs. Finally, some economists assert that the concept of reciprocity may be captured and

⁴Dell (1986) discusses the “mercantilist game of reciprocity”.

misused by protectionist interest groups for their own benefits, at the expense of national welfare (Krugman, 1987; Dixit, 1984).

In this paper, we measure the welfare impacts of the threat and/or the effective application of strict reciprocity implemented by the US against its main trading partners. We also determine whether the US threat of retaliation through reciprocal taxes is credible. In game theory, a threat is credible if it serves the interest of the player who made it, at the time when it must be executed and if it hurts the other player (Bouët, 1992). In this case, the US threat would be credible if the US were to benefit from the implementation of its threat and if its trading partners were negatively impacted by such implementation.

We use a general equilibrium model of international trade, MIRAGRODEP, to quantify and compare the trade and welfare consequences of two potential situations. In the first scenario, we assume that the US threat of implementing reciprocal taxes results in a reduction in the tariffs of the US trading partners on their imports of US goods. Under this scenario, the US trading partners believe that they would lose more from the application of reciprocal taxes by the US than from the lowering of their own trade barriers on US products. They also think that if they maintain their tariffs, it would be in the interest of the US to carry out its threat. The US threat of implementing strict reciprocity thus appears as credible and US trading partners prefer to lower their tariffs on US goods than face reciprocal taxes on their exports to the US. In the second scenario, we assume that the US trading partners refuse to reduce their trade barriers on US products and that, as a result, the US imposes reciprocal taxes on its imports from its trading partners.

We thus develop a game in which, in a first step, the US threatens its trading partners with reciprocal taxes (e.g. through the USRTA bill); in a second step, the US trading partners decide whether to lower their trade barriers on US goods; and in a third step, the US chooses whether to implement reciprocal taxes.⁵ We do not consider a fourth step in which the US trading partners could retaliate against strict reciprocity imposed by the US for two reasons. First, the chosen value of retaliation would have been arbitrary. Second, as mentioned in Section 3.2, many papers have already investigated the welfare consequences of potential trade wars. Although, such scenarios are of interest, they are not the focus of our analysis.

⁵If the US trading partners decide to reduce their trade barriers on US products, the game stops at the end of the second step, since the US should not implement strict reciprocity. On the contrary, if the US trading partners maintain their trade barriers on US goods, the game moves on to the third step.

Using a recursive dynamic multiregion and multisector general equilibrium model, such as MIRAGRODEP, enables us to compute the payoffs at the end of the second and third steps for both the US and its main trading partners,⁶ and allows us to conclude on the credibility of the US threat of retaliation through reciprocal taxes. Moreover, MIRAGRODEP provides results on many variables of interest, such as sectoral production, sectoral consumption, and sectoral trade, for each region included in the analysis. Other models, such as new quantitative trade models (NQTMs), do not appear as appropriate for this study since they rely on many theoretical assumptions and thus provide few and model-based results. To the best of our knowledge, this paper is the first to quantify the welfare consequences of the use of reciprocal taxes between major trading countries.

We find that although the threat of retaliation through reciprocal taxes may lead to global gains, its effective application would result in a reduction in both the US and the world's welfare. Furthermore, we demonstrate that this threat of retaliation does not appear as credible to most of the US main trading partners.

These results seem to contradict recent US behaviour: why would the US threaten its trading partners with a policy that would damage its own economy? What would the US use a non-credible threat against its trading partners? In Section 3.5.4, we offer three potential explanations for such attitude.

We conclude that the US should seek peaceful negotiations with its trading partners rather than threatening them with, or implementing, reciprocal taxes to force them to lower their trade barriers.

The rest of this paper proceeds as follow. Section 3.2 reviews the literature on the theoretical welfare effects of strict reciprocity and on welfare analyses of recent US trade policies. Section 3.3 presents a descriptive summary of trade relationships between the US and its top 10 trading partners. Section 3.4 describes the model, data and scenarios used in this paper. Section 3.5 reports the results for each scenario under study and discusses them. Finally, Section 3.6 concludes.

⁶The top 10 trading partners of the US in 2018 were: Brazil, Canada, China, European Union, India, Japan, Mexico, South Korea, Switzerland, and Taiwan (U.S. Census Bureau, 2018).

3.2 Review of Literature

This investigation relates to the literature on the welfare effects of strict reciprocity. To the best of our knowledge, there is no empirical analysis of the welfare effects of strict reciprocity on the US (or any other) economy. There exists, however, qualitative studies on the potential impacts of the implementation by the US of a trade policy based on strict reciprocity, which we review in a first subsection.

In a second subsection, we focus on the welfare consequences of recent protectionist trade measures implemented by the US. While none of these latter analyses specifically consider scenarios of strict reciprocity, they provide quantitative insight into the welfare effects of a unilateral rise in US tariffs.

3.2.1 Theoretical Welfare Effects of Strict Reciprocity

The literature on strict reciprocity, and more precisely on the welfare consequences of such trade policy, is scarce. Most investigations on this topic date back to the 1980s, and were conducted in reaction to the Reciprocal Trade and Investment Act of 1982 introduced in the Senate by Senator Danforth, as well as to several reciprocity bills introduced in the ninety-seventh Congress. At this time, the principle of reciprocity, which was initially understood as reciprocity at the margin, was revised and became strict reciprocity, as previously defined.

Cline (1983) is one of the first to explore whether such approach to trade relations would serve the US and the world's interests. The author qualitatively computes the net effect of such strategy and determines that reciprocity enforced by retaliation may only be successful if: i) the probability of foreign capitulation is high; ii) the gains from opening foreign markets are high; iii) the gains from the terms of trade improvement are high; iv) the home costs of protection are low; v) the probability of counter-retaliation is low; and vi) the home costs of counter-retaliation are low. Cline (1983) concludes that due to the unilateral nature of a trade policy based on strict reciprocity, which may precipitate potential retaliation by foreign countries or trade wars, such trade policy may lead to welfare losses to both the home and the foreign countries. Moreover, even if the foreign country did not retaliate, the home country would suffer from the imposition of additional trade barriers. These barriers would result in higher prices for domestic consumers, in a loss of efficiency as domestic resources would be shifted to inefficient sectors, in a loss of competitive stimulus to technological change, etc. According to Cline (1983), implementing

a trade policy based on strict reciprocity would be a “historic mistake in US policy”. The author hence advises the US to pursue open markets through alternative strategies, such as the use of Articles XXIII and XXVIII of the GATT, or through sectoral and bilateral trade negotiations.⁷

On the contrary, Gadbow (1982) believes that reciprocity is “a step in the right direction” and that the use of Section 301 of the Trade Act of 1974, for example, may be an effective tool for the US to put additional pressure on its trading partners to negotiate reductions in their trade barriers.⁸ The author argues that the US market is more open than foreign market, which leads to a growing US deficit (especially with Japan). Strict reciprocity thus appears as a tool to enhance “fair” trade relations. In addition, he considers that reciprocity is one vehicle to deal with the phenomenon of “arbitrary comparative advantage” in some sectors, such as manufactures.⁹

Although not focused on the welfare consequences of reciprocity, but rather on the political mechanisms underlying trade policies, Dell (1986) demonstrates that reciprocity, whether “general” (at the margin) or “aggressive” (strict), has been, and will continue to be, the way towards freer trade. The author explains that reciprocity is an attractive concept for politicians because the latter adopt a mercantilist approach to trade relations, in which the principle of reciprocity acts as an “insurance against losing out in trade negotiations”. The author, however, argues that under such approach to trade relations, free trade can never be achieved.

Bhagwati and Irwin (1987) offer a comprehensive comparison of the situation in the US at the end of the twentieth century with the situation of Britain at the end of the nineteenth century. While the authors point out to several similarities explaining the return of the “reciprocitarians” in both countries (e.g. their shrinking positions in the world economy, growing trade deficits, slower growth, higher unemployment, among others), they emphasise their diverging ideologies with regard to reciprocity. While

⁷Under Article XXIII of the GATT, a country may seek compensation for “nullification or impairment” of past trade concessions by another country. If the GATT/WTO rules in favour of the complainant and if the affected foreign country refuses to compensate the complaining country, the latter may be allowed to implement retaliatory measures, such as an increase in its tariffs. Under Article XXVIII of the GATT, a country may modify or withdraw previous trade concessions, either by agreement or unilaterally (World Trade Organisation, 2019e).

⁸Section 301 of the Trade Act of 1974 allows the US to enforce US rights under trade agreements and to address “unfair” foreign barriers to US exports (Morrison, 2019).

⁹According to Cline (1983), “arbitrary comparative advantage” refers to the idea that for products in which the traditional bases for trade specialisation (e.g. labor, capital) no longer dominate, the pattern of trade may be arbitrary, and factors such as government intervention may determine which country prevails.

Britain embraced unilateral free trade, the US always searched for reciprocity in trade relations. Bhagwati and Irwin (1987) warn against the “perils” of strict reciprocity as they believe that it may disguise protectionism. In particular, the authors are concerned with the potential use of voluntary import expansions (VIE), which they consider as export protectionist measures, and the misuse of subsidy–countervailing and anti–dumping actions by protectionist interest groups.

More recently, Chow and Sheldon (2018) demonstrate that the principle of strict reciprocity is based on the misconception of elementary economic concepts. According to them, the US bases its trade policies on the idea that international trade is a zero–sum game rather than a positive–sum game. They review the literature on the welfare effects of international trade, from Smith (1976) to Costinot and Rodriguez-Clare (2014), and conclude that the US trade deficit is a structural macroeconomic problem that will not be solved through trade policies. In particular, if the US were to implement additional tariffs, its imports would be reduced, but its exports would also decline due to a real appreciation of the dollar. Furthermore, Chow and Sheldon (2018) signal the potentially harmful unintended long–term effects of such trade policy (retaliation or trade wars) and request the US to provide an alternative and valid justification to the recent series of unilateral tariffs rises. Finally, they are concerned with the deleterious effect of recent US trade policies on the WTO’s authority and relevance.

Although these investigations offer qualitative analysis of the potential welfare effects of strict reciprocity, they do not offer quantitative results with regard to the welfare consequences of the implementation of such trade policy nor with regard to the credibility of such threat. Our analysis aims to fill these shortcomings.

In the following subsection, we review quantitative analyses of recent US trade policies that relate, to some extent, to our scenarios of strict reciprocity.

3.2.2 Empirical Welfare Analyses of Recent US Trade Policies

Analyses of recent US trade policies focus on the macroeconomic consequences of potential bilateral trade wars between the US and several of its trading partners. For example, Bouët and Laborde (2018) provide an evaluation of potential trade wars between the US and Mexico and/or China. Demertzis and Fredriksson (2018) and Hübler and Herdecke (2019) focus on EU response to US tariffs. Studies by Guo et al. (2018), Tyers and Zhou (2019), and Bolt et al. (2019) concern the escalating trade war between the US and China.

The trade war scenarios implemented in previous literature either model measures announced by President Donald J. Trump during its election campaign (Bouët and Laborde, 2018; Guo et al., 2018), or model measures implemented by the US in 2018 (Bown, 2018; Bellora et al., 2018; Hübler and Herdecke, 2019). Some also model random increases in US tariffs and associated retaliation by US trading partners (Tyers and Zhou, 2019; Bolt et al., 2019).¹⁰ While these investigations provide useful results with regard to the welfare consequences of trade wars, none of them focus on the effects of strict reciprocal trade policies on US welfare.

Findings from previous literature are, nonetheless, of interest. Besides acknowledging the deleterious effects of such trade wars on the protagonists and sometimes, on third countries, these investigations often present results with regard to the impacts of a unilateral imposition of additional import duties by the US, which directly relates to this article.

In Bouët and Laborde (2018), a 35 percentage point rise in US global tariffs against Mexico leads to a real appreciation of the US dollar and thus to a decrease in US exports by 3 percent. Impacts on US macroeconomic variables is limited because total US imports are only reduced by 2.8 percent, due to trade deviation effects. When the additional import duties of 35 percent are applied to US imports from China rather than from Mexico, US global exports decrease by about 5 percent. In this case, US welfare decreases by 0.2 percent. Finally, when US tariffs increase by 35 percentage point on imports from both Mexico and China, US global exports decrease by about 8 percent and US welfare decreases by 0.1 percent.

Tyers and Zhou (2019) find similar results: when the US applies unilateral tariffs against Chinese imports, US welfare decreases by 0.15 percent in the short-run. They, however, show that depending on the fiscal policy applied by the US, domestic welfare either decreases by 0.1 percent or increases by 0.2 percent in the long-run.

Bolt et al. (2019) consider a 10 percent rise of US tariffs on Chinese products. Under unilateral imposition of this tariff by the US, the authors demonstrate that the US gross domestic product declines. In this case, US tariffs lead to a higher cost of imported intermediaries and decrease employment. Consequently, US consumption and investment also decline. Finally, the real appreciation of the US dollar undermines US exports. This study confirms previous results.

Hübler and Herdecke (2019) evaluate the welfare impact of US additional duties on

¹⁰These two papers are recent and have not yet been published.

steel and aluminum products at 0.05 percent using Eaton and Kortum (2002)’s model. US welfare also slightly increases (by 0.07 percent) following the unilateral implementation of US tariffs on various Chinese products. Although the US would gain under these scenarios from the imposition of unilateral tariff measures, the authors show that welfare gains to the US from free trade (0.2 percent) or from TTIP (0.1 percent) would be higher than those from the implementation of protectionist measures.

Bellora et al. (2018) also quantify the impact of recent US trade policies applied under Sections 232 and 301. They find that in the short-run, US production costs would increase by 0.5 percent due to restrictive measures on steel and aluminum products and by 0.17 percent due to restrictive measures against China. Consumer prices would similarly increase by 0.09 percent and by 0.48 percent, respectively. In the long-run, the measures against China would cost US\$ 25 billion in bilateral exports to both China and the US.

These studies agree that the welfare loss to the US would be even larger if US trading partners were to implement retaliatory measures.¹¹ Qualitative analyses also confirm the harmful effects of recent US trade policies on US welfare.

Bown (2018) shows that recent US trade policies affect intermediate inputs and consumer goods. Tariffs on the former lead to an increase in the cost of production to US downstream industries. These firms will thus suffer from a decrease in their competitiveness both in the domestic and foreign markets. Tariffs on the latter negatively affect US households by lowering the volume of imports, by reducing their access to foreign varieties, and by raising prices.¹²

Irwin (2017) confirms that protectionism will hurt rather than benefit the US. He demonstrates that restrictive trade measures will not increase jobs in the manufacturing sectors, nor reduce US trade deficits since factors, other than trade, are the cause of US macroeconomic difficulties. Moreover, Irwin (2017) emphasises that US trading partners are now “sure to retaliate”, which was not the case in the 1980s.

¹¹In Hübler and Herdecke (2019) the US gains from the imposition of restrictive trade policies. These gains, however, are reduced when China or the EU implements retaliatory measures against the US.

¹²Indeed, Jean and Santoni (2018) study the impact of US trade policies implemented through December 2018 on US inflation. They find that the additional duties should increase inflation in the US by 0.25 percentage point to 0.38 percentage point. Forecasting a 25 percentage point increase in US tariffs on all Chinese products leads to an increase in US inflation ranging between 0.66 percentage point and 0.99 percentage point. Finally, if the US government follows through the announced additional duties of 25 percentage points on imports of autos and auto parts, US inflation would further increase by 0.67 percentage point to 1.03 percentage point. These results would be reduced to 0.47 percentage points and to 0.73 percentage points if Canada and Mexico were excluded from the additional import duties.

