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# **Three essays on non-tariff measures and the role of the World Trade Organization**

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THREE ESSAYS ON NON-TARIFF MEASURES AND THE  
ROLE OF THE WORLD TRADE ORGANIZATION

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"In a nutshell – and at the risk of some simplification – the old world of trade was a world where production systems were national and where obstacles to trade were about protecting domestic producers from foreign competition. By contrast, the new world is a world where production is transnational along global supply chains of goods and services and where obstacles to trade are about protecting the consumer from risks. We are not yet totally out of the old world, we are not totally yet in the new world; we are somewhere."

— Pascal Lamy (former head of the WTO, at the Third Jan Tumlir Lecture, Brussels 2015).

Pour Apolline, Camille & Léopold et tous ceux qui viendraient encore. Apprenez, mes chers enfants, à remettre en question vos certitudes et celles du monde pour trouver en vous la Vérité. Ne vous laissez pas abattre par les difficultés et les échecs, ne vous laissez pas gonfler d'orgueil par vos facilités et vos réussites, mais saisissez-les chacun pour croître en vertu.



## ABSTRACT

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As Pascal Lamy said a few years ago, the world of trade is evolving towards a different game. The old world was rather a game of nations playing with tariffs, going up and down with the political turmoil. The new world is a game of firms and lobbies where non-tariff measures are the new toy, much more complex to predict. It is no longer a game of protection but a game of precaution. It is more necessary than ever to understand how this new world of trade works. It is especially true with the arrival of issues such as nationalism and their protectionist policies (i.e. take the example of Trump), or with the global covid epidemic, and the war in Ukraine. In this thesis, I show the important compass role of the World Trade Organization (WTO) in terms of precautionism (specifically focusing on Specific Trade Concerns). My goal is to bring a new understanding of the way regulations affect trade.

In chapter 2, I construct a theoretical model to understand the economic impact of new regulations (e.g. standards) in three differently shaped trade agreement frameworks: mutual recognition, harmonization, and national treatment. I lay out an upgraded Melitz model with quality standards, and heterogeneous love-for-quality across two countries. The baseline result is that welfare can only improve with quality standards when the distribution of firms across productivity is rather unequal. If this is the case, partners are satisfied with the national treatment framework. However, it is more likely that welfare decreases with higher quality standards. Then, the best framework is mutual recognition.

In chapter 3, with the help of a new database we built, we look at Specific Trade Concerns (STCs). Increasingly present at the WTO, STCs are assumed to signal the most stringent TBTs. However, a TBT STC captures

two effects, due to the policy and to the concern. The existing WTO STC database does not distinguish concern dates from implementation ones, making it unfeasible to produce a correct inference. In fact, one third of all STCs are raised a long time before or after the TBT is in force. By means of a new WTO STC database, a one-to-one match of STCs with respective TBTs notification and enforcement dates is created. Neglecting the timings of notification and concerns leads to biased estimates. Consequently, using our new database, our aim is twofold. First, we check whether the previous literature is correct in using Specific Trade Concerns (STCs) dates to approximate the implementation date of a TBT. Second, the goal is to investigate the trade impact of Specific Trade Concerns (STCs) on technical barriers to trade (TBTs) through various dimensions. With my co-author, we wonder which country is most affected, and when the complaint should be lodged in relation to the introduction of the TBT. We also check the effects on the agricultural and manufacturing sectors. Finally, we ask whether TBT STCs have a long-term impact. We found that TBT STCs decrease trade, except for agriculture and that timing of complaints matters for agriculture and manufacturing, not for all sectors together. Finally, we find some heterogeneity in terms of which country is more impacted. Exporters from non-G20 country seem advantaged by new TBTs from G20 countries, while disadvantaged by new TBTs from non-G20 countries. On the other hand exporters from G20 countries are disadvantaged by TBTs from other G20 countries.

In the fourth chapter, I focus on G20 economies. Indeed, they are more prolific in using the most stringent TBTs (those with STCs) and are more active in GVCs trade. Using the augmented WTO STC database which matches STC with TBT notifications, I create TBT STC categories with different stringency index. The stringency index is based on the reasons of complaints, the number of raised dates by STC, and the time span between two raised dates. I look at the TBT STC impacts on GVC trade, for both upstream and downstream relations. I find a significant impact of TBT STCs

on both forward and backward value added and on GVCs participation. TBTs subject to STC hurt foreign value-added in export and favor domestic value-added. Thus, they are protectionist. The duration of complaints is the best proxy for the stringency of TBT STCs.



## PUBLICATIONS

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### WORKING PAPERS

Chapter 2: Beguin, M. (2021). Harmonization, Mutual Recognition or National Treatment: a Melitz approach (No. 2021010). Université catholique de Louvain, Louvain Finance (LFIN).

Chapter 3: Beguin, M. (2022). Specific Trade Concerns and Technical Barriers to Trade: evidence from a new database (No. 2022023). Université catholique de Louvain, Institut de Recherches Economiques et Sociales (IRES).

Chapter 4: it is yet to be published in a working paper serie.



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Thésée, vainqueur du Taureau de Marathon



painter: VAN LOO Carle (dit), between 1732-1734. Photography licensed under a Creative Commons ; Bob Ramsak / piran café pirancafe.com

I sometimes felt that this doctorate was like the Minotaur in the maze. Sometimes, I no longer knew which way to go. It is only since a few months that I see the end and that I feel ready to fight the Minotaur, like Theseus (name that, interestingly enough, looks like thesis).

While waiting to embellish this section orally during the public defense, I wish to thank some people who particularly helped me to advance in this journey. The genesis of this desire for economic research came from my

time in Detroit, which made me aware of income inequality. This made me choose the study of economics, which I pursued with a research master's degree in labor economics. In the context of research, I would like to thank Muriel Dejemeppe who really introduced me to research during my dissertation on discrimination in hiring. I would also like to thank Patrick Scarmure for calling me and offering me an assistant position that afternoon in July. Thanks also to my thesis advisor Natacha Gilson who allowed me to develop research far from hers but who nevertheless advised me and listen to me in my whole research process. I then thank the other members of my thesis committee, Gonzague Vannoorenberghe and Mathieu Parenti. Gonzague, thank you for the time taken to proofread and comment thoroughly on the first two papers. Thank you also for the questions you gave me about my presentation at the doctoral workshop last year. I would also like to thank Carl Gagné for his welcome at Inrae, in a Covid but very warm atmosphere. Thank you for the time taken to listen to my projects. I also thank you for your presence in the jury. I would also like to thank various people who took time to listen to my research project in its early stages. I will mention Bruno Vanderlinden, Florian Mayneris, Maria Bas, Anne-Célia Disdier, Lionel Fontagné, Angela Cheptea, Alexandre Gohin, Karine Latouche, and Stéphane Turolla. I also thank participants at the PSE summer school (2018), Tinbergen Institute summer school (2019), Warsaw International Economic Meeting (June '22), ETSG (September '22), EcoMod (September '22), IATRC Annual Meeting (December '22) for their comments.