Our results from the “strict reciprocity” scenarios display similar patterns and quantitatively establish that US consumers and workers in downstream industries will lose from US protectionist trade policies. We, however, adopt a forward-looking perspective by evaluating scenarios of strict reciprocity, a principle that is increasingly supported by the Trump’s administration. Furthermore, we compare the scenarios of strict reciprocity with scenarios in which the US trading partners reduce their tariffs on their imports of US goods (by fear of US retaliation), which allows us to conclude on the credibility of the US threat.

3.3 Descriptive Summary of Trade Relations

This section provides summary statistics of US trade relations with its top 10 trading partners. The first subsection focuses on the global patterns of trade between the US and its top 10 trading partners. It also presents information on the global level of protection and on the bilateral level of protection for all regions included in the analysis. The second subsection concentrates on the gaps, or differences, in the levels of protection between the US and China on one side, and the US and the EU on the other side, by sector and by HS6 product line. We focus on these regions since they appear as the main targets of new US trade policies. The analysis at the HS6 product line reveals a clear difference in the tariffs gaps existing between the US and China on one hand and the US and the EU on the other hand. While tariffs gaps between the US and China appear on a large number of products, they remain in a relatively low range. On the contrary, tariffs gaps between the US and the EU appear on few sectors, but may be very large. Finally, the second subsection concludes by reporting the gaps in protection levels between the US and its other top 10 trading partners, by sector.

3.3.1 Global Patterns of Trade

Figure 3.3.1 presents the value of US exports to, and imports from, its top 10 trading partners, as well as bilateral trade balances. Trade between the US and its top 10 trading partners constitute almost 80 percent of US total trade. As previously mentioned, the US has a trade deficit (trade in goods) with most of its main trading partners. In particular, US bilateral trade deficits with China and the EU equaled US\$ 419 billion and US\$ 169 billion in 2018, respectively. Although US bilateral trade deficits with its other trading partners are smaller than with China or the EU, they remain significant. For example,

Figure 3.3.1: US exports, imports and trade balance with its top 10 trading partners, in 2018 (in current US\$ billion)

Rank	Trading Partner	Exports	Imports	Total Trade	Percent of Total Trade	Trade Balance	Trade Balance as a Percent of Bilateral Trade
1	European Union	319	488	807	19.2%	-169	-20.9%
2	China	120	540	660	15.7%	-419	-63.5%
3	Canada	299	319	617	14.7%	-20	-3.2%
4	Mexico	265	347	612	14.5%	-82	-13.3%
5	Japan	75	143	218	5.2%	-68	-31.1%
6	South Korea	56	74	131	3.1%	-18	-13.8%
7	India	33	54	88	2.1%	-21	-24.3%
8	Taiwan	30	46	76	1.8%	-16	-20.5%
9	Brazil	40	31	71	1.7%	8	11.7%
10	Switzerland	22	41	63	1.5%	-19	-29.9%
Total	Top 10 Countries	1259	2082	3341	79.4%	-823	-24.6%
Total	All Countries	1664	2543	4207	100%	-879	-20.9%

Source: Author's calculations based on data from US Census Bureau (2018).

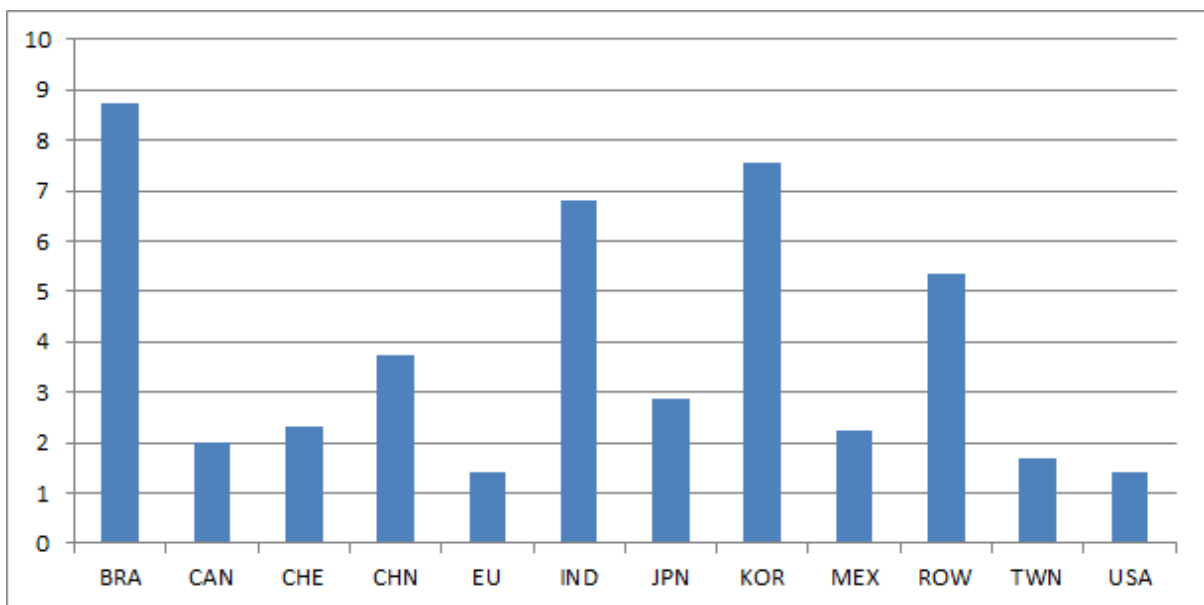
US trade deficit with Japan represents 31 percent of their total bilateral trade. Moreover, Brazil is the only country with which the US runs a trade surplus, equal to US\$ 8 billion in 2018.

Figure 3.3.2 displays the average level of protection by region included in this study.¹³ Brazil reports the highest level of global protection at 8.7 percent, followed by South Korea at 7.6 percent. On the contrary, the US and the EU have the lowest average level of protection at around 1.4 percent, followed by Taiwan at 1.6 percent and by Canada at 2 percent. China's global level of protection equals 3.7 percent.

Figure 3.3.3 shows the average bilateral levels of protection for all regions included in this analysis. The US faces an average protection level of 4.8 percent on its exports to China, while it imposes an average level of protection of 2.6 percent on goods imported from China. Similarly, the US faces an average protection level of 2.1 percent on its exports to the EU, while it imposes an average level of protection of 1.3 percent on goods imported from the EU. South Korea appears as the country with the highest level of bilateral protection against US products (28.3 percent).

¹³The average level of protection is computed by weighting tariffs by bilateral trade, which may underestimate the average level of protection.

Figure 3.3.2: Level of protection by region (in percentage)



Source: Author's calculations based on data from GTAP 9 (2019). The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.3.3: Bilateral level of protection (in percentage)

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		4.3	45.0	2.6	5.1	9.8	1.9	31.0	6.4	5.1	0.6	1.1
CAN	6.7	17.4	7.4	2.8	1.4	16.1	11.3	7.5	0.8	4.7	1.5	0.1
CHE	9.5	3.3		5.2	0.7	9.9	0.4	2.0	1.1	3.8	2.7	1.2
CHN	13.9	4.0	0.4	0.5	3.8	7.2	4.0	6.1	6.3	7.4	2.0	2.6
EU	11.5	3.8	4.1	7.7	0.0	9.5	4.8	7.9	0.4	5.8	2.8	1.3
IND	5.6	4.3	0.9	2.0	2.4		1.0	15.0	11.1	6.6	2.1	2.2
JPN	13.6	2.8	7.2	6.4	3.3	8.3		4.9	3.2	7.9	2.4	1.2
KOR	14.4	10.0	4.9	5.1	1.1	7.5	2.1		7.7	7.9	1.0	1.1
MEX	2.5	0.1	4.3	5.2	0.2	3.9	22.0	4.0		3.4	1.6	0.1
ROW	3.1	1.8	0.7	1.4	1.4	5.3	1.2	4.0	5.6	3.8	1.0	1.1
TWN	10.5	1.7	1.4	3.4	2.3	6.9	1.4	1.9	4.8	4.4		1.5
USA	7.5	1.2	0.7	4.8	2.1	8.4	7.5	28.3	0.2	4.3	1.6	

Source: Author's calculations based on data from GTAP 9 (2019). The list of abbreviations and their correspondences is provided in Appendix A.

Since we are interested in the US top 10 trading partners, with a special focus on China and the EU, we consider in the subsequent sections trade relations between the US and China on one side, and between the US and the EU on the other side: China and the EU represent the two most important trading partners of the US that have not entered into a free trade agreement with the latter. We then examine trade relations with the US and its top 10 trading partners, excluding Canada and Mexico. Although US trade with Canada and Mexico represented 14.7 percent and 14.5 percent of US total trade in 2018, respectively, we do not shock Canada nor Mexico's trade policies because renegotiation of the North American Free Trade Agreement (NAFTA), which started in mid-2017, led to a new free trade arrangement (USMCA) between the three countries at the end of 2018.

3.3.2 Gaps in Protection Levels

Figure 3.3.4 presents the structure of import duties between the US and China, by sector. The gap, or difference, in the levels of protection between the US and China is negative in ten sectors: animals and animal products, chemical, rubber and plastic products, crops, fishing, machinery and equipment, manufactures, meat and dairy products, motor vehicles and parts, petroleum and coal products, and processed food. In these sectors, the US applies lower tariffs on its imports from China than the tariffs applied by China on its imports of US products. The gap is the largest in the motor vehicles and parts sector. In this sector, the US applies a tariff equal to about 1 percent on imports from China, whereas China applies a tariff equal to 22 percent on imports from the US.

Figure 3.3.5 displays the differences in import duties applied by the US on Chinese products and by China on US goods, by HS6 line. The gap in tariffs between the US and China is negative for 4,317 HS6 lines out of 5,206 HS6 lines. In other words, US tariffs on imports from China are lower than Chinese tariffs on imports from the US in 83 percent of all HS6 lines. Moreover, the tariffs gap is below -5 percent in 65 percent of these 4,317 HS6 lines, and below -10 percent in 30 percent of these 4,317 HS6 lines. When the tariffs gap is negative, it equals on average 8 percent. On the contrary, US tariffs on imports from China are greater than Chinese tariffs on imports from the US in 9 percent of all HS6 lines. When the tariffs gap is positive, it equals on average 5 percent. Tariffs between the US and China are equivalent in 8 percent of all HS6 lines.

We observe the largest negative differences in tariffs between the US and China in

Figure 3.3.4: Level of protection between the US and China by sector (in percentage)

Sectors	Tariffs US imposes	Tariffs US faces	Gap
Animals and animal products	0.4	6.3	-5.9
Chemical, rubber, plastic products	2.7	5.7	-2.9
Coal, oil, gas	0.1	0.0	0.1
Crops	1.4	3.0	-1.6
Electronic equipment	0.3	0.6	-0.3
Fishing	0.0	8.0	-8.0
Forestry	1.6	0.0	1.6
Machinery and equipment nes	1.5	4.6	-3.1
Manufactures nes	1.6	8.3	-6.7
Meat and dairy products	2.8	8.3	-5.4
Metals and metal products	2.2	2.6	-0.4
Mineral and mineral products	4.3	4.5	-0.2
Motor vehicles and parts	0.9	22.0	-21.1
Petroleum and coal products	0.2	3.2	-3.0
Processed food	2.8	8.3	-5.5
Textile	8.9	5.8	3.1
Transport equipment	3.4	2.5	0.9
Wearing and leather products	12.6	7.5	5.1
Wood and paper products	0.5	0.9	-0.4

Source: Author's calculations based on data from GTAP 9 (2019).

vermouth and other wine of fresh grapes (-64 percent).¹⁴ The US applies an import duty equal to 1.0 percent on imports of these products originating from China while China applies an import duty of 65 percent on imports of these products from the US. The tariffs gaps are also highly negative (-45 percent) for motorcycles and cycles.¹⁵ China faces a 0 percent tariff on its exports of motorcycles and cycles to the US while the US faces a 45 percent tariff on its exports of motorcycles and cycles to China.

On the other side, the US applies higher import duties on Chinese ground-nuts (+67 percent), compared to Chinese import duties on US ground-nuts.¹⁶ The gap is also large (+60 percent) on manufactured tobacco and manufactured tobacco substitutes.¹⁷

If China were to reduce its tariffs on its imports of US products on a reciprocal basis, its average tariffs against the US would decrease by 23 percent. On the other side, if the US were to apply unilateral strict reciprocity against China, its average tariffs against China would increase by 80 percent.

Figure 3.3.6 describes the tariff schedule between the US and the EU, by sector. US

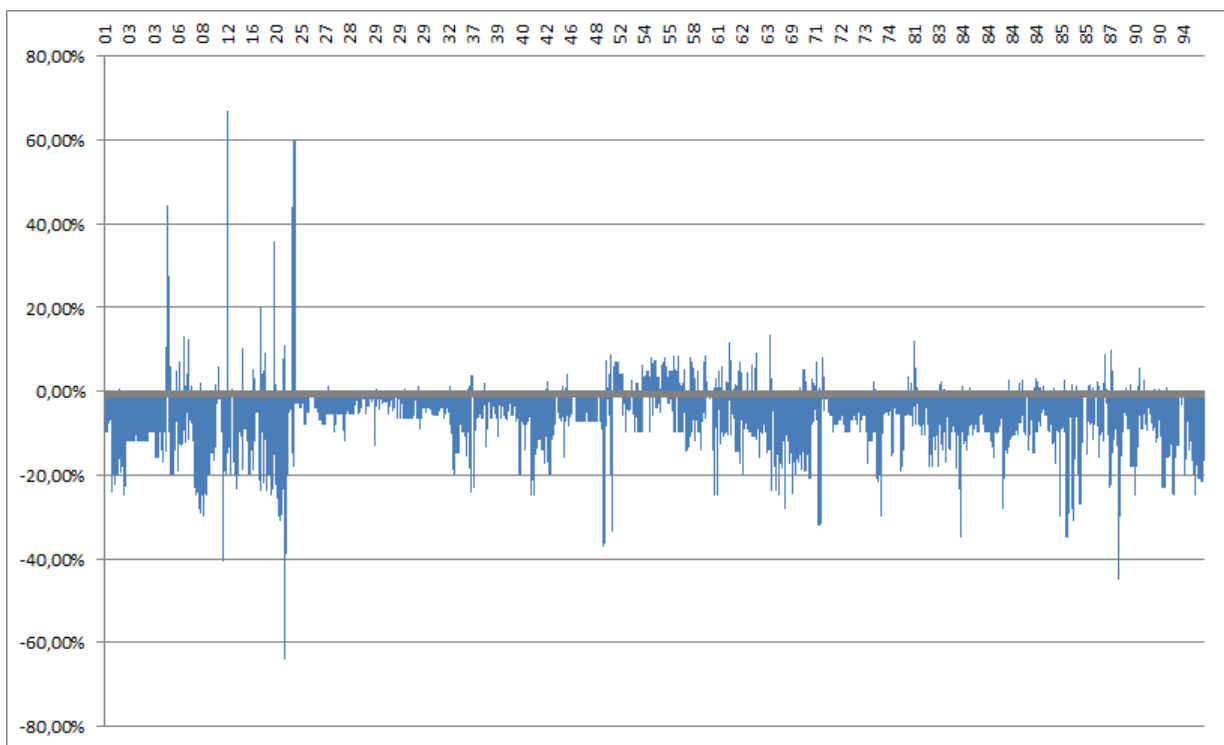
¹⁴HS6 codes 220510 and 220590.

¹⁵HS6 codes 871110, 871120, 871130, and 871190.

¹⁶HS6 codes 120241 and 120230.

¹⁷HS6 codes 240311, 240319, 240391, and 240399.

Figure 3.3.5: Level of protection between the US and China by HS6 line



Source: Author's calculations based on data from MacMap (2016). For clarity purpose, HS2 lines are reported on the horizontal axis. We thank Houssein Guimbar from the CEPII for providing the MacMap database.

Figure 3.3.6: Level of protection between the US and the EU by sector (in percentage)

Sectors	Tariffs US imposes	Tariffs US faces	Gap
Animals and animal products	1.7	2.4	-0.7
Chemical, rubber, plastic products	1.3	2.1	-0.8
Coal, oil, gas	0.1	0.0	0.1
Crops	2.7	3.2	-0.5
Electronic equipment	0.3	0.6	-0.3
Fishing	0.4	7.9	-7.5
Forestry	0.5	1.1	-0.6
Machinery and equipment nes	0.9	1.3	-0.4
Manufactures nes	0.9	0.9	0.0
Meat and dairy products	8.2	39.9	-31.7
Metals and metal products	1.2	1.8	-0.6
Mineral and mineral products	3.7	1.8	1.9
Motor vehicles and parts	1.1	7.9	-6.8
Petroleum and coal products	1.6	1.8	-0.2
Processed food	1.9	10.3	-8.4
Textile	5.9	6.0	-0.1
Transport equipment	0.1	1.2	-1.1
Wearing and leather products	8.7	7.8	0.9
Wood and paper products	0.2	0.2	-0.0

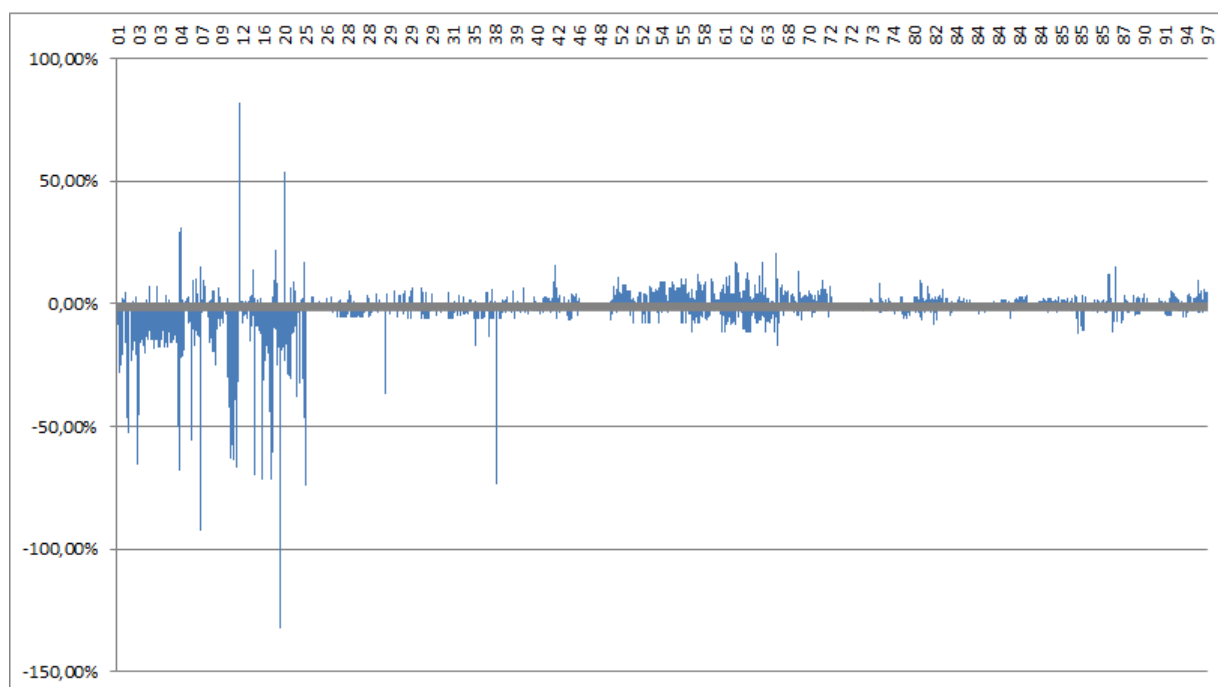
Source: Author's calculations based on data from GTAP 9 (2019).

tariffs are lower than EU tariffs in ten sectors: animals and animal products, chemical, rubber and plastics, crops, fishing, forestry, meat and dairy products, metals and metal products, motor vehicles and parts, processed food, and transport equipment. We observe that gaps between US and EU tariffs, in most sectors, are smaller than those between US and Chinese tariffs. One sector, however, stands out as the gap between US tariffs on meat and dairy products imported from the EU and EU tariffs on meat and dairy products imported from the US reaches 32 percent.

Figure 3.3.7 illustrates the tariffs gaps between the US and the EU at the HS6 product line level. The tariffs gap is negative for 2,498 HS6 lines out of 5,206 HS6 lines. The US applies tariffs on its imports of EU products that are lower than tariffs applied by the EU on its imports of US goods in 48 percent of all HS6 lines. The tariffs gap is below -5 percent in 29 percent of these 2,498 HS6 lines, and below -10 percent in 14 percent of these 2,498 HS6 lines. When the tariffs gap is negative, it equals on average 5 percent. On the contrary, US tariffs on imports from the EU are greater than EU tariffs on imports from the US in 28 percent of all HS6 lines. When the tariffs gap is positive, it equals on average 3 percent. Tariffs between the US and the EU are equivalent in 24 percent of all HS6 lines.

The largest negative tariffs gaps occur on import duties applied by the US and the EU with regard to sugar beet (-296 percent), vegetable preparations (-124 percent), and

Figure 3.3.7: Level of protection between the US and the EU by HS6 line



Source: Author's calculations based on data from MacMap (2016). For clarity purpose, HS2 lines are reported on the horizontal axis and we remove HS6 line 121291 for which the gap equals -296 percent.

mushrooms (-93 percent).¹⁸ On the contrary, the largest positive gaps occur on import duties applied by the US and the EU with regard to ground-nuts (+66 percent to +82 percent).¹⁹ Contrary to tariffs gaps between the US and China, tariffs gaps between the US and the EU exist in a lower number of products, but are larger.

If the EU were to lower its tariffs on US goods, its average tariffs against the US would decrease by 38 percent. On the other side, if the US were to apply unilateral strict reciprocity against the EU, its average tariffs against the EU would increase by 62 percent.

Finally, Figure 3.3.8 presents the gaps in protection levels between the US and its top 10 trading partners, except China and the EU. As expected, gaps in protection levels between Canada and Mexico equal zero in most sectors. The US has, however, a large and negative gap with Canada on meat and dairy products (-46.0 percent), on animal and animal products (-14.5 percent), and on processed food (-8.1 percent).

Furthermore, the US has negative gaps with Brazil, India and South Korea in most sectors, with the largest gap reached between the US and South Korea on trade of crops

¹⁸HS6 code 121291, 200310 and 071151, respectively.

¹⁹HS6 codes 120230, 120241 and 120242, respectively.

Figure 3.3.8: Level of protection between the US and its main trading partners by sector (in percentage)

Sectors	Bilateral tariffs gaps with the USA							
	BRA	CAN	CHE	IND	JPN	KOR	MEX	TWN
Animals and animal products	-2.2	-14.5	-22.2	-11.9	-5.4	-2.2	0	-0.7
Chemical, rubber, plastic products	-6.7	0	0.4	-7	1	-3.1	0	0.5
Coal, oil, gas	0	0	0	0	0	0	0	0
Crops	-6.5	0	1.8	-22.6	-5.3	-253.5	-0.6	-0.6
Electronic equipment	-8.3	-0.1	0.1	-0.6	0	-0.3	0	0.2
Fishing	0	0	0	0	-3.6	-8.5	0	-16.1
Forestry	0	0	0.4	-9.7	0.3	0	0	0.4
Machinery and equipment nes	-11.1	0	0.9	-7.1	0.9	-3.9	0	0
Manufactures nes	-14.9	-0.2	1.6	-9.4	-0.7	-13.4	0	1.6
Meat and dairy products	-11.6	-46	-91.9	-27.7	-48.9	-16.2	0	-7.9
Metals and metal products	12.3	0	1.5	-8.1	0.8	-1.7	0	1.4
Mineral and mineral products	-3.8	0	0.1	-5.2	1.8	-1.5	0	-2.7
Motor vehicles and parts	-16.9	0	-0.1	-27	0	-6.7	0	-14.4
Petroleum and coal products	0.1	-0.1	1	-3.7	0.8	-2.6	0	0.1
Processed food	-13.2	-8.1	-15.7	-30.6	-19.3	-26.4	-1.5	-5.7
Textile	-15.9	-0.1	0.3	-4.3	0.3	-0.4	0	4.2
Transport equipment	-1.6	-0.1	0.2	-5.6	0	-1	0	3.1
Wearing and leather products	-23.3	-0.2	4.4	-2.9	-10.1	0.1	0	10.2
Wood and paper products	-9.8	0	-2.4	-9.2	-0.2	-0.3	0	0

Source: Author's calculations based on data from GTAP 9 (2019).

(-253.5 percent).

Finally, gaps between the US and Switzerland, Japan and Taiwan are either positive or negative, depending on the type of products traded. For example, the US imposes a lower tariff on its imports of Taiwanese motor vehicles and parts than the tariff imposed by Taiwan on its imports of US motor vehicles and parts whereas it imposes a higher tariff on its imports of Taiwanese wearing and leather products than Taiwan imposes on its imports of US wearing and leather products.²⁰

3.4 Methodology

This section describes the main features of the model, the data, and each scenario run for our investigation.

²⁰To be brief, we do not present the tariff analysis at the HS6 product line for all other US trading partners, but they may be requested from the author.

3.4.1 Model

In this paper, we use the MIRAGRODEP model, developed by David Laborde and Antoine Bouët. MIRAGRODEP has already been used in several analyses of international trade and trade policy, such as Bouët et al. (2014), Bouët et al. (2017), Laborde and Martin (2018), and Bouët and Laborde (2018). MIRAGRODEP is a recursive dynamic multiregion, multisector general equilibrium model calibrated on the GTAP database and based on the MIRAGE (Modelling International Relations under Applied General Equilibrium) model.²¹ As previously mentioned, one of the main advantages of using a CGE model over new quantitative trade models (NQTMs) lies in its detailed production structure and linkages, which allows us to predict changes in industry-level production and trade flows in response to trade reforms. Beyond quantifying the global welfare impact of reciprocal taxes, using a CGE model allows us to disentangle the welfare implications of such trade policy and to conclude on its desirability.

MIRAGRODEP is a CGE model with perfect competition and constant returns to scale. It represents the government as a different entity from households, which allows its users to assess the impacts of shocks on the public and private sectors separately.

MIRAGRODEP distinguishes between five factors of production: skilled labor, unskilled labor, natural resources, capital and land. While skilled workers are assumed to be perfectly mobile across sectors of production, unskilled workers are not assumed to be perfectly mobile across sectors.

On the production side, total output is a Leontief function of total value added and of total intermediate consumption. Therefore, there is no possibility of substitution between the two aggregated inputs. Total value added is a constant elasticity of substitution (CES) function of unskilled labor, land, natural resources and a capital-skilled labor bundle. Factors of production are thus imperfect substitutes. Total intermediate consumption is a CES function of intermediate consumption of each commodity used in the production process.

Households are assumed to be homogeneous and own all factors of production. Households' savings are a fixed proportion of their income net of direct taxes. The rest of their income is dedicated to consumption.

²¹The MIRAGE model, developed by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), is a CGE model for trade policy analysis. For further information on the MIRAGE model, see Bchir et al. (2002), and Decreux and Valin (2007).

Government income consists of taxes collected on production, on factors of production, on exports, on imports, on consumption, and on households' income. Preferences between goods are characterized by a linear expenditure system–constant elasticity of substitution (LES–CES). This specification allows for changes in the demand structure of each region to be accounted for as its income level changes. Government spending on each commodity is a fixed share of total public expenditure on goods and services. Demand for investment purposes is also characterised by a CES function.

Commodities are assumed to be differentiated by country of origin, following Armington assumption. We further assume that the current account is constant as a percentage of GDP, and that the real exchange rate adjusts to maintain this constraint. Under this assumption, the global trade balance of a region is constant as a percentage of GDP, regardless of potential changes in its trade policy. This assumption reflects the previously–mentioned idea that a country, such as the United States, may not be able to reduce its global trade deficit simply by changing its trade policy, but may need to implement policies designed to increase savings (e.g. fiscal policies). As Chow and Sheldon (2018) state, the United States trade deficit appears as a “structural macroeconomic problem” that will not be solved by new trade policies. Therefore, while the model allows for changes in bilateral trade balances following the implementation of bilateral trade negotiations, it does not allow for changes in global trade balances (as a percentage of GDP).

Finally, in MIRAGRODEP every economic agent balances income and expenditure.²²

3.4.2 Data

All data used in the model comes from the GTAP 9 database. The GTAP 9 database contains information on bilateral trade, transport and protection linkages for 140 regions and 57 sectors. Further information on GTAP 9 database can be found in Aguiar et al. (2016).

In this paper, we aggregate GTAP 9 data into 12 regions and 25 sectors. In particular, we aggregate regions as to obtain the United States and its top 10 trading partners, in 2018: Brazil, Canada, China, European Union, India, Japan, Mexico, South Korea, Switzerland and Taiwan (U.S. Census Bureau, 2018). We aggregate other countries into a larger region, called the rest of the world (ROW).

We aggregate sectors to obtain four agricultural and food sectors (animals and animal

²²For a detailed description of MIRAGRODEP, see Robichaud et al. (2013).

products, crops, meat and dairy products and processed food). We regroup energy products (coal, oil and gas) into one sector. We follow similar aggregation logic for mineral and mineral products, for metal and metal products, for wearing and leather products, and for wood and paper products. We also aggregate utilities into one sector. Finally, we aggregate services into two distinct sectors: transportation services and all other services. We believe that such aggregation strategy allows for a good balance between sufficient disaggregation among sectors and technical considerations. Appendices A and B list all regions and sectors included in the model, with their GTAP correspondences.

3.4.3 Scenarios

This paper aims to verify whether the threat and/or application of reciprocal taxes may be an effective tool for the US to force its trading partners to lower their trade barriers. We build our scenarios in accordance with the previously mentioned game in which: i) the US threatens its trading partners of implementing reciprocal taxes; ii) the US trading partners chooses whether to reduce their own trade barriers on US products; and iii) if the US trading partners maintained their trade barriers, the US decides whether to implement reciprocal taxes on its imports from its trading partners. We thus compare the trade and welfare effects of a situation in which the US trading partners lower their tariffs, by fear of US retaliation, with one in which the US applies unilateral strict reciprocity against its trading partners.

We implement both situations between the US and China, the US and the EU, and the US and its top 10 trading partners, excluding Canada and Mexico.²³ We thus build our analysis on six scenarios. In all scenarios, variations in tariffs are performed at the GTAP sectoral level.