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Finally, I would like to thank my family and my entourage who believed in me despite periods of doubt and who allowed me to move forward. Apolline, thank you for everything, you believed in me more than myself and you helped me to surpass myself. It was not easy to deal with this thesis for all those years, but I want to express my gratitude and appreciation. I could not have done it without you. Papa et maman, thank you for the questions about my thesis when it was sometimes far from your concerns, and thank you for your support throughout this PhD. Thank you to my in-laws for your interest in my research and for the faith in my success.



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## ACRONYMS

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|           |                                                            |
|-----------|------------------------------------------------------------|
| STC       | Specific Trade Concerns                                    |
| TBT       | Technical Barriers to Trade                                |
| NTM       | Non-Tariff Measures                                        |
| SPS       | Sanitary and Phyto-Sanitary Measures                       |
| WTO       | World Trade Organization                                   |
| Qs        | Quality Standards                                          |
| QS        | Quality Standard                                           |
| C-firm    | Constrained firm                                           |
| U-firm    | Unconstrained firm                                         |
| LMC       | Labor Market Clearing                                      |
| OECD      | Organisation for Economic Co-operation and Development     |
| WIIW      | The Vienna Institute for International Economic Studies    |
| UCLouvain | Université catholique de Louvain                           |
| GATT      | General Agreement on Tariffs and Trade                     |
| WIOD      | World Input Output Database                                |
| TiVA      | Trade in Value Added                                       |
| DVA       | Domestic Value Added                                       |
| FVA       | Foreign Value Added                                        |
| AVE       | Ad Valorem Equivalent                                      |
| PTA       | Preferential Trade Agreement                               |
| ITPD-E    | International Trade and Production Database for Estimation |
| WITS      | World Integrated Trade Solution                            |

AVEs AHS Ad Valorem Equivalent weighted average of effectively applied rates

TRAINS Trade Analysis Information System

UNCTAD United Nations Conference on Trade and Development

MFN Most Favored Nation

PPML Poisson Pseudo Maximum Likelihood

TVE Trade Volume Effect

CEPII Centre d'études prospectives et d'informations internationales

OLS Ordinary Least Squares

FE Fixed Effect

ITC International Trade Center

ACRI Additional Compliance Requirement Indicator

GFCF Gross Fixed Capital Formation

FDI Foreign Direct Investment

TTIP Transatlantic Trade and Investment Partnership

US United States of America

CETA Comprehensive Economic and Trade Agreement

GMP Good Manufacturing Practices

NT National Treatment

H Harmonization

MR Mutual Recognition

NTBs Non Tariff Barriers

CAGR Compound Annual Growth Rate



## INTRODUCTION

---

Looking back at the hundreds of years preceding the 21st century, trade was a story of tariff levels, quotas, and a game of nations. Also, free trade was not always on the agenda. The opposition between Malthus and Ricardo is an example of early debates on free trade. Promoting the food autarky in Great Britain, Malthus feared unrestricted free trade (endorsed by Ricardo). According to him, it would lead to an important dependence on imports (in the 1815 Corn Laws).

However, free trade was rapidly introduced among developed nations enabled by new technologies such as railroads, telegraphs, automobiles, and airplanes. Tariff levels and quotas went down. In fact, free trade generated growth and welfare for the nations taking part in it. Great Britain is the best example of the positive effect of free trade on economic growth. Yet, it was also unequally distributed, and many sectors were importantly hurt by free trade policies. Several political and economic shocks altered free trade. The First World War, the Great Recession, and the Second World War forced policymakers from developed nations to rethink the way to trade ([Grampp, 1987](#); [Irwin, 1988](#)).

A more regulated version of free trade was agreed on. New international institutions (the World Bank, the International Monetary Fund, and the General Agreement on Tariffs and Trade) guided it. Such as with the Gold Standard between the 1870s and the 1920s, many developed countries arrived at a consensus for world trade with the Multilateral Trade Agreement in 1927. It was followed by the GATT (General Agreement on Tariffs and Trade) in 1947. GATT brought a new regulatory landscape during the next fifty years. It aimed at increasing market access through multilateral

negotiations (GATT served eight rounds of negotiations on tariffs between 1947 and 1994). The WTO (World Trade Organization) replaced the GATT in 1995. The WTO is the largest international economic organization with 164 members. Some of its objectives are the lowering of quotas and tariffs. Other objectives aim at the establishment of trade agreements between its members, and the standardization of norms. Before explaining those last two objectives, let us dive into the new way of trading that emerged from the reorganization of international production.

### 1.0.1 *The rise of global value chains*

The market is no longer ruled by nations as it was a hundred years ago. Multinationals and exporting firms are the new key players in the trade game. The last decades have changed how trade is viewed because of the change in the production processes: many firms are multinationals and production networks are largely extended across the globe (see figure 13). For the past thirty years, the world has been experiencing a regional decentralization of the production chain. This decentralization has led to an increase in the exchange of intermediate goods. Additionally, small companies can now easily enter into the global market (J. Lee and Gereffi, 2015; Miroudot et al., 2009). Economists call these new networks the "global value chains" (GVCs). The main reasons for the arrival of GVCs are technological progresses. They allowed transportation costs to plummet and to operate services from far away using the worldwide web. Distance was not such an issue anymore. In the same vein, consumers became more likely to buy from far abroad with new technologies facilitating their purchase (e.g., on the internet).

Trade in intermediate goods is assessed using the concept of value added. Intuitively, an intermediate good may be exported from a producing country to another country. This other country may import it to re-export or 'consume' it within its borders. It is therefore important to know the source

and destination of each product to measure trade in value added. This measure is made possible by the data provided by the national accounts and by the input-output databases: WIOD, EORA, and TiVA (to name a few). Within the scientific community, numerous measures of these value chains have emerged to identify the size of trade in intermediate goods. As explained by [Borin and Mancini \(2019\)](#), there are a multitude of ways to measure trade in value added depending on the economic question (see figure 19). One may want to know the number of intermediaries (the length of the value chain, so-called upstreamness). Another may want to measure the share of a country's exports that are home-made (Domestic Value Added). Also, the share of a country's exports that originates from a foreign country (Foreign Value Added) is another interesting information.

As Lamy explains, value-added measures allow a "far more faithful picture of international trade" ([Lamy, 2015](#), p.7). The metric developed to study value chains provides precision on many issues. For example, it allows to estimate the role of value chains in the development of developing countries. It is also possible to investigate the role of international organizations in regulating these value chains, which seems necessary for GVCs to be oiled and to function smoothly ([Ponte and Gibbon, 2005](#); [Porter, 1985](#)).

### 1.0.2 *The rise of non-tariff measures*

As shown in the figure 14, policymakers have progressively, and concomitantly to GVCs, used new objects to regulate trade. Non-tariff measures (NTMs) include all measures used to favor or control exported and imported goods (by public or by private sectors). There are many NTMs ranging from technical to non-technical and export measures. Here is a non-exhaustive list: countervailing duties, safeguards, quotas, rules of origin, SPS (Sanitary and Phytosanitary measures), TBT (Technical Barriers to Trade), subsidies, intellectual properties, etc. An exhaustive list is proposed in the table 22.