Scenarios 1 and 2 focus on US trade policies vis-à-vis China. Scenario 1 represents a situation in which China, by fear of US retaliation, reduces its tariffs on a bilateral, sectoral, and reciprocal basis to the levels of US tariffs. The US, however, does not change the tariffs it applies on its imports from China. As a result, both China's tariffs on its imports from the US and US tariffs on its imports from China are equal, at the level of US tariffs.²⁴ In scenario 1, China decreases its tariffs on goods imported from the US in

²³As previously mentioned, the US, Canada and Mexico have already renegotiated their free trade agreement. We thus exclude any change in these countries' trade policies vis-à-vis one another from our analysis. We, nonetheless, check the validity of our results by shocking these countries' trade policies. Results are not reported but may be requested from the authors.

²⁴In all scenarios, when US tariffs on its imports from its trading partners are greater than its partners'

ten sectors (see Figure 3.3.4). The reduction in Chinese tariffs corresponds to the “gap”, or difference, between the tariffs that the US faces on its exports to China and the tariffs China faces on its exports to the US. For example, in this scenario, we reduce Chinese tariffs on animals and animal products originating from the US by 6 percent. In scenario 2, the US pursues a policy of unilateral strict reciprocity with China. In other words, the US increases its tariffs on goods from China in all sectors in which Chinese tariffs on US goods are greater than US tariffs on Chinese products. China does not, however, change the tariffs it applies on its imports from the US. Consequently, both US tariffs on its imports from China and China’s tariffs on its imports from the US are equal, at the level of Chinese tariffs.

Scenarios 3 and 4 consider US trade relations with the EU. Similarly, scenario 3 represents a situation where the EU lowers its tariffs on US products, on a bilateral, sectoral, and reciprocal basis. In scenario 3, the EU reduces its tariffs on imports from the US in ten sectors (see Figure 3.3.6). Scenario 4 represents the opposite situation: the US applies unilateral strict reciprocity with the EU.

Finally, scenarios 5 and 6 examine US trade relations with its top 10 trading partners, excluding Canada and Mexico (i.e. Brazil, China, European Union, India, Japan, South Korea, Switzerland, and Taiwan). In scenario 5, these countries reduce their tariffs on their imports from the US, on a bilateral, sectoral, and reciprocal basis. Brazil, India, Japan, South Korea, Switzerland, and Taiwan decrease their tariffs on US imports in 14, 17, 7, 13, 4, and 7 sectors, respectively (see Figure 3.3.8). In scenario 6, the US implements a trade policy based on unilateral strict reciprocity with its top 10 trading partners, excluding Canada and Mexico.

It is worth noting that in scenarios 1, 3 and 5, the US trading partners respect the bound tariff rates agreed upon at the WTO since they lower their tariffs on US products. They do not, however, respect the MFN rule as reductions in tariffs apply only to their imports of US products. In scenarios 2, 4 and 6, the US does not respect the bound tariff rates since it increases its tariffs above these rates, nor does it respect the MFN principle since it raises its tariffs in a discriminatory manner.

tariffs on their imports of US products, we assume that all tariffs are left unchanged.

3.5 Results

This section is divided into three subsections, each focusing on different US trading partners. The first subsection reports results of the two scenarios involving the US and China (scenarios 1 and 2). The second subsection presents results of the two scenarios involving the US and the EU (scenarios 3 and 4). Finally, the third subsection displays results of the two scenarios involving the US and its top 10 trading partners, excluding Canada and Mexico (scenarios 5 and 6).

3.5.1 US Trade with China

In scenario 1, the reduction in Chinese tariffs on US products leads to an increase in Chinese imports of US goods equal to 17 percent and to a decrease in Chinese imports from all of its other trading partners (Figure 3.5.1). In particular, Chinese imports of motor vehicles and parts, and of meat and dairy products from the US increase by 2.9 percent and 2.6 percent, respectively. Moreover, the reduction in Chinese tariffs leads to a real depreciation of the yuan, rendering Chinese exports to the US, and to all its other trading partners, cheaper. As a result, Chinese exports to the US increase by 1.4 percent and Chinese aggregate exports increase by 1.1 percent (Figure 3.5.3). Under this first scenario, the US trade deficit with China decreases by 6.0 percent.

On the contrary, if the US applies unilateral strict reciprocity with China and increases its tariffs on Chinese goods, US imports of Chinese products decrease by 6.4 percent (Figure 3.5.2). To compensate, the US imports more from all of its other trading partners, especially from India (+2.7 percent). Similarly, China increases its exports to all its trading partners, in particular to Mexico (+2.5 percent) and Canada (+2.2 percent). Chinese aggregate exports, however, decrease by 0.3 percent (Figure 3.5.3). The increase in US tariffs leads to a real appreciation of the US\$, which reduces US exports to China by 1.6 percent and US aggregate exports by 0.7 percent. Under this second scenario, the US trade deficit with China decreases by 8.6 percent. The US bilateral trade deficit with China would thus be further reduced if the US applied unilateral strict reciprocity with China.

Figure 3.5.1: Variation in bilateral export volumes (in percentage) - Scenario 1

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		0.4	-0.1	-0.7	-0.0	0.1	-0.1	0.1	0.1	0.1	0.0	0.6
CAN	-0.3	0.1	-0.4	-0.9	-0.4	0.0	-0.3	-0.1	0.4	-0.2	-0.4	0.4
CHE	-0.1	0.6		-0.9	0.0	-0.1	-0.2	0.0	0.7	0.1	-0.1	0.6
CHN	1.0	1.5	1.1	0.4	0.9	1.1	0.7	1.0	1.7	1.0	0.9	1.4
EU	-0.1	0.5	0.0	-1.6	-0.1	0.1	-0.2	0.0	0.6	0.0	-0.1	0.9
IND	0.2	0.6	0.5	-0.1	0.1		0.1	0.3	1.1	0.4	0.2	0.7
JPN	0.0	0.7	0.1	-1.2	0.0	0.1		0.0	0.7	0.1	-0.1	0.8
KOR	0.2	0.9	0.4	-0.6	0.3	0.3	0.0		1.0	0.3	0.3	0.9
MEX	-0.3	0.4	-0.2	-1.1	-0.3	-0.2	-0.4	-0.1		-0.1	-0.2	0.4
ROW	0.1	0.5	0.2	-0.2	0.1	0.3	-0.1	0.2	0.7	0.2	0.1	0.6
TWN	0.1	0.7	0.2	-0.3	0.1	0.2	-0.1	0.1	0.7	0.2		0.7
USA	-0.9	-0.4	-1.1	17.0	-0.9	-0.8	-1.1	-0.9	-0.3	-0.9	-1.1	

Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.2: Variation in bilateral export volumes (in percentage) - Scenario 2

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		0.5	-0.1	-0.5	0.0	0.2	-0.2	0.0	1.0	0.0	0.0	0.8
CAN	-0.4	0.0	-0.5	-1.0	-0.4	0.0	-0.4	-0.3	0.4	-0.3	-0.5	0.6
CHE	-0.2	0.6		-1.1	-0.1	-0.1	-0.3	-0.2	0.8	-0.1	-0.2	1.8
CHN	1.6	2.2	2.0	0.7	1.	1.8	1.4	1.6	2.5	1.6	1.6	-6.4
EU	-0.2	0.5	0.0	-1.0	-0.1	0.1	-0.2	-0.1	0.8	-0.1	-0.2	1.4
IND	0.1	0.4	0.4	-0.5	0.0		-0.1	0.1	1.1	0.2	0.1	2.7
JPN	-0.2	0.8	0.1	-1.0	0.0	0.0		-0.2	0.9	0.0	-0.2	1.9
KOR	0.1	1.0	0.5	-0.5	0.3	0.4	0.0		1.0	0.3	0.2	1.5
MEX	-0.6	0.2	-0.5	-1.1	-0.6	-0.4	-0.7	-0.5		-0.5	-0.6	0.8
ROW	0.1	0.6	0.3	-0.4	0.1	0.4	-0.1	0.2	0.9	0.2	0.0	1.1
TWN	0.0	0.8	0.3	-0.5	0.1	0.3	0.0	0.0	0.8	0.1		1.4
USA	-0.9	-0.2	-1.0	-1.6	-0.8	-0.6	-0.9	-0.9	-0.1	-0.8	-1.0	

Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

It is also worth noting from Figure 3.5.3 that almost all other regions included in the model would benefit from either a reduction in bilateral Chinese tariffs against US products or an increase in US tariffs against Chinese goods. Their aggregate levels of exports rise, except Brazil, Japan and the EU, which would face a reduction in their aggregate exports, under the first scenario.

Moreover, variations in Chinese and US exports follow the same direction, regardless of the scenario under study. Both Chinese and US exports increase (decrease) under the first (second) scenario. US loss in terms of aggregate exports in the second scenario would, however, be higher than Chinese loss under this scenario. This pattern does not, however, replicate when considering Chinese and US welfare (Figure 3.5.4).

Both Chinese and US welfare increase in scenario 1, although Chinese gains (+0.35 percent) are higher than US gains (+0.05 percent). Such increase is expected for the US since the reduction in Chinese tariffs on US goods leads to greater exports from the US to China. US value added increases in many sectors, in particular in the production of motor vehicles and parts (+2.1 percent).²⁵ The real rates of remuneration of all factors of production in the US also increase. Finally, US consumption by households increases for all sectors, which leads to a rise in US welfare in scenario 1.

In China, prices of final private consumption decrease in all sectors, following the reduction in Chinese tariffs on US products. This drop may be explained by lower prices of aggregate imports in China, in all sectors, and results in an increase in households' consumption. Chinese welfare thus increases by 0.35 percent in scenario 1.

Two countries particularly benefit from the reduction in Chinese tariffs on US goods: India and Mexico. Although India suffers from a small loss in its exports to China (-0.1 percent), it re-directs them to all other trading nations included in the model, in particular to Mexico. On the other side, Mexico faces a greater loss in its exports to China (-1.1 percent) but re-directs its exports to Canada and the US. Furthermore, both India and Mexico benefit from cheaper imports from China.

In the second scenario, US welfare decreases by 0.03 percent as a result of increased US tariffs on Chinese goods. Under such measures, the US favours few producers (US value added in manufactures, machinery and equipment, and motor vehicles and parts increase by 5.1 percent, 0.15 percent and 0.23 percent, respectively) to the detriments of all other US producers. Prices of intermediate consumption in the US increase in all sectors. US total output decreases, except in motor vehicles and parts, machinery and equipment, fishing,

²⁵Recall from Figure 3.3.4 that the largest gap between bilateral US and Chinese tariffs appears in motor vehicles and parts.

processed food, petroleum and coal products, and manufactures (i.e. sectors for which the gaps in the levels of protection between the US and China were high). Finally, real rates of remuneration of all factors, but capital, decrease in the US under scenario 2. The rise in the real rate of remuneration of capital in the US remains, however, small: it increases by 0.01 percent whereas the real rate of remuneration of unskilled labor in agricultural sectors decreases by 0.2 percent.

Compared to the US, China benefits from a US policy based on strict reciprocity (Figure 3.5.4). As previously mentioned, although China reduces its exports to the US under scenario 2, it is able to re-direct (and increase) them to all of its other trading partners. Consequently, Chinese value added increases in all sectors, except in motor vehicles and parts, and in manufactures. Moreover, Chinese intermediate consumption increases, except in the above-mentioned sectors. Overall, total output in China increases along with consumption by households.

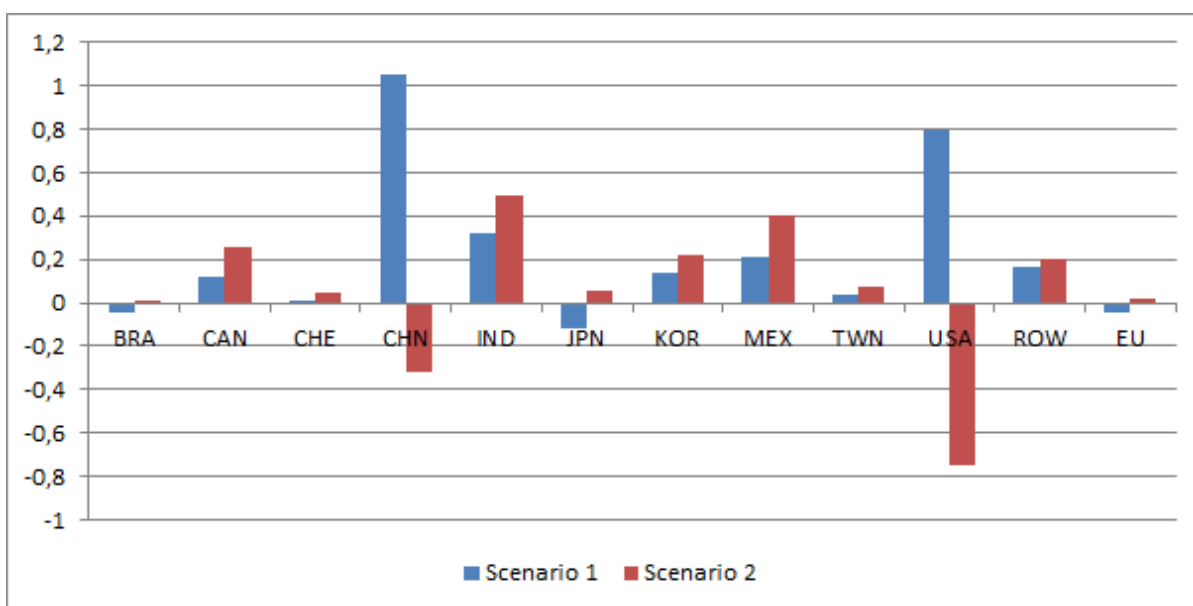
Once again, India and Mexico appear as the main beneficiaries of a change in the bilateral trade policies of either China or the US. In scenario 2, their welfare increases by 0.35 percent and 0.33 percent, respectively. This rise reflects the expansion of both India and Mexico's aggregate exports. In particular, they are the only two countries whose aggregate exports increase by more than 0.4 percent. The development of India and Mexico's aggregate exports is mainly supported by a growth in their exports to the US: +2.7 percent and +0.8 percent, respectively. In particular, India's exports to the US rise in road transportation and services while Mexico's exports to the US increase in mineral and mineral products, transportation services, and in petroleum and coal products.

Three preliminary conclusions emerge from this subsection. First, while the US would be better off if China were to reduce its tariff barriers on US products, it would incur a loss if it were to effectively apply strict reciprocity with China. Second, China would benefit from such policy. Consequently, the USRTA does not appear as a credible threat against China. Third, India and Mexico benefit the most from either a reduction in Chinese bilateral tariffs against the US or an increase in US tariffs against Chinese products.

3.5.2 US Trade with the EU

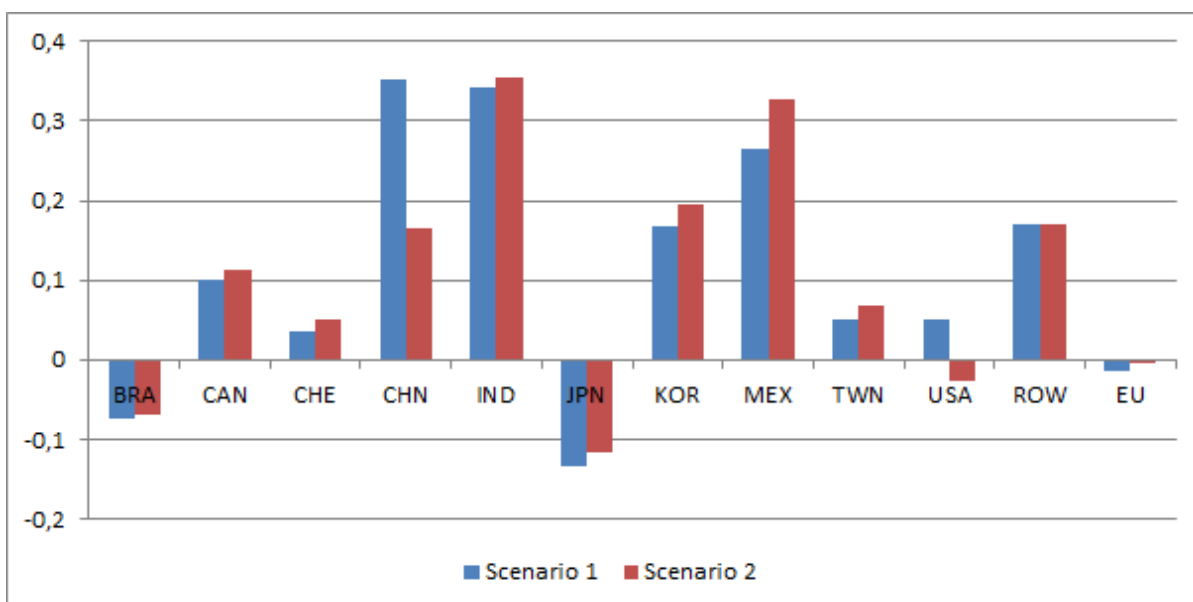
Considering US relations with the EU, we observe that a reduction in EU tariffs on US products, on a sectoral and reciprocal basis, increases US exports to the EU by 3.3 percent (Figure 3.5.5). In particular, US exports to the EU increase in animals and animal products, in meat and dairy products, and in transport equipment. On the other side, an

Figure 3.5.3: Variation in export volumes by region (in percentage) - Scenarios 1 and 2



Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.4: Variation in welfare (equivalent variation) by region (in percentage) - Scenarios 1 and 2



Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

increase in US tariffs on EU products reduces EU exports to the US by 4.7 percent (Figure 3.5.6), as it decreases EU exports to the US in all sectors. In such scenario, the rise in US tariffs leads to a real appreciation of the US\$ and hence to a decrease in US exports to the EU by 1.1 percent and to all of its other trading partners. US aggregate exports decrease by 0.6 percent (Figure 3.5.7). Although the direction of US and EU aggregate exports are identical for each scenario, the magnitude of variations in US aggregate exports is higher than those of EU exports. EU exports seem less affected by changes in trade policies of either the US or itself than US exports.

Figure 3.5.5: Variation in bilateral export volumes (in percentage) - Scenario 3

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		0.2	-0.4	0.2	-0.5	0.1	-0.1	0.1	0.5	0.0	0.1	0.3
CAN	-0.2	0.1	-0.5	0.1	-0.6	0.1	-0.1	0.1	0.3	-0.1	-0.1	0.3
CHE	0.2	0.6		0.4	-0.3	0.1	0.2	0.3	0.7	0.2	0.3	0.6
CHN	0.2	0.6	0.1	0.3	-0.1	0.3	0.2	0.4	0.8	0.3	0.4	0.5
EU	0.2	0.6	0.1	0.5	-0.2	0.4	0.3	0.5	0.8	0.4	0.5	0.7
IND	0.2	0.5	0.2	0.6	-0.1		0.2	0.4	1.0	0.4	0.4	0.5
JPN	-0.2	0.3	-0.4	0.0	-0.6	-0.1		0.0	0.4	-0.1	0.0	0.3
KOR	0.1	0.5	-0.1	0.3	-0.5	0.2	0.1		0.7	0.2	0.4	0.5
MEX	-0.1	0.4	-0.2	0.2	-0.6	0.0	-0.1	0.1		0.0	0.1	0.3
ROW	0.1	0.4	0.1	0.4	-0.1	0.3	0.0	0.3	0.6	0.2	0.2	0.5
TWN	-0.1	0.4	-0.2	0.2	-0.3	0.1	0.0	0.2	0.5	0.1		0.4
USA	-0.7	-0.3	1.0	-0.4	3.3	-0.5	-0.6	-0.5	-0.1	-0.5	-0.6	

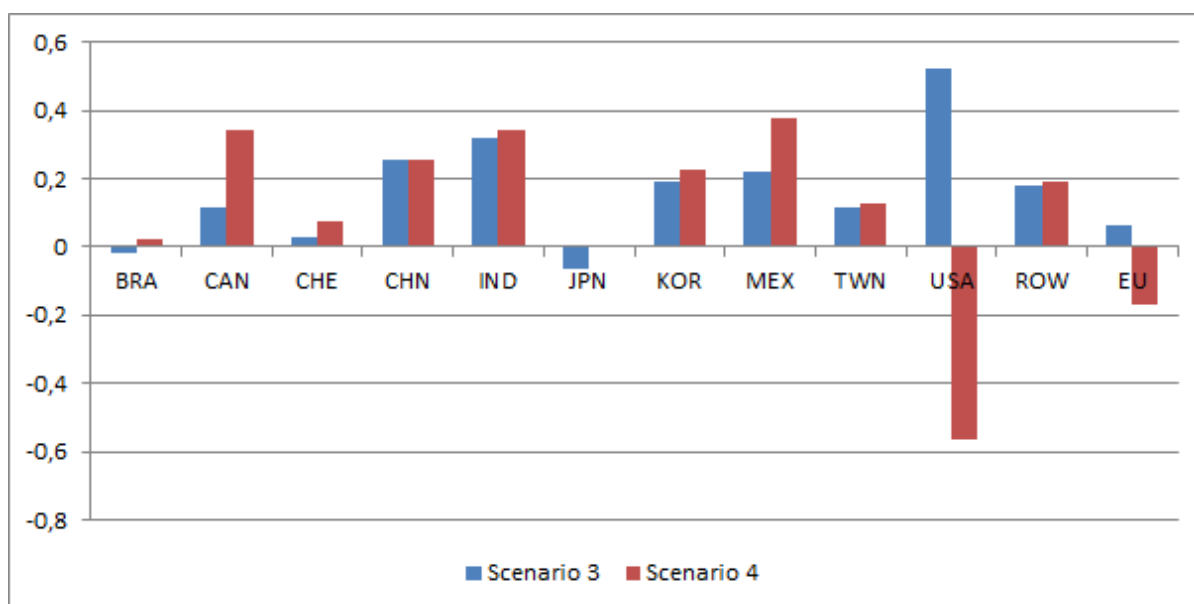
Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.6: Variation in bilateral export volumes (in percentage) - Scenario 4

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		0.4	-0.5	0.2	-0.6	0.0	-0.1	0.1	0.9	-0.1	0.1	0.8
CAN	-0.5	0.0	-0.9	-0.2	-1.0	-0.2	-0.3	-0.2	0.3	-0.4	-0.4	0.8
CHE	0.2	0.9		0.4	-0.3	0.1	0.3	0.4	1.0	0.2	0.4	1.0
CHN	0.2	0.8	0.0	0.3	-0.3	0.3	0.2	0.4	0.9	0.2	0.4	0.7
EU	0.5	1.1	0.3	0.8	0.0	0.6	0.6	0.7	1.3	0.6	0.7	-4.7
IND	0.2	0.7	0.2	0.6	-0.2		0.2	0.4	1.3	0.4	0.4	0.8
JPN	-0.3	0.7	-0.6	-0.1	-0.8	-0.3		-0.1	0.7	-0.2	-0.1	1.2
KOR	0.0	0.8	-0.2	0.2	-0.4	0.1	0.1		0.8	0.1	0.3	1.1
MEX	-0.5	0.4	-0.8	-0.2	1.0	-0.3	-0.4	-0.2		-0.4	-0.3	0.7
ROW	0.2	0.7	0.0	0.4	-0.2	0.3	0.1	0.3	0.9	0.2	0.3	0.8
TWN	-0.1	0.6	-0.3	0.2	-0.5	0.1	0.1	0.2	0.6	0.0		0.6
USA	-0.7	0.0	-1.1	-0.5	-1.1	-0.5	-0.6	-0.4	0.1	-0.6	-0.5	

Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.7: Variation in export volumes by region (in percentage) - Scenarios 3 and 4



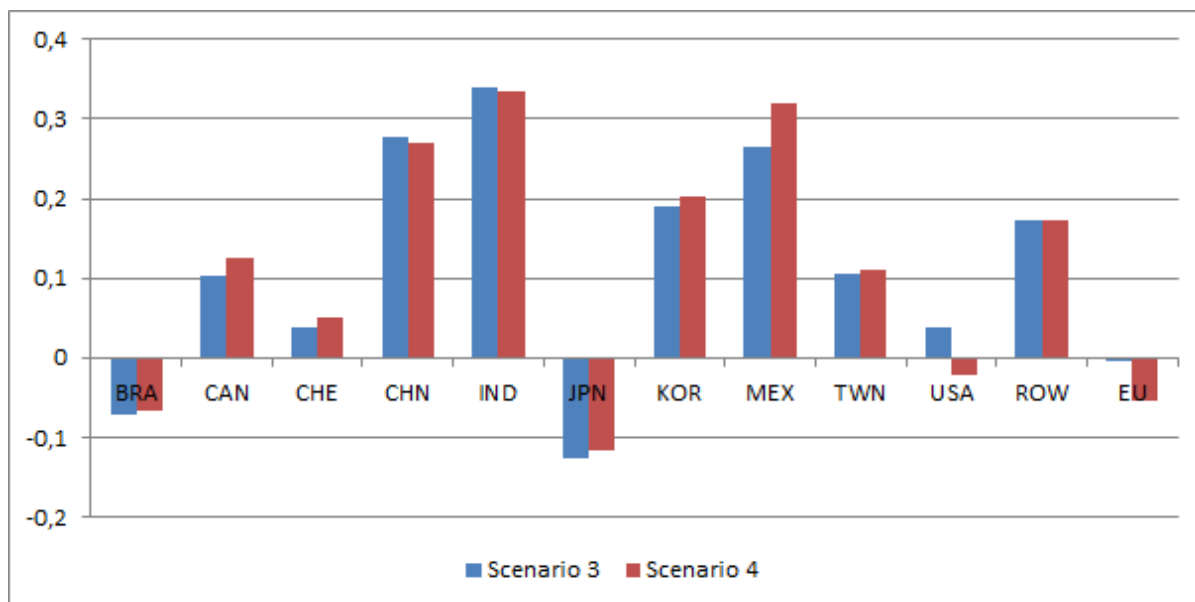
Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.8 reveals that EU welfare is negatively impacted under both scenarios 3 and 4, although variation in EU welfare remains low or negligible (-0.04 percent in scenario 3 and -0.05 percent in scenario 4). In scenario 4, the decrease in EU exports to the US and in aggregate EU exports leads to a reduction in EU value added in several sectors. In particular, EU value added decreases by 1.2 percent, 0.5 percent and 0.4 percent in motor vehicles and parts, processed food, and meat and dairy products, respectively. As in the previous case, these sectors reflected the initial largest gap in protection levels between the US and the EU (Figure 3.3.6). Moreover, the real rate of remuneration of labor decreases in the EU.

Variations in US welfare in scenario 3 and 4 follow similar patterns as in scenarios 1 and 2. While US welfare increases by 0.04 percent when the EU liberalises trade with the US, it decreases by 0.02 percent when the US applies strict reciprocity with the EU.

Variations in welfare of all other US trading partners range within the same values as in scenarios 1 and 2. We find that India and Mexico are, yet again, the main beneficiaries of a change in either EU or US trade policies vis-à-vis one another, along with China. While Chinese welfare gains are smaller in scenario 3 than in scenario 1, they are much higher when the US implements reciprocal taxes against the EU than against China, as expected.

Figure 3.5.8: Variation in welfare (equivalent variation) by region (in percentage) - Scenarios 3 and 4



Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

This subsection emphasises that the US may use the threat of reciprocal tariffs against the EU to force the latter to lower its tariffs on its imports of US products. If the US were to implement this trade policy, the EU would suffer from a welfare loss. On the other side, a decrease in its tariffs on US goods would have a negligible impact on its welfare. It also confirms that India and Mexico benefit the most from changes in the EU or the US trade policies vis-à-vis one another, along with China.

3.5.3 US Trade with its Top 10 Trading Partners, Excluding Canada and Mexico

In this subsection, we first examine the effects of a reduction in bilateral tariffs of the US top 10 trading partners, excluding Canada and Mexico, on their imports of US products, on a sectoral and reciprocal basis.²⁶ Figure 3.5.9 presents variations in bilateral export volumes under scenario 5. This reduction in tariffs leads to higher US exports to almost all of its trading partners. In particular, US exports to South Korea, India, Brazil and Japan

²⁶In this scenario, all regions reduce their tariffs on US goods except Canada, Mexico and the rest of the world.

increase by 49.5 percent, 39.2 percent, 37.8 percent and by 17.7 percent, respectively. As expected, US exports to Canada and Mexico decrease. US exports to the EU and to Taiwan also decrease despite the lowering of their own tariffs on US goods. These results may be explained by the lower number of sectors in which a gap in the level of protection exists between the US and the EU or Taiwan and by the smaller values of such gaps. As expected, the US bilateral trade deficits decrease with India, Japan and, although to a lower extent, China. Moreover, the US bilateral trade surplus with Brazil increases and the US trade deficit with South Korea transforms into a surplus. US bilateral trade deficits with Canada, Mexico and Taiwan, however, increase.

Furthermore, the reduction in bilateral tariffs of the US top 10 trading partners (excluding Canada and Mexico) leads to a real depreciation of their home currency against the US\$ and thus to an increase in their exports to the US and to their other trading partners. Aggregate exports of Brazil, India, Japan and South Korea increase by 2.6 percent, 1.8 percent, 1.7 percent and 4.9 percent, respectively (Figure 3.5.11).

On the other side, when the US applies strict reciprocity against all its top 10 trading partners, except Canada and Mexico, US imports from these countries decrease. Specifically, US imports from Brazil, India and South Korea decrease by 23.2 percent, 18.3 percent, and 9.7 percent, respectively (Figure 3.5.10). The increase in US tariffs leads to a real appreciation of the US\$ and thus to a reduction in US exports to all its trading partners. US aggregate exports decrease by 2.1 percent (Figure 3.5.11). Variations in US bilateral trade balances follow similar patterns in scenario 6 as in scenario 5. Two exceptions are worth noting: i) although the US bilateral trade deficit with South Korea decreases, it does not transform into a surplus; and ii) US bilateral trade deficit with Japan increases. This latter result may be explained by the reduction in US exports to Japan, following the real appreciation of the US\$, combined with an increase in US imports from Japan.