As with value chains, there are several ways to measure NTMs economically. The most classical way to take them into account is to calculate one of these three indexes: frequency index, coverage ratio, and prevalence ratio. The frequency index considers the sum of imported products with at least one NTM out of the sum of all imported products. The coverage ratio considers the sum of imported values rather than the volume of imports. The prevalence ratio considers the number of NTMs per product knowing the import volume. Also, another measure is used to interpret the impact of NTMs in relation to the impact of tariffs: Ad-Valorem Equivalents use either prices or trading volume. However, the real challenge is to have the necessary data regarding the price or quantity traded. It remains that this method relies on a dummy accounting for the presence of a NTM concerning a product or sector. The interpretation of the results is complex and highly dependent on the quality of the NTMs data, which are not always reported by the maintaining country ([A.-C. Disdier, Fugazza, et al., 2020](#)).

Due to their large numbers and diversity, the impact of NTMs on trade is not as obvious as with tariffs. It is necessary to make distinctions between each type of NTMs to obtain consistent results. However, even within the same type, it is not clear whether the effect will be clearly positive or clearly negative. For example, TBTs and SPSs aim at correcting market failure ([A.-C. Disdier, Fugazza, et al., 2020](#)). They will be established for reasons such as consumer or environmental protection, or to guarantee quality standards in the production chain. All these reasons can be either favorable or unfavorable to trade. Consumer protection may push up demand, but it may also lead to higher production or administrative costs. One of the major problems with those NTMs will be that the same product will have to follow different levels of measures in different countries, sometimes contradictory. These different levels of measures provide room for the intervention of international organizations such as the WTO.

The WTO wishes to limit the use of trade restrictive measures. Thus, the WTO has defined and adopted, in 1995, the most used NTMs: TBT and SPS

measures. TBTs set technical requirements or standards that must be met (e.g. requirements related to product safety, health, environmental protection, etc.). SPS measures are set to protect against risks to human, animal, or plant health (e.g. requirements for quarantine, testing, certification, etc.). It is stated in TBT and SPS agreements that TBTs and SPSs must not be used to discriminate between domestic and foreign producers, or between domestic and foreign consumers. It must be justified that using these measures is for consumer protection and not to undermine trade. The real problem is that it is difficult to know where the line between protectionism and liberalism lies in this context. To respond to potential spillovers, the WTO has set up the TBT and SPS committee bodies<sup>1</sup>. They bring together member countries that wish to complain about a specific TBT or SPS (which are called TBT and SPS Specific Trade Concerns) and make requests to facilitate trade. As the number of TBTs and SPSs increases over the years, the number of complaints to the WTO is also rising.

### 1.0.3 *The rise of new regulation schemes*

With the multiple failures of the Doha Round of negotiations (2005, 2006, and 2008), the role of the WTO has been weakened. Multilateralism is no longer on the agenda of developed economies. Most of these new NTMs have been included in bilateral trade agreements, the so-called deep PTAs (Preferential Trade Agreements), so as to protect developed markets from potentially disruptive and harmful behaviors from developing countries. The problem has thus become twofold for the WTO. It has to deal with these new forms of trade barriers and with the accumulation of bilateral trade treaties. Those bilateral trade agreements often run counter to the WTO's multilateral principle. All this can undermine trade between WTO

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1. Other tools have been put in place by the WTO to facilitate trade in the face of NTMs numbers: the Trade Facilitation Agreement and the Dispute Settlement body.

members because it discriminates against parties not included in preferential agreements.

#### 1.0.3.1 *The legal frameworks used to facilitate trade*

To facilitate trade in a multilateral or preferential trade agreement, partners commonly use three types of legal frameworks: national treatment, mutual recognition, and harmonization. Note that every country outside of a preferential agreement is discriminated against. In the national treatment scheme, all firms from all origins selling in a destination market must follow the same destination rules. These rules apply to every similar product and service. With mutual recognition, each country approves its partner's standards, and this allows exporters to enter a foreign market with no adaptation costs. In the third legal framework, harmonization, countries agree on common international standards. In chapter 2, I analyze those three frameworks with the famous Melitz trade model and the angle of quality standards. My goal is to figure out why use one framework over another in a given situation.

Whichever legal form of agreement is chosen in a preferential agreement, it contradicts the original idea of the WTO, which aims primarily at multilateralism. However, the WTO itself is considering which legal type of agreement to put in place when settling multilateral agreements. The WTO is initially less inclined towards national treatment and harmonization schemes. Indeed, both tend to be less discriminatory than mutual recognition but might lead towards unnecessary barriers to trade.

#### 1.0.4 *Thesis overview*

This first chapter introduced the different themes which the following chapters will discuss with more focus. From three different angles, the

general idea linking these chapters is to study the impact of NTMs on trade and the role of the WTO.

In the second chapter, I wish to find the legal framework which is the best for welfare. I use of an upgraded Melitz model with quality standards and heterogeneous love-for-quality across two countries<sup>2</sup>. While some firms are not constrained by the presence of a new quality standard, some either adopt it or leave the market. In terms of welfare, I find that quality standards can either improve or hurt it: it mainly depends on the distribution of firms according to productivity. A more unequal distribution has more chance to improve welfare. In the end, when welfare is hurt by standards, the mutual recognition framework is the best for both partners. But when welfare is improved by standards, national recognition remains the best framework.

In the third chapter, I (with my co-author) investigate the impact of Specific Trade Concerns at the WTO. We use a novel approach which questions the previous literature and find that a new methodology must be adopted by this literature to find accurate results. Increasingly present at the WTO, Specific Trade Concerns (STCs) are assumed to signal the most stringent Technical Barriers to Trade (TBTs). However, a TBT STC captures two effects, due to the policy and to the concern. The existing WTO STC database does not distinguish concerns dates from implementation ones, making it unfeasible to infer correctly. By means of our new WTO STC database, we can make a one-to-one match of STCs with respective TBT notifications and enforcement dates. We show that neglecting the timings of notification and concerns leads to biased estimates. Additionally, we found that TBT STCs decrease trade, except for agriculture and that timing of complaints matters for agriculture and manufacturing, not for all sectors together. We also give insights on whether who sets new TBTs and who complains matters. Finally, we look at the long-term impacts of TBT STCs on trade.

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2. This fits better the empirical findings on how firms trade internationally, compared to the previous literature on legal trade framework which focused only on duopoly.

In the fourth chapter, I focus on G20 economies which are more prolific in using the most stringent TBTs (technical barriers to trade) and are more active in GVCs trade. Using the augmented WTO STC database which matches STC with TBT notifications, I create TBT STC categories with different stringency index. With this, I look at their GVC trade impacts, for both upstream and downstream relations. I control for the reasons of complaints, for the number of raised dates by STC, and for the time span between two raised dates. I find a significant impact of TBT STCs on both forward and backward value added and on GVCs participation. TBTs subject to STC hurt foreign value-added in export and favor domestic value-added. Thus, they seem protectionist. The duration of complaints is the best proxy for the stringency of TBT STCs.

Chapter 5 concludes so as to respond to the introduction.

## HARMONIZATION, MUTUAL RECOGNITION OR NATIONAL TREATMENT?

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### A MELITZ COMPARISON OF LEGAL TRADE FRAMEWORKS WITH QSS

#### 2.1 INTRODUCTION

The latest and most developed multilateral trade agreements largely introduce non-tariff measures (NTMs) which include horizontal standards (e.g. electrical plug types) and vertical standards (e.g. CO<sub>2</sub> emission limits). Often, for similar goods or services, the level of those standards differ across partners and this impedes trade. Take the examples of pallets which are subject to the multiplicity of standards, increasing trade costs and disadvantaging specifically low and developing countries with low value added of exports ([Raballand and Aldaz-Carroll, 2007](#)). Indeed, exporting firms need to fit their production to each destination market and, consequently, production costs increase.

To avoid negative trade impacts, trade partners agree on specific legal schemes. Considering the existing trade agreements between countries members of the WTO/GATT, of the Trans-Pacific Partnership (TPP), and of the European Union, there are three types of legal frameworks: national treatment (NT), harmonization (H), and mutual recognition (MR). NT is the minimal framework imposed to WTO partners<sup>1</sup> and to members of the TPP. All firms from all origins selling in a destination market must follow the

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1. See Article III:1 of the GATT 1994.

same destination rules. It is the case for every alike products or services<sup>2</sup>. MR is the minimal framework imposed to EU members (Sykes, 1995). Each country approves its partner's standards, assuming they achieve similar goals<sup>3</sup>. Finally, with H, countries must agree on common standards created by a norm-setting authority outside of the domestic country, such as the ISO organization. All exporters from all origins follow the same rules<sup>4</sup>.

Knowing which framework is the best in terms of economic and welfare effects is not so obvious. Already, by looking at the "minimal" framework allowed, the EU and the WTO differ (i.e. imposing MR or NT, respectively). But, even inside the EU, mutual recognition and harmonization have been promoted concomitantly in different sectors (Klamert, 2015). Mutual recognition seems to fit better certain types of goods or services while harmonization would be more suited to others. This article will compare the welfare impacts of the three legal trade frameworks using a game theory approach<sup>5</sup>. Innovatively, I will introduce a Melitz framework (Melitz, 2003) with vertical differentiation and with quality standards (Qs) imposed by policymakers. The goal is to determine if one framework is preferable.

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2. A historical example of different standards in two economic regions for a similar good is the Citroën DS car headlamp for French and US markets. Between 1940 and 1983, the US regulation only allowed "sealed beam" lights while the European regulation was banning them, forcing Citroën to adapt its production to both countries, although the functionality of headlamps remained identical.

3. For example, in the (potential) future TTIP (Transatlantic Trade and Investment Partnership) between the US (United States) and the EU, the EU will automatically certify tires made in the US. The CETA (Comprehensive Economic and Trade Agreement) introduces this scheme through the recognition of GMP (Good Manufacturing Practices) in many industrial sectors (car industry, machinery, electrical goods, and the pharmaceutical sector).

4. An example of harmonization is also present in the CETA. Canada has recognized several quality measures from the United Nations global forum for the harmonization of automotive standards through the CSB ("Companion Standardization Body"). An external board sets these Qs. Both partners also created a work program on the convergence of safety measures for motorists.

5. It is similar to previous papers in the literature (Costinot, 2008; Lutz and Pezzino, 2012).

The use of a Melitz framework provides new insights comparatively to the previous literature<sup>6</sup>. A handful of papers already compare the social impacts of legal trade frameworks, but none approach them with heterogeneous firms, vertical standards, and heterogeneous love-for-quality. By adapting the Melitz model to Qs, I fill this gap. My model brings important insights not only on welfare but also on entry/exit of firms in the market following the imposition of a new QS and on the quality updates that occurs when countries make a trade agreement.

My main result is that welfare is either increased or decreased with the increase in standards. It mainly depends on the distribution of firms according to their productivity. A more unequal distribution is more likely to improve welfare because firms with a high productivity are more able to benefit from higher prices and lower competition that is induced by the introduction of a higher quality standard. Low productivity firms are more likely to exit the market or to lower their profit by being forced to produce a higher quality than their optimal quality without standard. I find that mutual recognition is the preferred framework for both partners when welfare is negatively impacted by quality standards. Countries with low standards will only make trade agreements with countries having a higher standard if the agreement protects their exporters enough. Mutual recognition does that and it is found to be a Pareto improvement compared with the National Treatment scheme (the minimal agreement scheme). Mutual recognition is also found to be a Nash equilibrium. However, when welfare is positively impacted by quality standards, national treatment remains the best choice.

In the next subsections, I provide a brief summary of the reason why I will use heterogeneous firms and vertical standards to tackle this question.

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6. One Phd thesis from [Laget \(2019\)](#) uses a Melitz framework to study the case of harmonization and mutual recognition. However, the model uses aggregated quality across markets and this ends up to be unresolved. In addition, [Tabarki \(2020\)](#) is also using a Melitz model to study the impact of several types of standards (horizontal, vertical, vertizontal). He only looks at harmonization to find that it is welfare improving for specific conditions, in the case of weak vertizontal standards.

### 2.1.1 *Literature Review of the Economic Analysis of Legal Trade Frameworks*

[Costinot \(2008\)](#) builds a game-theory framework with two symmetric countries to compare MR and NT. In an oligopolistic world, he considers vertical standards (i.e. standards on the quality level). He points out that MR makes governments produce too few standards because they do not account for externalities brought in by the exporting market. As a result, NT is preferable in a world with high consumption externalities while MR is preferred when externalities are low. [Lutz and Pezzino \(2012\)](#) propose a model with two firms in two asymmetric countries. In comparison with [Costinot \(2008\)](#), they enlarge the range of agreements by adding a harmonization setting (H) to MR and NT. [Lutz and Pezzino \(2012\)](#) conclude that MR is always welfare improving compared to NT and H. While those two papers come close to my paper in the fact that they tackle the question with game theory, they do not account for taste differences across countries<sup>7</sup>.

[Geng \(2019\)](#) upgrade the model from [Costinot \(2008\)](#) to account for countries heterogeneity (using non-homothetic preferences depending on per capita income). He shows that NT is preferable to MR the more trade partners are heterogeneous. Similarly, he finds that harmonization can be desirable under specific levels of externalities but not all.

None of the three papers above use a monopolistic competition framework (although it is more realistic). [Grossman et al. \(2021\)](#) do so by using a Venables model of homogeneous firms. They implement heterogeneity in taste-for-variety across countries (i.e. heterogeneity in preference), without taking quality into account<sup>8</sup>. Without externalities, they conclude that MR is the best choice among the three legal frameworks presented above.

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7. Indeed, it is likely that members across the WTO differ in many characteristics such as size, GDP, culture, taste for quality, etc.

8. [Venables \(1987\)](#) builds the first model with homogeneous firms but distinct market shares in different lands.