Figure 3.5.9: Variation in bilateral export volumes (in percentage) - Scenario 5

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		5.9	3.1	1.5	2.9	1.5	-5.9	-15.5	7.5	3.3	3.0	7.0
CAN	-6.6	0.3	-2.4	-2.2	-1.6	-5.1	-9.0	-13.2	2.0	-1.4	-2.1	1.3
CHE	-7.2	2.8		-0.6	0.2	-2.2	-1.5	-2.7	3.2	0.3	0.1	3.5
CHN	-6.5	2.8	0.7		0.6	-1.8	-0.9	-2.7	3.1	0.7	0.7	3.4
EU	-5.5	2.0	-0.1	-1.5	-0.1	-2.0	-2.3	-4.0	2.6	0.1	-0.3	3.1
IND	-1.9	3.2	2.1	0.8	1.4		-0.4	-0.8	4.7	1.6	0.7	4.4
JPN	-5.9	4.2	1.8	0.5	1.5	-1.2		-0.6	4.3	1.7	1.6	4.9
KOR	-5.0	5.9	0.2	3.7	0.9	4.8	11.0		3.0	6.0	4.0	6.5
MEX	-7.5	0.3	-2.4	-2.8	-2.4	-3.1	-10.5	-5.7		-2.2	-1.9	0.9
ROW	-3.8	1.9	0.0	-0.6	0.0	-1.2	-1.4	-2.5	2.6		-0.3	2.8
TWN	-6.2	2.3	-0.1	-0.5	0.0	-2.2	-1.1	-1.2	2.3	0.1		2.9
USA	37.8	-2.5	2.6	11.0	-0.45	39.2	17.7	49.5	-2.4	-5.0	-4.2	

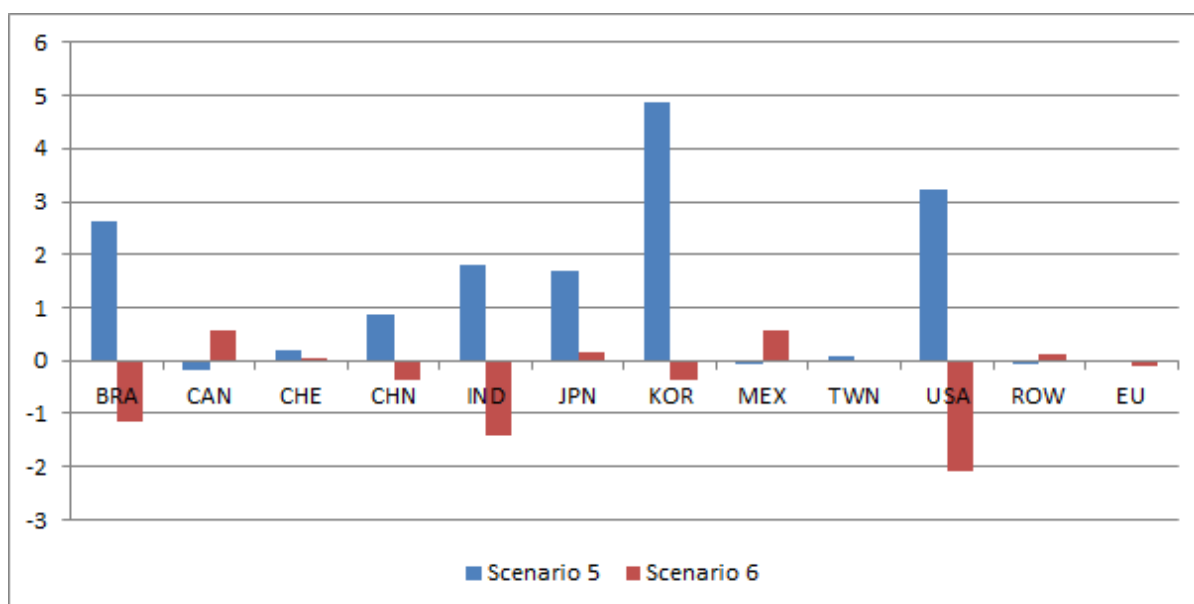
Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.10: Variation in bilateral export volumes (in percentage) - Scenario 6

	Importer											
Exporter	BRA	CAN	CHE	CHN	EU	IND	JPN	KOR	MEX	ROW	TWN	USA
BRA		3.9	2.1	1.1	1.6	0.5	1.7	1.3	5.2	2.1	2.1	-23.2
CAN	-3.2	-0.3	-2.2	-2.1	-2.0	-3.0	-1.3	-1.9	0.5	-1.6	-1.7	1.9
CHE	-1.5	2.1		-0.8	-0.2	-1.6	0.3	-0.6	2.3	0.1	0.2	2.5
CHN	-0.5	3.1	1.4	0.5	1.0	-0.4	1.4	0.6	3.2	1.3	1.3	-5.0
EU	-1.2	2.0	0.3	-0.5	0.0	-1.3	0.5	-0.5	2.5	0.4	0.3	-2.2
IND	0.3	3.9	2.8	1.4	1.9		1.7	1.2	5.0	2.3	1.4	-18.3
JPN	-2.0	2.2	-0.4	-1.2	-0.6	-2.1		-1.0	2.0	-0.3	-0.4	4.5
KOR	-0.5	3.5	1.3	0.5	1.0	-0.5	1.1		3.3	1.2	1.2	-9.7
MEX	-3.9	-0.1	-2.7	-2.5	-2.6	-3.1	-2.2	-2.5		-2.3	-2.2	1.6
ROW	-1.4	1.5	-0.1	-0.5	-0.2	-1.0	0.0	-0.3	1.9	0.0	0.0	2.6
TWN	-1.7	1.9	0.0	-0.5	-0.2	-1.5	0.3	-0.4	1.7	0.1		1.0
USA	-3.5	-0.5	-3.0	-3.2	-2.5	-4.0	-2.1	-3.0	-0.4	-2.3	-2.6	

Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

Figure 3.5.11: Variation in export volumes by region (in percentage) - Scenarios 5 and 6



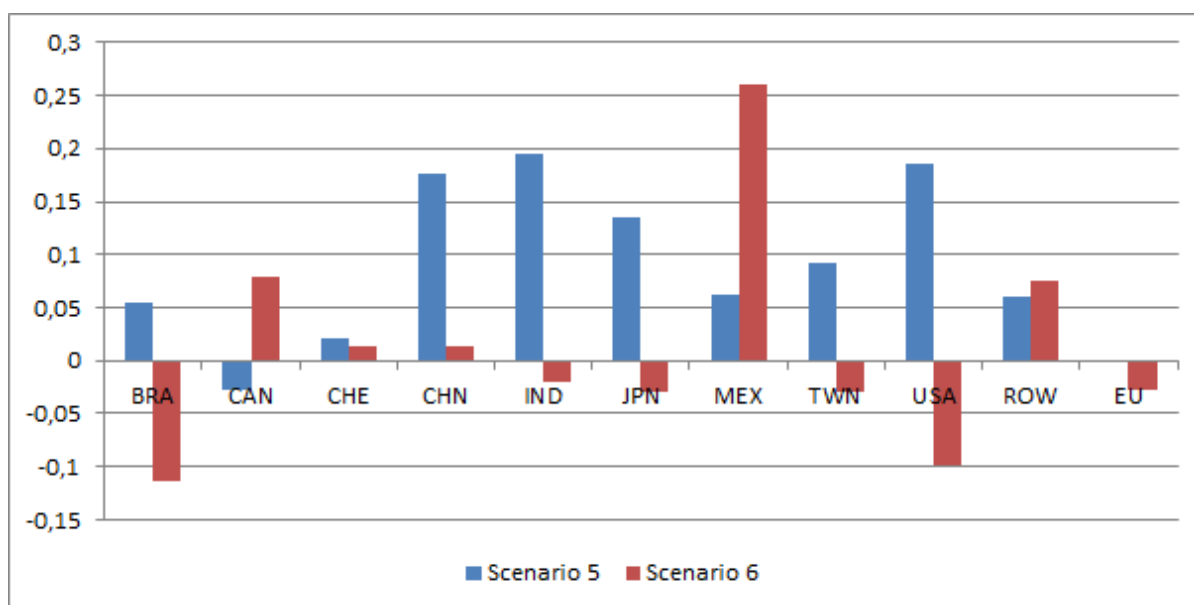
Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A.

The impact of both trade policies on welfare differ by country and scenario. In scenario 5, all US top 10 trading partners, excluding Canada, benefit from a welfare gain, ranging from 0.02 percent in Switzerland to 6 percent in South Korea.²⁷ Mexican welfare increases by 0.06 percent in scenario 1 as Mexican imports from all its trading partners, but the US, increase. Such increase in Mexican imports leads to reduced prices of Mexican imports in all sectors (except in crops, animals and animal products, and meat and dairy products) and to reduced prices of domestic goods in all sectors (except in crops). Consumption by Mexican households increase in almost all sectors. Although Canada also experience an increase in its imports from all its trading partners (except the US), this increase does not compensate for the larger decrease in Canadian aggregate exports. Finally, US welfare increases by 0.2 percent while EU welfare remains constant (as in previous scenarios).

In scenario 6, we observe diverging welfare consequences of the implementation by the US of a trade policy based on strict reciprocity depending on the affected country.

²⁷The large increase in South Korean welfare following the reduction in its trade barriers with the US reflects the country's high initial level of bilateral protection with the US (28 percent) and dispersion in tariff gaps between both countries across sectors. While the US and South Korea charge virtually the same bilateral tariffs vis-à-vis one another in forestry, electronic equipment, wood and paper products, textile, and wearing and leather products, gaps in protection level between these two countries reach 254 percent in crops, 26 percent in processed food, and 16 percent in meat and dairy products.

Figure 3.5.12: Variation in welfare (equivalent variation) by region (in percentage) - Scenarios 5 and 6



Source: Author's calculations. The list of abbreviations and their correspondences is provided in Appendix A. For clarity purpose, the variation in South Korean welfare is not represented. It equals +6.3 percent and -0.1 percent in scenarios 5 and 6, respectively.

Welfare in Brazil and South Korea decrease while welfare in China and Switzerland increase. Compared to countries such as Brazil or South Korea, China's exports to the US decrease by only 5 percent while Switzerland's exports to the US increase by 2.5 percent (Figure 3.5.10). Variations in welfare in India, Japan, Taiwan and the EU are negative, although they remain below 0.1 percent. Canada and Mexico benefit from this discriminatory trade policy, as their respective welfare increase by 0.08 percent and by 0.3 percent. Once again, US welfare decreases (-0.1 percent) under a scenario of strict reciprocity.²⁸

Overall, the US has incentives to force its trading partners to reduce their trade barriers as its welfare would increase by 0.2 percent. The threat of retaliation through reciprocal taxes may be credible since the cost to the US of applying this threat would be lower than

²⁸We have run both scenarios 5 and 6 including shocks on Canada and Mexico in our analysis. We find that a decrease in the tariffs of all the US top 10 trading partners leads to an increase in Canadian and Mexican welfare. On the contrary, the implementation of a trade policy based on strict reciprocity by the US on all its top 10 trading partners does not affect Canadian welfare and increases Mexican welfare, as is the case for China. Moreover, US welfare in these scenarios also decreases. We conclude that the US threat of retaliation through reciprocal taxes may not force Canada nor Mexico to further lower their trade barriers. This may be explained by the fact that tariff barriers between the US and Canada and the US and Mexico are already low and only few sectors would be affected by such measure (Figure 3.3.8). All other results hold when including shocks on Canada and Mexico in the analysis.

the benefits the US would incur from the reduction in the trade barriers of its trading partners. This conclusion does not, however, consider any counter-retaliation that may be implemented by the US trading partners.

Furthermore, the US threat of applying reciprocal taxes may not function for several countries. As previously mentioned, China and Switzerland would gain under such scenario, while India, Japan, Taiwan and the EU are virtually not affected. Consequently, a bill such as the USRTA, may only force Brazil and South Korea to negotiate with the US. While the US may rationalise the use of the USRTA to reduce its bilateral trade deficit with South Korea, such justification would be incomprehensible for Brazil, with which the US runs a trade surplus. Implementing reciprocal taxes may thus hurt the US without affecting its trading partners' willingness to negotiate.²⁹ Moreover, while the US threat of implementing reciprocal taxes may have a trade-liberalising effect and be globally beneficial (world welfare increases by 0.2 percent under scenario 5), its effective application would, however, have a negative impact on world welfare (-0.02 percent).

3.5.4 Discussion

In previous subsections, we found that the US would lose from the application of its threat. The US threat of implementing reciprocal taxes is hence not credible. Moreover, we have determined that the US trading partners may benefit from a reduction in their tariffs on US goods. Then, why would the US threaten its trading partners with a non-credible threat? Similarly, why would the US trading partners maintain their tariff rates on US products? This section discusses three potential answers to these questions.

First, the game we analysed was static, rather than dynamic. Considering a repeated game, we may find that the US and/or its trading partners have incentives to keep a strong position i.e. implement a threat that may be irrational³⁰ and/or preserve current tariff rates. With regard to the US position, the US may be able to lend credibility to its irrational threat through a reputation effect (Kreps and Wilson, 1982; Milgrom and Roberts, 1982; Bouët, 1992). In particular, the US may choose to execute its threat, although it is not rational, to build a reputation for future negotiations. If the US decided in the third step not to apply its threat, then its trading partners would know that the US threat was not rational and would not concede in future negotiations. On the contrary, if

²⁹The US trading partners may even be less willing to negotiate under such threat of retaliation by the US and may apply counter-retaliation against the US if the latter were to implement reciprocal taxes.

³⁰A threat may be considered as irrational if its application does not serve the interest of the player who made it (Bouët, 1992).

the US develops this reputation effect, its trading partners may always concede in future negotiations. Similarly, the US trading partners may chose to maintain their tariffs to establish their reputation in trade negotiations.

Second, our study does not consider other issues that are at stake between the US and its trading partners, especially between the US and China. For example, concerns with regard to the protection of intellectual property rights, technology transfers, and the self-proclaimed developing country status of China at the WTO, among others, complicate trade relations and negotiations between the US and China. For instance, China may prefer to maintain its current tariff rates on its imports of US products in order to use it as a bargaining tool in other ongoing conflicts. These problems may thus affect the US and its trading partners' decisions to apply reciprocal taxes and/or to maintain current tariff rates, regardless of the trade and welfare consequences associated with such trade policies. We cannot, however, examine these issues in our model.

Finally, the US may consider the welfare losses associated with the implementation of reciprocal taxes against its trading partners as negligible. We found that US welfare decreases by 0.03 percent, 0.02 percent and by 0.1 percent when the US raises its tariffs on a bilateral, sectoral and reciprocal basis against China, the EU, and its top 10 trading partners (excluding Canada and Mexico), respectively. Moreover, governments may have other objectives than maximizing their exports or their welfare. By way of illustration, Donald J. Trump may prefer to favour few producers who constitute his electorate to the detriments of consumers and producers in downstream industries. In scenario 6, when the US applies reciprocal taxes against its top 10 trading partners (except Canada and Mexico), US value added in manufactures and motor vehicles and parts increases by 5.6 percent and 1.4 percent, respectively. On the contrary, US value added in almost all other sectors decreases under this scenario.³¹

3.6 Conclusion

In this paper, we investigate whether the US may benefit from the threat and/or application of reciprocal taxes. In particular, we use a general equilibrium model, MIRAGRODEP, to quantify the trade and welfare consequences of a reduction in the US trading partners' tariffs on US products, by fear of US retaliation, and of the

³¹Another explanation may be that Donald J. Trump does not (realistically) anticipate the consequences of a policy based on strict reciprocity. This is probable as Donald J. Trump believes that an increase in US tariffs will reduce the US global trade deficit, although such theory is economically not viable.

implementation of strict reciprocity by the US on its main trading partners.

Several results are worth noting. First, US welfare increases in all scenarios involving a reduction in its trading partners' tariffs. Second, US welfare decreases in all scenarios of strict reciprocity applied by the US on its trading partners. This suggests that while the threat of retaliation through reciprocal taxes may be beneficial to the US, the effective application of such threat would undermine the US economy.