### 2.1.2 *Why use a Melitz model to study my question?*

The welfare analysis of free trade in the literature has not been unidirectional ([Arkolakis et al., 2012](#)). The Melitz model ([Melitz, 2003](#)) has brought new discernment on the complex welfare impacts of globalization (positive and negative)<sup>9</sup>. The Melitz model implements heterogeneous firms. It is enabled by the increasing availability of data since the early 21st century<sup>10</sup>. Statistical improvement allowed economists to analyze deeper firm characteristics, such as quality. From the Melitz framework comes out contrasting results on free trade.

First, it expands the market size and decreases the price threshold<sup>11</sup>: it encourages the entry of low productive firms (the so-called market-size effect) ([Melitz and Ottaviano, 2008](#))<sup>12</sup>.

Second, inequality among firms grows after globalization, decreasing the consumer surplus because of higher prices in the market<sup>13</sup>.

Third, when adding quality standards in Melitz, a new standard on quality is expected to improve consumers surplus. But, it might also lower the producers surplus. Indeed, it increases development costs (research and ad-

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9. The classic trade models with homogeneous firms using Krugman's monopolistic competition framework present the positive effect of free trade ([Krugman, 1979](#)). Indeed, those models of open markets demonstrate that globalization creates more varieties. In turn, it induces higher competition and improved welfare (through representative consumer utility and firm profit). Even more refined theories show an exhaustive improvement of surpluses for companies and consumers. For example, globalization brings more profits, more market shares, more exports for firms, more varieties, and higher quality for consumers ([Amiti and Khandelwal, 2013](#); [Bas and Berthou, 2017](#); [Fan et al., 2018](#); [Hallak and Sivadasan, 2013](#); [Mangelsdorf et al., 2012](#)).

10. At the start of our century, computer developments have allowed access to larger databases; they became cheaper and much easier to deal with.

11. More firms in the market increase competition, and lowers the price level.

12. Thus, continuing this reasoning, it would be more optimal in terms of productivity and efficiency to have a few large firms. But this increases market power.

13. It is observed in more complex Melitz models such as in [Parenti \(2018\)](#)

ministrative work) to get to this quality (J. Beghin and Bureau, 2001)<sup>14</sup>. This encourages companies to discriminate between customers and destination countries. Indeed, firms sell high quality goods in developed economies with high standard and low quality goods in developing economies with low standards (Clerides and Hadjiyiannis, 2008).

Fourth, firms are not equally impacted by standards. Regulations seem to hurt small exporters the most, even when they sell high-quality goods. L. Fontagné, Orefice, et al. (2015) and Gaigne et al. (2021) specify that high-premium firms are more hit by standardization if they are too small. De facto, with a new standard, they face less differentiation in terms of quality compared to their competitors and this leads to less profit. Unexpectedly, higher quality standard lowers the average quality level because high-premium firms exit the market.

In conclusion, introducing a more refined model such as Melitz brings more understanding of the complex problem of trade regarding welfare, specifically when dealing with quality standards and trade agreements.

The rest of the paper is structured as follows. First, I solve the model when the quality standard (QS) is set to zero. Then, it becomes positive and I find the impact on welfare. Next, assuming heterogeneous standards across countries, I analyze which legal frameworks is the most welfare enhancing. Finally, I discuss my results and conclude.

## 2.2 THE MODEL

Before the game begins, each firm receives its process productivity  $\varphi_{ij}$ , where  $ij$  signals the direction of trade from country  $i$  to  $j$  (i.e.  $i$  represents the domestic/producing country,  $j$  represents the destination market which is either the domestic market  $i$  or the foreign market  $x$ ). Each country has a

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14. The introduction of quality into the Melitz model along with the study of free-trade agreements enables to investigate the welfare impacts of liberalization concerning non-tariff measures

different willingness-to-pay for quality ([Aizenman and Brooks, 2008](#); [Auer, 2010](#); [Fajgelbaum et al., 2015](#))<sup>15</sup>. In the first stage, governments set Qs and make a trade agreement. They choose between NT, MR, or H to maximize national welfare. In the second stage, firms adjust to that new scheme. They enter or not, paying the entry fee sunk cost  $f_e$ . Following [Lugovskyy and Skiba \(2015\)](#), firms can produce one quality level among a continuous interval of quality  $(\underline{\theta}; \bar{\theta})$ . There are two lines of products for each company, one by destination (home or foreign market). Each firm maximizes its profit on quality and price for each line of goods ([Costinot, 2008](#); [Curzi and Olper, 2012](#); [Kugler and E. Verhoogen, 2012](#); [Lutz and Pezzino, 2012](#); [Macedoni and Weinberger, 2022](#))<sup>16</sup>. Cultural, institutional, educational, or revenue dissimilarities could explain why a firm selling the same quality in two markets will face different outcomes and why it might be interesting to sell specific quality for each market.

I first establish the structure of demand and supply. In a world without quality standards, companies and consumers maximize their objective function. They find a common optimal solution for price and quality level. Then, in a world with a positive quality standard, the game is played again

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15. Intuitively, countries set different standards initially ([Fajgelbaum et al., 2015](#)). Heterogeneity in taste between and among markets is explored in several empirical works. For example, [Aizenman and Brooks \(2008\)](#) study those divergences in preference for the industry of beer and wine. They show how culture explains a significant part of the trade patterns, although wine is more consumed in producing countries. Other authors have the same conclusion: international distinction in taste affects the pattern of trade ([Auer, 2010](#); [Bernard et al., 2012](#); [Crozet et al., 2012](#); [A. C. Disdier, Head, et al., 2010](#); [A. C. Disdier, Tai, et al., 2010](#); [Holloway, 2014](#); [Aw-Roberts et al., 2020](#)).

16. [Kugler and E. Verhoogen \(2012\)](#) are the first to use product differentiation in quality in a Melitz model. They try to explain why high quality is observed in some firms and not others, using R&D and advertisements expenditures as fixed quality investments. This quality feature generates a correlation between company size and input prices, which was not present in the original Melitz model. Consequently, they find that quality is a major determinant of the company size and export status (see also [Curzi and Olper \(2012\)](#)). Adding the vertical dimension to my problem also fits better the problem of NTMs since most of them relate to quality issues.

by firms and consumers and a welfare impact of the quality standard is found. Finally, using this welfare result, I discuss the best legal framework agreed on between two countries with different standards.

### 2.2.1 *The Demand*

As in [Melitz \(2003\)](#), consumers follow CES preferences for the differentiated products. A homogeneous aggregate good is available. I dispatched both types of goods into a Cobb-Douglas utility function. Also, I add the heterogeneous "willingness-to-pay for quality" inside the consumer preferences. Intuitively, this plays a major role in the setting of Qs and in the optimal qualities set by each firm for each destination.

Consumer utility  $U$  in a country  $j$  is:

$$U_j = q_{0j}^{1-\mu} \left( \int_{\Omega_{kj}} \left( \theta_j(k)^{\beta_j} q_j(k) \right)^{\frac{\sigma-1}{\sigma}} dk \right)^{\frac{\mu\sigma}{\sigma-1}} \quad (1)$$

Where  $\Omega_{kj}$  is the set of varieties  $k$  available in country  $j$ : it includes varieties either imported from foreign to domestic country or locally produced.  $\sigma > 1$  is the constant elasticity of substitution between varieties;  $\mu$  is strictly between 0 and 1.  $q_j(k)$  is the quantity of the heterogeneous goods attached to variety  $k$  and  $q_{0j}$  is the quantity of the homogeneous good whose price is normalized to 1. Also, note that  $\theta_j$  is one quality level available in market  $j$  that relates positively to the consumer's utility.  $\theta_j$  belongs to the interval  $(\underline{\theta}_j, \bar{\theta}_j)$  with a minimum  $(\underline{\theta}_j)$  and a maximum  $(\bar{\theta}_j)$  level, respectively. A change in Qs will change the minimum quality level  $\underline{\theta}_j$  available in market  $j$ .

Each country has a different "willingness-to-pay for quality" drawn from  $\mathbb{B}$ , a set of continuously distributed  $\beta$ 's:  $\beta_i > 0$  for domestic country ( $j = i$ ) and  $\beta_x > 0$  for foreign country ( $j = x$ )<sup>17</sup>.

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17. If both  $\beta$ 's are equal, it results in a homogeneous countries' model.

### 2.2.2 Cost structure

Firms are heterogeneous in terms of productivity ( $\varphi > 0$ ), which is the ability to reduce production costs. It is exogenously set by a Pareto-distribution over a subset of  $[1, \infty[$  (Chaney, 2008a).  $\varphi_a$  is the lowest bound (equal to 1), and  $\gamma$  (with  $\gamma > \sigma - 1$ ) is the dispersion parameter of the productivity distribution (assumed identical across countries for analytical simplicity). Therefore, ex-ante, the cumulative distribution function is:

$$G(\varphi) = 1 - \left(\frac{\varphi_a}{\varphi}\right)^\gamma \text{ for } \varphi_a \leq \varphi \quad (2)$$

Note that, as it is standard in Melitz, the ex-post distribution function will differ according to the equilibrium found when deriving with respect to quality and price.

For each firm  $k$ , I account for the fixed costs and the variable costs linked to domestic or foreign destinations. In the rest of the paper, the  $k$  index is dropped to simplify the notations. Firms selling in both markets are "multi-products" producers in the sense that they sell one variety with two qualities: one of quality  $\theta_{ii} \geq 0$  (for the domestic market) and one of quality  $\theta_{ix} \geq 0$  (for the foreign market).

Total expense in one market takes the following form:

$$C_{ij} = c_{ij}t_{ij}q_{ij} + \omega_{ij} + F_{ij} \quad (3)$$

Where  $j = i$  for the domestic costs and  $j = x$  for the exporting costs. Also,  $F_{ij} = f + \mathbb{I}_x f_x$  with  $\mathbb{I}_x = 1$  if the firm is exporting to country  $x$ . The different components of the cost function in equation 3 are now explained.

#### 2.2.2.1 Fixed costs

I set three fixed costs: the standard fixed transportation cost  $f_x$  and a fixed expense  $f$  necessary to produce a positive quantity. Also, the cost  $\omega_{ij}$

depends on quality. It represents the price for technology and labor training necessary to upgrade quality  $\theta_{ij}$  to a certain level for destination country  $j$ <sup>18</sup>. For simplicity, firms must pay the upgrading cost for each destination. Each firm pays the upgrading fixed cost for building a new product line for each country-specific quality. The quality elasticity of upgrading fixed cost is  $\alpha_i > 1$ , which is specific to the producing country. I assume diminishing returns to quality<sup>19</sup>:  $\frac{1}{\alpha_i} \in ]0; 1]$ , thus  $\alpha_i \in [1; \infty[$ . The upgrading cost function is the following:

$$\omega_{ij} = \theta_{ij}^{\alpha_i} \quad (4)$$

Equivalently, quality depends on the upgrading fixed cost.

$$\theta_{ij} = \omega_{ij}^{\frac{1}{\alpha_i}}$$

#### 2.2.2.2 Variable costs

I set a variable marginal cost  $c_{ij}$  which depends negatively on the firm process productivity  $\varphi_{ij}$  and positively on indexation of quality  $\theta_{ij}^\varepsilon$ .  $\varepsilon \in (0; 1)$  is the quality elasticity of the marginal cost.

$$c_{ij} = \frac{\theta_{ij}^\varepsilon}{\varphi_{ij}} \quad (5)$$

I also propose a variable transportation cost that relies upon ad valorem and product-specific components such as c.i.f. price<sup>20</sup>.

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18. It is a close definition to the  $\lambda$  in [E. A. Verhoogen \(2008\)](#) which represents "entrepreneurial ability or technical skill."  $\lambda$  is proxied in their data by "log domestic sales deviated from industry mean." It means that it can only be easily measured with domestic sales data for each firm compared to the industry mean.

19. This is like [Feenstra and Romalis \(2014\)](#).

20. Cost, insurance and freight (c.i.f.) prices include all the shipping charges incurred by the sector until the buyer receives the good. They depend on the traded products.

Considering these elements leads to using a cost function which is like an iceberg transportation cost.

$$t_{ij} = 1 + a_{ij} + b_{ij} \geq 1$$

where  $t_{ij}$  is the iceberg trade cost and is the quantity of variety  $k$  paid to ship one unit of the good from the origin country to the destination country. If there are no transportation costs (i.e. when origin is destination),  $t_{ij} = 1$ ; otherwise,  $t_{ij} > 1$ .  $a_{ij}$  and  $b_{ij}$  are, respectively, the ad valorem cost<sup>21</sup> and the c.i.f. price. A positive trade cost also implies that there will always be distinct qualities for the two destinations (even when  $\beta$  is not country specific).

### 2.2.3 Supply

Every firm makes a unique variety, with a different quality for each destination market (it is a monopolistic competition environment). Following Melitz's framework (2003), the only factor of production is labor. A wage rate of 1 pays for labor for simplicity. Also, there is a constant return to scale and perfect competition for the numeraire sector for which both countries produce a positive amount.

The profit function of a firm making a variety  $k$  in one market  $i$  and selling in market  $j$  is:

$$\pi_{ij} = p_{ij}q_{ij} - c_{ij}t_{ij}q_{ij} - \omega_{ij} - F_{ij} \quad (6)$$

Where  $j = i$  for the domestic profit and  $j = x$  for the exporting profit.

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21. Such as VAT, it is a tax put on the transported product given its value.

### 2.2.4 Firm's optimal choices

I now solve the firm and consumer problems to find the production and exporting cutoff functions. In a first step, the QSs are set to  $\underline{\theta}_{ij} = 0$ . It will provide an intuitive result when firms choose their quality. Each firm can produce its quality level among a continuous interval of quality  $(0; \bar{\theta}_{ij})$  <sup>22</sup>.