Furthermore, this threat does not appear as credible for most of the US trading partners since it is not in the US interest to execute it. Moreover, welfare in China and Mexico rises when the US applies reciprocal taxes on its imports from these two countries. Welfare in many countries, such as Japan, India and Taiwan, is not affected by the implementation of strict reciprocity by the US. Welfare in the European Union may be negatively impacted by such policy, but only if the US applies it to the EU in a discriminatory manner (scenario 4). Finally, welfare in Brazil would decrease if the US were to implement reciprocal taxes, but the US could not justify the use of reciprocity against Brazil based on the balance of payments issue since it runs a trade surplus with Brazil.

We conclude that while the threat of retaliation through reciprocal taxes may result in a global gain, its effective application would reduce the US and the world's welfare. Moreover, since this threat does not seem credible, its sole effect may be to increase tensions between the US and its trading partners, which may hinder, rather than foster, trade negotiations. Although further trade liberalisation on the part of the US trading partners may be desirable, threatening them with a bill, such as the USRTA, may simply be a false good idea.

In an extension of this study, it would be interesting to quantify the difference in terms of welfare (or exports) gains for both the US and its trading partners, if they were to set their tariffs to zero. For instance, what would be the welfare gain of the US if China were to set its tariffs on its imports of US products to zero, and vice versa? Such exercise would allow us to compute a Chinese tariff for which the welfare gains for the US from a reduction of China's tariffs to zero would equal the welfare gains for China following a reduction in US tariffs to zero. This approach would aim at redefining the principles of reciprocity and fair trade: fair trade would no longer be achieved when countries apply strict reciprocity, but when they set tariffs as to reach the above-mentioned equilibrium.

3.7 Appendices

Appendix A. List of regions included in the model and GTAP correspondences

Region title	Region label	GTAP regions
Brazil	BRA	BRA
Canada	CAN	CAN, XNA
China	CHN	CHN, HKG
European Union	EU	AUT, BEL, CYP, CZE, DNK, EST, FIN, FRA, DEU, GRC, HUN, IRL, ITA, LVA, LTU, LUX, MLT, NLD, POL, PRT, SVK, SVN, ESP, SWE, GBR, BGR, HRV, ROU
India	IND	IND
Japan	JPN	JPN
Mexico	MEX	MEX
Rest of the World	ROW	AUS, NZL, XOC, XEA, KHM, IDN, LAO, MYS, PHL, SGP, THA, VNM, XSE, BGD, PAK, LKA, NPL, XSA, ARG, BOL, CHL, COL, ECU, PRY, PER, URY, VEN, XSM, CRI, GTM, NIC, PAN, SLV, HND, XCA, DOM, JAM, PRI, TTO, XCB, NOR, XEF, ALB, BLR, RUS, UKR, XEE, XER, KAZ, KGZ, MNG, XSU, ARM, AZE, GEO, IRN, TUR, ISR, JOR, ARE, BHR, KWT, OMN, QAT, SAU, XWS, EGY, MAR, TUN, XNF, NGA, SEN, BEN, BFA, CIV, GHA, GIN, TGO, XWF, CMR, XCF, ETH, KEN, MDG, MWI, MUS, MOZ, RWA, TZA, UGA, ZMB, ZWE, XEC, BWA, ZAF, NAM, XSC, XTW
South Korea	KOR	KOR
Switzerland	CHE	CHE
Taiwan	TWN	TWN
United States of America	USA	USA

Source: Author's calculation.

Appendix B. List of sectors included in the model and GTAP correspondences

Sector label	GTAP sectors
Animals and animal products	CTL, OAP, RMK, WOL
Chemical, rubber, plastic products	CRP
Coal, oil, gas	COA, OIL, GAS
Construction	CNS
Crops	PDR, WHT, GRO, V_F, OSD, C_B, PFB, OCR
Electronic equipment	ELE
Fishing	FSH
Forestry	FRS
Machinery and equipment nes	OME
Manufactures nes	OMF
Meat and dairy products	CMT, OMT, MIL
Metals and metal products	I_S, NFM, FMP
Mineral and mineral products	OMN, NMM
Motor vehicles and parts	MVH
Petroleum and coal products	P_C
Processed food	VOL, PCR, SGR, OFD, B_T
Road transportation	OTP
Services nes	CMN, OFI, ISR, OBS, ROS, OSG, DWE
Textile	TEX
Trade	TRD
Transport equipment	OTN
Transportation services	WTP, ATP
Utilities	ELY, GDT, WTR
Wearing and leather products	WAP, LEA
Wood and paper products	LUM, PPP

Source: Author's calculation.

Chapter 4

General Conclusion

In this dissertation, we propose three independent papers to reflect on the WTO dispute settlement procedure, as well as on the welfare consequences of non-multilateral responses to trade disputes. We first use an empirical model to investigate the determinants of countries' participation in the WTO DSS. In particular, we inquire about the accessibility of the WTO DSS to developing countries. Second, we build a partial equilibrium model of illegal trade to study the welfare effects of smuggling. As demonstrated in our case study, illegal trade may be a viable mean of circumventing disputed measures. Finally, we use a general equilibrium model of trade to determine whether the United States may benefit from the threat and/or implementation of a trade policy based on strict reciprocity. As previously mentioned, unilateral strict reciprocity appears to the United States as a credible tool to respond to trade disputes.

In the **first chapter**, we demonstrate that the WTO DSS is rules-based. The structure of trade appears as a main determinant of countries' probability of filing a dispute before the DSS and of the number of disputes filed. We find, however, that the legal capacity of a country positively affects its participation in the DSS. Countries which lack legal capacity may not recognise trade concerns and may not be able to initiate and/or sustain a formal trade dispute before the DSS. Furthermore, we highlight the importance of a country's capacity to retaliate against a potential respondent in its probability to initiate a dispute. As previously mentioned, the WTO dispute settlement body does not have a sanctioning power. As a result, it relies on complainants to implement retaliatory measures against guilty defendants. Countries who lack such retaliatory capacity may find the WTO DSS worthless: even if they obtain a positive ruling from the DS body, they may not benefit from the removal of the disputed trade measure by the respondent. At a time

of increasing tension in international trade relations and rising protectionist movements across the world, it is important that WTO members engage in a concrete dialogue to find mutually acceptable solutions to reform and reinforce the WTO DSS.

In the **second chapter**, we consider the emergence of smuggling following trade disputes. As our case study demonstrates, illegal trade offers the opportunity to economic agents, in both the country that has implemented the restrictive measure and in the affected country, to pursue their activities despite trade regulations. In the context of Costa Rica and its import prohibition on avocados imported from Mexico, smuggling is welfare-improving compared to the “no-smuggling” situation. Illegal trade partially compensates for the negative effects of the prohibition. It does not, however, lead to additional gains compared to the “free trade” situation, except if enforcement by public authorities is low. We conclude that smuggling may be a healthy reaction to a bad trade policy because it allows for the preservation of trade relations.

In the **third chapter**, we investigate the welfare effects of a unilateral response to trade disputes. In particular, we focus on the United States implementation of a trade policy based on unilateral strict reciprocity, as this new principle is supported by President Donald J. Trump’s administration, and compare its welfare impacts with those of a reduction in the trade barriers of the trading partners of the United States (by fear of retaliation). We find that although the threat of retaliation through reciprocal taxes may be beneficial to the US, its effective application would weaken the US economy. Furthermore, we demonstrate that the US threat is not rational and may thus not be credible. We conclude that the use of the threat of retaliation through reciprocal taxes, or its implementation, by the United States may create additional tension in trade relations and provoke counter-retaliation from its trading partners, rather than lead to freer trade. Moreover, the implementation of strict reciprocity by the United States would impair the WTO’s authority and imperil the rules-based multilateral trading system.

We believe that these issues are of increasing importance since the WTO DSS may become inoperative. In recent years, the United States has been undermining the WTO DSS by blocking the appointment of new appellate body judges. Consequently, there remains only three judges in the appellate body since October 1, 2018, which represents the minimum number of judges required to hear an appeal. By January 2020, only one judge will remain in the appellate body and all disputes will be frozen at the appeal stage.

Lawyers and economists offer several potential solutions to the WTO DSS deadlock. Charnovitz (2017) suggests allowing the automatic completion of appeals. Andersen et al.

(2017) and Pohl (2017) propose to enable appeals through WTO arbitration. WTO members could also adopt a temporary waiver on appellate review (Payosova et al., 2018). Kuijper (2017) recommends WTO members to appoint appellate body members by voting rather than by consensus. Finally, Payosova et al. (2018) advises constructive discussion and negotiations to reform the DSS so that WTO member countries are no longer concerned by the “overreach” of appellate body reports.¹

Although we have lately observed some momentum among several WTO members’ policymakers to discuss potential reforms of the DSS,² there is no consensus, so far, among politicians nor academics with regard to the right way forward to solve the DSS crisis.

Considering the current WTO DSS deadlock, a first extension of this dissertation could quantify trade benefits provided by the WTO DSS to its members since its inception. A quantitative evaluation of the DSS could raise WTO members’ awareness on the emergency of the situation. Following Mayer et al. (2018), we could quantify the “Cost of Non–DSS” using a gravity model. Such counter–factual analysis could be performed to assess the trade and welfare impacts of trade disputes brought to the DSS, if the latter had not existed. While such exercise may not be carried out for all WTO members because it would involve large and time–consuming data manipulations, it may be replicated for members that are the most involved in WTO litigation (e.g. the United States, the European Union, and China). Concurrently, a qualitative analysis could be conducted within developed and developing WTO members to understand the perceived value of the DSS to governments, industries, and businesses. This investigation could contribute to the debate on potential reforms of the DSS.

Second, a global study on illegal trade may be contemplated. Our case study reveals that illegal trade emerges following the implementation of an inconsistent measure, and that it may be beneficial to the home country. Complementary analyses of the welfare effects of smuggling could verify and potentially generalise our results. Although research on illegal trade is difficult due to the lack of data, simple models of trade, similar to the model used in chapter two of this dissertation, may be applied to other cases involving trade disputes not (yet) solved through the formal WTO adjudication system.

Finally, we would like to further explore US trade policy, especially vis–à–vis China. Beyond the lack of reciprocal taxes, one of the major US trade concerns is the *quid pro quo*

¹For a detailed discussion on the cures of the DSS crisis, see Payosova et al. (2018).

²The European Commission suggested to increase the number of judges in the appellate body and to increase the length of their mission to six to eight years, with one non–renewable, but full–time mandate (Hiault, 2018). Moreover, the European Commission recently proposed to set up an alternative arbitration process that would mirror the function of the appellate body (Chrysoloras and Baschuk, 2019).

policy implicitly imposed by China through which it exchanges market access for transfers of technology capital. Using the MIRAGRODEP model and the study by Holmes et al. (2015), we could compare the benefits accrued to the US if China were to give up on its *quid pro quo* policy with the costs to the US of a trade war with China. We would thus be able to answer the following question: is a trade war between the US and China worthwhile from the US's perspective? Moreover, by integrating the costs to the US of China's *quid pro quo* policy in the MIRAGRODEP model and by modifying it as to make US tariffs endogenous, we could compute an "optimal" US tariff under which China's costs from the trade war would be higher than its gains from maintaining its *quid pro quo* policy. Under such a tariff, China would either stop requiring technology transfers for market access or would suffer from a net loss associated with continued retaliation by the US.

While a trade war initiated by the US against China may lead to the discontinuance of China's *quid pro quo* policy, it may also harm the US economy. As such, it may be in the US's interest to solve this conflict through the WTO DSS. On March 23, 2018, the US filed a complaint (DS542) before the DSS against certain Chinese measures concerning the protection of intellectual property rights (World Trade Organisation, 2018a). As of January 16, 2019, the director general of the WTO composed the panel of experts and both parties are now awaiting for the report of the panel. A formal resolution of this trade dispute may, however, never emerge due to the blockage of the appointment of new appellate body judges by the United States itself.

As long as countries enter into trade agreements with one another, trade disputes will inexorably emerge. If the WTO DSS becomes inoperative, another dispute settlement mechanism will have to be agreed upon, prior to the collapse of the rules-based international trading system. WTO members should be cautious not to abandon a beneficial system for another, potentially more power-based, structure.

Résumé de la thèse en français

Contexte

Les différends commerciaux reflètent des “promesses non-honorées” (Organisation Mondiale du Commerce, 2019a). Ces promesses correspondent aux accords commerciaux conclus entre plusieurs états. L’Organisation Mondiale du Commerce (OMC) représente le plus large groupe de pays ayant signé un ensemble de règles commerciales multilatérales. En effet, les 164 membres de l’OMC ont convenu d’une réglementation sur le commerce de biens et de services, ainsi que sur les aspects commerciaux liés aux droits de propriété intellectuelle. Ces accords ne sont, cependant, pas toujours respectés par leurs signataires, créant de nombreux différends commerciaux entre les pays membres de l’OMC.

Ces différends commerciaux semblent inévitables pour plusieurs raisons. Tout d’abord, le nombre important de pays membres de l’OMC et leur part dans le commerce international augmentent la probabilité d’un conflit commercial. Plus il existe de pays membres de l’OMC et plus ces pays échangent entre eux, plus la probabilité qu’un conflit commercial éclate est forte. Avec 164 pays membres représentant 98 pourcent du commercial international,³ des différends commerciaux ne peuvent qu’émerger entre les pays membres de l’OMC.

Deuxièmement, les gouvernements de ces différents pays membres de l’OMC font face à des pressions protectionnistes de la part de certains groupes qui demandent la mise en place de mesures pour se protéger de la concurrence étrangère. Afin de satisfaire ces groupes potentiellement puissants d’un point de vue politique, certains gouvernements mettent en place des mesures qui restreignent le commerce avec des pays étrangers. Les membres de l’OMC ont, par exemple, imposé 3,604 mesures d’antidumping de 1995 à 2017 afin

³Le commerce des membres de l’OMC représentait 98 pourcent du commerce mondial de marchandises et de services en 2017 (Organisation Mondiale du Commerce, 2018d).

de protéger certaines industries domestiques de la concurrence étrangère (Organisation Mondiale du Commerce, 2019b).

Troisièmement, les opérations de commerce international sont complexes, notamment à cause des barrières techniques au commerce, telles que les règlementation techniques, les normes et les procédures d'évaluation de la conformité. Bien que ces barrières techniques apparaissent parfois comme nécessaires pour que les états atteignent certains objectifs légitimes, tels que la protection de la santé et la sécurité, elles peuvent entraver le commerce international et devenir le sujet de différends commerciaux si elles ne sont pas harmonisées entre les pays membres de l'OMC.

Quatrièmement, il existe des différences de culture entre les pays qui font qu'un produit ou un mode de production accepté dans un pays ne le soit pas dans un autre. Par exemple, la Communauté Européenne a imposé en 1996 une directive qui interdisait l'utilisation de certaines substances ayant une action hormonale dans l'élevage de bétail.⁴ Cette directive a donné lieu à un différend commercial entre la Communauté Européenne et les États-Unis qui a duré dix-huit ans.

Enfin, des différences dans les niveaux de développement entre les membres de l'OMC sont également source de conflits commerciaux. Les échanges entre pays riches et pays pauvres font naître naturellement des conflits. Les pays en développement ont, par exemple, des difficultés à importer des médicaments en provenance des pays riches à un prix abordable.

Cette liste non-exhaustive explique, en partie, l'occurrence et la fréquence des différends commerciaux entre les pays membres de l'OMC. Etant donné que ces différends apparaissent comme inéluctables, nous pouvons nous demander de quelle manière les membres de l'OMC peuvent les gérer?