#### 2.2.4.1 Entry

Production occurs after each firm learns its productivity by paying a fixed entry cost  $f_e$ . Firms pay this cost only if the expected post-entry profit is positive:

$$\bar{\pi}_{ij} = \sum_{j=i}^x \int_0^{\infty} \pi_{ij}(\varphi_{ij}) g(\varphi) d\varphi = f_e > 0 \quad (7)$$

#### 2.2.4.2 Equilibrium demand

Deriving utility <sup>23</sup>, I find the following demand at the equilibrium for a variety made in  $i$  and sold in market  $j$ :

$$q_{ij} = \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j p_j^{\sigma-1} \quad (8)$$

where

$$p_j^{1-\sigma} = \sum_{j=i}^x \int_{\varphi_{ij}} \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma}(\varphi_{ij}) M_{ij} \mu_{ij}(\varphi) d\varphi \quad (9)$$

is the price index in  $j$  <sup>24</sup>, and  $L_j$  is the number of consumers (workers) in  $j$  (which is allowed to differ across countries).  $M_{ij}$  is the mass of firms producing in  $i$  and selling in  $j$ ;  $\mu_{ij}(\varphi)$  is the ex-post distribution of productivity

22. In the next step of the model, a positive QS will become the lower bound  $\underline{\theta}_{ij}$  in this interval. As such, it truncates this interval.

23. See equation 1

24. The price index is endogenously determined and is as a constant in monopolistic competition.

conditional on a variety produced in  $i$  and consumed in  $j$  over a subset of  $[1, \infty[$ .

The expenditure function is the following for market  $j$ :

$$r_{ij} = \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \quad (10)$$

The representative firm maximizes profit according to two elements: f.o.b. price and quality (Feenstra and Romalis, 2014; Rodriguez, 1979).

To obtain a feasible result (i.e. a non-negative quality),  $\varepsilon < \beta \in B$ . It means that the willingness-to-pay for quality is always strictly greater than the quality elasticity of the marginal cost. Indirectly, it forces the model to assume a positive fixed cost ( $F_{ij} = f + \mathbb{I}_x f_x > 0$ ) to obtain a possible result. Also,  $\sigma$ ,  $\alpha_i$ ,  $\beta_j$ ,  $\varepsilon$ ,  $P_j$  are assumed identical in similar industries.

#### 2.2.4.3 Exporting firm

Without domestic and foreign quality standards, exporting is always more expensive than selling domestically<sup>25</sup>. Thus, exporting firms sell both in  $i$  and  $x$  when there is no quality standard.

The first-order optimal price is  $p_{ij} = \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{ij}^\varepsilon$ . Note that the first-order price diminishes thanks to productivity gains. The optimal quality is:

$$\theta_{ij}^* = \left( \frac{\beta_j - \varepsilon}{\alpha_i} \left( \frac{\sigma-1}{\sigma} \right)^\sigma \varphi_{ij}^{\sigma-1} t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right)^{\frac{1}{\alpha_i - \Lambda_j}} \quad (11)$$

Where  $\alpha_i - \Lambda_j = \alpha_i - (\sigma-1)(\beta_j - \varepsilon) > 0 \iff \alpha_i - \Lambda_j < \alpha_i$  since  $\sigma > 1$  and  $\varepsilon < \beta_j$  by assumption.

**Proposition 1.** *More productive firms can invest more in quality upgrading.*

**Proposition 2.** *A higher willingness-to-pay for quality in  $j$  implies a larger optimal quality.*

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25. Melitz and Redding (2014) prove this and find a relation between the production and exporting cutoffs such that it is always true. In section 2.3.6, I show it is also the case when introducing quality standards under specific conditions.

As expected, a higher  $\varphi_{ij}$  leads to a lower marginal cost  $c_{ij}$  and to a larger optimal quality  $\theta_{ij}^*$ . Everything else being equal, more productive firms can invest more in quality upgrading. A bigger  $\alpha_i$  (the elasticity of the upgrading cost) lowers  $\theta_{ij}^*$  because upgrading quality costs relatively more. It encourages firms to adopt a lower optimal quality (since it costs less). Notice also that a higher willingness-to-pay for quality  $\beta_j$  implies a larger optimal quality because companies want to meet consumers' desire for quality. Finally, a greater quality elasticity of the marginal cost  $\varepsilon$  leads to lower quality, as expected.

In its final form, the optimal price is deduced from the optimal quality:

$$p_{ij}^* = \left( \frac{\beta_j - \varepsilon}{\alpha_i} \right)^{\frac{\varepsilon}{\alpha_i - \lambda_j}} \left( \frac{\sigma - 1}{\sigma} \right)^{\frac{\beta_j(\sigma - 1) + \varepsilon - \alpha_i}{\alpha_i - \lambda_j}} \times \varphi_{ij}^{\frac{\beta_j(\sigma - 1) - \alpha_i}{\alpha_i - \lambda_j}} \left( t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right)^{\frac{\varepsilon}{\alpha_i - \lambda_j}} \quad (12)$$

Price increases or decreases with a change in  $\varphi_{ij}$  because it depends on the sign of  $\beta_j(\sigma - 1) - \alpha_i$ <sup>26</sup>. Two opposite effects are at play when  $\varphi_{ij}$  rises. It depends on the willingness-to-pay for quality and the elasticity of substitution which pushes price upwards, and on the quality elasticity of the upgrading cost which pushes price downwards. I adjust price given willingness-to-pay for quality to obtain a more refined interpretation (when setting  $\tilde{p} = \frac{p}{\theta^{\beta_j}}$ ):

$$\tilde{p}_{ij} = A_{ij} \varphi_{ij}^{\frac{-\alpha_i}{\alpha_i - \lambda_j}} \left( t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right)^{\frac{\varepsilon - \beta_j}{\alpha_i - \lambda_j}} \quad (13)$$

with

$$A_{ij} \equiv \left( \frac{\sigma - 1}{\sigma} \right)^{\frac{-\alpha_i - \beta_j + \varepsilon}{\alpha_i - \lambda_j}} \left( \frac{\beta_j - \varepsilon}{\alpha_i} \right)^{\frac{\varepsilon - \beta_j}{\alpha_i - \lambda_j}}$$

**Proposition 3.** *With a fixed quality, more productive firms are better able to lower their optimal price.*

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26. As in [Hallak and Sivadasan \(2013\)](#).

Clearly  $\tilde{p}_j \searrow$  if  $\varphi_{ij} \nearrow$ . Higher productivity leads to a lower price adjusted for quality. It means that by keeping a fixed quality, more productive firms are better able to lower their optimal price.

Given quality and price, after a few calculation steps using equations 11 and 12, the optimal revenue is:

$$r_{ij}^* = H_{ij} \eta_{ij} (t_{ij}^{1-\sigma} L_j P_j^{\sigma-1})^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} = \frac{\omega_{ij}^* \sigma \alpha_i}{\Lambda_j} \quad (14)$$

Where:  $H_{ij} = \left(\frac{\sigma-1}{\sigma}\right)^{\frac{(\sigma-1)\alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}} \left(\frac{\beta_j - \varepsilon}{\alpha_i}\right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}}$  and  $\eta_{ij} \equiv \left(\varphi_{ij}^{\frac{\alpha_i}{\alpha_i - \Lambda_j}}\right)^{\sigma-1}$ .

It is easy to see that  $r_{ij}^* \nearrow$  if  $\varphi_{ij} \nearrow, \beta_j \nearrow$ .