Le rôle de l'OMC ne se limite pas à organiser des négociations commerciales, ni à fournir un cadre légal au commerce international. Au-delà de ces deux missions, l'OMC arbitre les différends commerciaux existant au sein de ses membres. Pour ce faire, un organe de règlement des différends (ORD) a été mis en place lors de la création de l'OMC. Cet organe ne peut, cependant, pas régler tous les différends se produisant entre ses membres pour plusieurs raisons.

Tout d'abord, seuls les gouvernements peuvent porter plainte à l'OMC. Ces derniers peuvent donc sélectionner les différends commerciaux qu'ils souhaitent soumettre à l'ORD en fonction de leurs intérêts politiques. Davis (2008) montre que la sélection américaine

⁴Directive du Conseil 96/22/EC.

des litiges commerciaux portés devant l'organe de règlement des différends de l'OMC suit une "logique politique" qui favorise les industries bien représentées aux États-Unis. Par conséquent, les autres différends sont soit négociés en dehors du cadre de l'OMC, soit ignorés.

De plus, l'ORD peut ne pas être accessible à certains pays membres de l'OMC de par le coût de la procédure de règlement des différends et de par son manque de pouvoir quant à l'application de ses recommandations. Les pays ne possédant pas une capacité légale suffisante peuvent ne pas reconnaître les mesures mises en place par leurs partenaires commerciaux allant à l'encontre des règles multilatérales et/ou peuvent ne pas porter plainte par manque de juristes, par exemple. De même, les pays n'ayant pas une capacité de représailles suffisante peuvent ne pas porter plainte à l'ORD car ils craignent que les recommandations de ce dernier ne soient jamais mises en place par leurs partenaires, même si ces derniers sont reconnus coupables. Cet argument quant à l'accessibilité de la procédure de règlement des différends de l'OMC, toujours débattu auprès des chercheurs, fait l'objet du premier chapitre de cette thèse.

En outre, l'OMC a des ressources humaines et financière limitées. Ainsi, la procédure de règlement des différends commerciaux peut être longue. Alors que les délais prévus par l'OMC pour résoudre un différend commercial sont de un an sans procédure d'appel et de un an et trois mois avec appel, le délai moyen actuel est de trois ans et demi (voir le Chapitre 1). Certains agents économiques ne peuvent, cependant, pas se permettre d'attendre aussi longtemps qu'un conflit commercial soit réglé. Ainsi, les différends commerciaux (et leur manque de résolution rapide) peuvent donner lieu à du commerce illégal. Le second chapitre de cette thèse s'intéresse à ce commerce illégal.

Enfin, l'ORD apparaît comme une solution multilatérale aux différends commerciaux. Ainsi, il impose certaines contraintes aux pays membres de l'OMC concernant leur politique commerciale,⁵ qui peuvent souffrir d'un manque de souveraineté dans leur décision de politique commerciale. Par conséquent, certains membres de l'OMC décident de mettre en place des politiques commerciales unilatérales (et parfois discriminatoires) afin de gérer leurs différends commerciaux. C'est actuellement le cas des États-Unis qui, ne semblant pas satisfaits de l'ORD, ont décidé de mettre en place des mesures commerciales unilatérales afin de régler leurs conflits commerciaux, notamment avec la Chine. Le troisième chapitre de cette thèse se concentre sur les conséquences de cette mise en place concernant le bien-être économique des pays concernés et du reste du monde.

⁵Les pays membres de l'OMC doivent par exemple suivre les recommandations de l'ORD et suivre la clause de la nation la plus favorisée.

Démarche adoptée et résultats obtenus

Dans le **premier chapitre** de cette thèse, nous exploitons une nouvelle base de données sur les litiges commerciaux initiés au sein de l'OMC, de 1995 à 2014. Nous décrivons les différends initiés durant cette période et identifions des sources possibles de biais concernant la participation des pays en développement à l'ORD. Notre analyse utilise trois modèles économétriques différents pour déterminer la probabilité qu'un pays i initie un litige à l'encontre d'un pays j auprès de l'ORD. Cette probabilité dépend soit de la structure commerciale des deux pays (modèle basé sur les règles), soit des caractéristiques spécifiques aux pays i et j (modèle basé sur un pouvoir unilatéral), soit des relations commerciales et économiques bilatérales entre les pays i et j (modèle basé sur un pouvoir bilatéral).

Nous trouvons que la structure commerciale du pays i avec le pays j explique en partie la probabilité que le pays i porte plainte contre le pays j devant l'ORD. De plus, nous soulignons que la capacité légale du pays i (variable du modèle basé sur un pouvoir unilatéral) et que la capacité de représailles du pays i envers le pays j (variable du modèle basé sur un pouvoir bilatéral) déterminent la participation des pays à l'ORD. Ces résultats sont presque tous confirmés à la fois pour la probabilité qu'un pays porte plainte et pour le nombre de plaintes portées devant l'ORD.

Dans un **second chapitre**, nous utilisons un modèle en équilibre partiel afin de déterminer l'impact du commerce illégal sur le bien-être économique d'un pays. Nous concentrons notre étude sur la récente prohibition des importations d'avocats en provenance du Mexique mise en place par le Costa Rica, le 5 mai 2015. Nous avons choisi cette étude de cas car le gouvernement Mexicain a porté plainte devant l'ORD contre le Costa Rica le 8 mars 2017 (Organisation Mondiale du Commerce, 2017). Un an et neuf mois plus tard, le litige n'était toujours pas résolu, mais un panel d'experts avait été créé. Il est intéressant de noter qu'un commerce illégal d'avocats est apparu avant que le Mexique n'initie sa plainte. En effet, en mai 2016, les autorités douanières du Costa Rica ont saisi 4,100 kilogrammes d'avocats Mexicain importés illégalement au Costa Rica par le Panama.

Après avoir collecté des données uniques sur le commerce, la production et le prix des avocats costa ricains et mexicains, nous estimons que le Costa Rica importe illégalement 4668 à 10232 tonnes métriques d'avocats par an, ce qui représente plus de quatre fois la quantité d'avocats produits localement. De plus, nous démontrons que le commerce illégal améliore le bien-être économique au Costa Rica par rapport à une situation sans

commerce illégal. En revanche, le commerce illégal n'améliore pas le bien-être par rapport à une situation de libre-échange, mais compense partiellement des effets négatifs de cette mesure protectionniste.

Dans un **troisième chapitre**, nous nous demandons si les États-Unis peuvent bénéficier de la menace et/ou de la mise en place d'une politique commerciale basée sur la réciprocité stricte envers ses principaux partenaires commerciaux, notamment envers la Chine et l'Union Européenne. La réciprocité stricte impliquerait une augmentation bilatérale et sectorielle des droits de douane américains pour que ces derniers soient égaux à ceux auxquels les États-Unis font face sur leurs exportations. Nous nous intéressons à cette politique commerciale car le Président américain, Donald J. Trump, soutient cette approche du commerce international. La réciprocité stricte est perçue par les États-Unis comme un moyen de régler ses différends commerciaux. En effet, les États-Unis seraient prêts à augmenter leurs droits de douane de manière réciproque envers ses partenaires commerciaux afin de les forcer à négocier. Dans ce chapitre, nous utilisons un modèle en équilibre général pour quantifier les effets d'une telle politique sur le bien-être économique. De plus, nous déterminons si la menace proférée par les États-Unis à l'encontre de ses partenaires commerciaux est crédible.

Nos résultats indiquent que bien que cette menace génèrerait des gains globaux, son application diminuerait le bien-être économique des États-Unis et du monde. En outre, nous démontrons que, pour la plupart des principaux partenaires commerciaux des États-Unis, la menace brandie par ces derniers n'est pas crédible. Nous concluons qu'en menaçant ses partenaires commerciaux, les États-Unis risquent d'augmenter les tensions entre les pays membres de l'OMC. Une telle attitude pourrait nuire aux négociations commerciales et provoquer des contre-représailles de la part de ses partenaires, au lieu d'ouvrir la voie du libre-échange. Enfin, la mise en place d'une politique commerciale basée sur la réciprocité stricte par les États-Unis déteriorerait l'autorité de l'OMC et nuirait au système commercial multilatéral.

Ces problématiques nous paraissent particulièrement importantes compte tenu du blocage actuel de l'ORD par les États-Unis. En effet, depuis quelques années les États-Unis bloquent la nomination de nouveaux juges au sein du panel d'appel de l'OMC. Par conséquent, il ne reste plus que trois juges au sein du panel d'appel de l'OMC depuis le 1 octobre 2018, ce qui constitue le nombre minimal de juges requis pour entendre un appel. D'ici janvier 2020, il ne restera plus qu'un seul juge et tous les différends commerciaux seront figés si l'une ou l'autre des parties fait appel. Bien que

certaines juristes et économistes aient proposé des solutions pour sortir de cette impasse, il n'existe, pour le moment, aucun consensus entre les pays membres de l'OMC concernant le meilleur moyen de résoudre cette crise. Si l'ORD venait à arrêter de fonctionner, les pays membres de l'OMC seraient certainement plus tentés de résoudre leurs litiges commerciaux via la mise en place de mesures protectionnistes unilatérales.

Extensions possibles

Etant donné l'impasse actuelle dans laquelle se trouve l'ORD, une première extension de cette thèse serait de quantifier les bénéfices obtenus par les pays membres de l'OMC grâce à l'ORD depuis sa création. Une évaluation quantitative de l'ORD pourrait aider les membres de l'OMC à prendre conscience de l'urgence de la situation. Reprenant Mayer et al. (2018), nous pourrions quantifier le "Coût du Non-ORD" en utilisant une équation de gravité. Ce type d'analyse contre-factuelle permettrait d'estimer les conséquences sur le commerce et sur le bien-être économique des disputes initiées à l'OMC, si ce dernier n'avait pas existé. Simultanément, une analyse qualitative pourrait être construite afin de mieux comprendre la perception des gouvernements, des industries et des entreprises de l'ORD, à la fois dans les pays développés et en développement. Cette enquête pourrait contribuer au débat sur les réformes potentielles de l'ORD.

Deuxièmement, une étude globale sur le commerce illégal pourrait être envisagée. En effet, notre étude de cas révèle que du commerce illégal émerge suite à la mise en place d'une mesure protectionniste, et que ce commerce illégal peut être bénéfique. Des études complémentaires pourraient permettre de confirmer et de généraliser les résultats obtenus dans ce second chapitre de thèse. Bien que les recherches sur le commerce illégal soient difficiles à cause du manque de données sur le sujet, des modèles similaires à celui utilisé dans le second chapitre pourraient être appliqués à d'autres cas impliquant des différends commerciaux non résolus dans le cadre de l'ORD.

Enfin, nous souhaiterions continuer d'analyser la politique commerciale américaine, notamment vis-à-vis de la Chine. Au-delà de la réciprocité tarifaire, une problématique importante pour les États-Unis concerne la politique de *quid pro quo* implicitement imposée par la Chine. Grâce à cette politique, la Chine échange l'accès à son marché contre des transferts de technologie et de savoir-faire. En utilisant le modèle MIRAGRODEP et l'étude de Holmes et al. (2015), nous pourrions comparer les bénéfices accumulés par les États-Unis si la Chine arrêta sa politique de *quid pro quo* avec le coût, pour les

américains, d'une guerre commerciale avec la Chine. Nous pourrions ainsi répondre à la question suivante: une guerre commerciale entre les États-Unis et la Chine vaut-elle la peine, du point de vue des États-Unis?

Bien qu'une guerre commerciale initiée par les États-Unis à l'encontre de la Chine puisse mettre fin à la politique chinoise de *quid pro quo*, elle pourrait également nuire à l'économie américaine. Ainsi, les États-Unis pourraient avoir intérêt à résoudre ce litige via l'ORD. Le 23 mars 2018, les États-Unis ont porté plainte devant l'ORD (DS542) contre certaines mesures chinoises concernant la protection des droits de propriété intellectuelle (Organisation Mondiale du Commerce, 2019c). Depuis le 16 janvier 2019, le directeur général de l'OMC a composé un panel d'experts et les deux parties attendent le rapport de ce panel. Une résolution formelle de ce litige pourrait, cependant, ne jamais apparaître car les États-Unis eux-mêmes bloquent la nomination de nouveaux juges au sein du panel d'appel de l'ORD.

Les différends commerciaux sont inexorablement liés aux accords commerciaux passés entre les pays. Si l'ORD devenait inactif, un autre mécanisme de règlement des différends devrait être mis en place, avant que le système commercial international basé sur des règles ne s'effondre. Les membres de l'OMC devraient donc faire attention à ne pas abandonner un système bénéfique, pour une structure potentiellement plus basée sur un pouvoir asymétrique entre les pays.

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Trade Disputes among Members of the World Trade Organization

Abstract: The objective of this dissertation is to explore how WTO members may respond to trade disputes. In chapter one, we empirically investigate whether the WTO DSS is beyond reach of developing countries. We find that while the structure of trade plays an important role in explaining the probability that a WTO member initiates a dispute at the WTO DSS, the legal capacity and the trade retaliatory capacity of a country also affects its participation in the DSS. In chapter two, we aim to determine the impact of smuggling on economic welfare. We build a partial equilibrium model of trade in which we introduce illegal trade and apply this model to the smuggling of avocado in Costa Rica. Our results show that smuggling improves welfare compared to the “no-smuggling” situation. Compared to the “free-trade” situation, smuggling does not always compensate for the negative effects arising from the restrictive trade measure. In chapter three, we use a general equilibrium model of trade to determine whether the United States may benefit from the threat and/or application of strict reciprocity against its main trading partners. We demonstrate that while the threat of retaliation through reciprocal taxes may generate a global gain, its effective application would reduce the United States and the world’s welfare.

JEL Classifications: F13; F14 ; F17; F51 ; D60

Keywords: trade disputes, World Trade Organization (WTO), welfare analysis.

Différends Commerciaux au sein des Pays Membres de l’Organisation Mondiale du Commerce

Résumé: L’objectif de cette thèse est d’étudier comment les pays membres de l’OMC peuvent gérer leurs différends commerciaux. Dans le premier chapitre, nous analysons empiriquement les déterminants de la participation des pays membres de l’OMC à son organe de règlement des différends (ORD). Nous démontrons que la probabilité qu’un pays porte plainte devant l’ORD dépend de sa structure commerciale, mais également de ses capacités légales et de représailles commerciales. Dans le deuxième chapitre, nous déterminons l’impact du commerce illégal sur le bien-être économique. Pour cela, nous construisons un modèle en équilibre partiel dans lequel nous ajoutons du commerce illégal. De plus, nous appliquons ce modèle au trafic d’avocats au Costa Rica. Nos résultats indiquent que le commerce illégal augmente le bien-être économique par rapport à une situation « sans commerce » illégal. En revanche, par rapport à une situation de « libre-échange », le commerce illégal ne compense pas toujours pour les effets néfastes provenant d’une mesure commerciale restrictive. Dans le troisième chapitre, nous utilisons un modèle en équilibre général afin de déterminer si les États-Unis peuvent bénéficier de la menace et/ou de la mise en place d’une politique commerciale basée sur la réciprocité stricte. Nous démontrons que bien que la menace de représailles puisse générer un gain global, sa mise en place réduirait le bien-être économique des États-Unis et du monde.

Mots-clés: différends commerciaux, Organisation Mondiale du Commerce (OMC), analyse de bien-être.