Finally, the optimal profit is:

$$\pi_{ij}^* = \eta_{ij} J_{ij} N_{ij} \left(t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}\right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} = \frac{\omega_{ij}^* (\alpha_i - \Lambda_j)}{\Lambda_j} - F_{ij} \quad (15)$$

With:  $J_{ij} \equiv \left(\frac{\sigma-1}{\sigma}\right)^{\frac{\sigma \alpha_i}{\alpha_i - \Lambda_j}} \left(\frac{\beta_j - \varepsilon}{\alpha_i}\right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}}$ ;  $N_{ij} \equiv \frac{\alpha_i t_{ij}^{\sigma} (\sigma t_{ij}^{-1} - \sigma + 1) - \Lambda_j}{\Lambda_j}$ ;  $\omega_{ij}^* = \theta_{ij}^{*\alpha_i}$

**Proposition 4.** *A higher willingness-to-pay for quality leads to a higher profit in destination j.*

A bigger  $\beta_j$  provides a greater profit since it positively impacts each part of the profit directly and indirectly (through  $\Lambda_j$ ). Also,  $\pi_{ij}^* \nearrow$  if  $\varphi_{ij} \nearrow$ . Firms only diverge in profit or revenue if they differ in productivity  $\varphi_{ij}$ .

A company decides to export if and only if  $\frac{\omega_{ij}^* (\alpha_i - \Lambda_j)}{\Lambda_j} \geq F_{ij}$ . Thus, here is the minimum productivity threshold to export:

$$\varphi_{ix}^{\sigma-1} = \theta_{ix}^{-\Lambda_x} \left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1} \frac{\sigma (\theta_{ix}^{\alpha_i} + F_{ix})}{t_{ix}^{1-\sigma} L_x P_x^{\sigma-1}} \quad (16)$$

In addition, there is a level of quality at which the firm can start exporting:

$$\theta_{ij}^{\alpha_i} = \frac{F_{ij} \Lambda_j}{\alpha_i - \Lambda_j} \quad (17)$$

Finally, the price index can be rewritten like this:

$$p_j^{\sigma-1} = \frac{\sigma \alpha_i}{\Lambda_j} \frac{\theta_{ij}^{\alpha_i - \Lambda_j} \bar{\varphi}_{ij}^{1-\sigma}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma - 1} \right)^{\sigma-1} \quad (18)$$

It takes into account the firm with minimal productivity producing in  $i$  and exporting in  $j$  as well as the first-order optimal price.

### 2.3 INTRODUCING A POSITIVE QS

For the second step, I introduce a positive QS set by the government. While the previous step, without QS (and without government intervention), was necessary to acknowledge the natural reaction of firms confronted to quality in a Melitz model, the step with a positive QS is necessary to study the impact of legal trade frameworks (which are made to allow the functioning of economies with heterogeneous quality standards). At first, I assume identical standards across countries. Each country sets an exogenous QS greater than 0 and denoted  $\theta_{sj}$  (where  $s$  stands for "standard"). The new continuous interval of quality is  $(\theta_{sj}; \bar{\theta}_{ij})$ .

From the start, a government can set a QS for several reasons. Most of the time, it is to solve market distortions such as asymmetries of information and environmental or health externalities. Sometimes, the goal is to boost the domestic economy (Clerides and Hadjiyiannis, 2008). Recent papers also highlight a misallocation channel and show that a higher QS improves welfare under certain conditions (Baqee and Farhi, 2020; Edmond et al., 2018; Gaigné and Larue, 2016; Macedoni and Weinberger, 2022; Weinberger, 2020). Heterogeneity in quality production creates a misallocation and it causes market disruptions. Macedoni and Weinberger (2022) find

that a standard allows reallocating production from low to high productivity firms<sup>27</sup>.

A QS does not impact firms with different productivity in the same way (Gagné and Larue, 2016; Hallak, 2006). Since the standard is positive, in this section, I assume that the QS is restrictive for at least one firm and not restrictive for at least one firm. It separates the problem into two categories of firms facing the standard: constrained (c-firms) and unconstrained (u-firms).

A firm is constrained by the standard when the new standard is higher than the firm's optimal quality level. She loses profit by paying the minimum fixed upgrading cost  $\bar{\omega}_{sj}$  which is higher than with her previous optimal quality without standard. The fact that some firms are constrained and others are not creates a first distortion in the distribution of the price adjusted for quality: all constrained firms have the same quality while unconstrained firms have various levels of quality.

Two new cutoffs are created by the QS (i.e. the productivity and the exporting cutoffs). These cutoffs are defined by the following expression (knowing the productivity cutoff sets  $t_{ij} = 1$  and  $F_{ij} = f$ ):

$$\bar{\varphi}_{ij}^{\sigma-1} = \theta_{sj}^{-\Lambda_j} \left( \frac{\sigma}{\sigma-1} \right)^{\sigma-1} \frac{\sigma \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)}{t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}} \quad (19)$$

**Proposition 5.** *A constrained firm decides to exit or upgrade the quality to meet the standard.*

Given its post-standard expected profit with the quality standard, a c-firm decides to exit or upgrade the quality to meet the standard. If a c-firm has a productivity below the new productivity cutoff  $\bar{\varphi}_{ii}$  created with the quality standard, she now exits the market. In other words, the new standard truncates the left part of the productivity distribution. This creates a

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27. In Gagné and Larue (2016), the conclusion is similar when the value of the quality elasticity of fixed cost is lower than 1. Macedoni and Weinberger (2022) get rid of the fixed cost to upgrade the quality.

distortion because fewer varieties are available in the market, as in [Gaigné and Gouel \(2022\)](#). Then, if a firm has a productivity below the exporting cutoff  $\bar{\varphi}_{ix}$  ( $t_{ij} > 1$  and  $F_{ij} = f + f_x$ ), she does not export. Anyway, it changes the ability for firms to export. Indeed, even if the exporting firm with the lowest productivity is unconstrained, the introduction of a positive QS creates a new price index based on the surviving firm with the lowest productivity  $\bar{\varphi}_{ij}$ .

$$p_j^{\sigma-1} = \theta_{sj}^{-\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{1-\sigma} \quad (20)$$

I start the analysis by studying the reactivity of exporters towards a new standard, identical in both countries (the non-exporters hold a symmetric result, once converting  $j$  into  $i$  indices, setting  $t_{ij} = 1$  and  $f_x = 0$ ).

### 2.3.1 The Constrained Firms problem

The foreign country sets a new QS:  $\theta_{sj}$ . I look at three characteristic equations: optimal profit, total sales, and optimal price. For the c-firm,  $\theta_{sj}$  is imposed. The c-firm does not maximize according to the quality level anymore.

The minimum exporting profit is the profit of the less productive firm able to adopt the standard (i.e. a c-firm). The minimum profit function varies positively with the quality level of the standard  $\theta_{sj}$ .

$$\pi_{ij}^c = \theta_{sj}^{\beta_j(\sigma-1)} p_j^{1-\sigma} L_j p_j^{\sigma-1} - \frac{\theta_{sj}^\varepsilon}{\varphi_{ij}} t_{ij} \theta_{sj}^{\beta_j(\sigma-1)} p_j^{-\sigma} L_j p_j^{\sigma-1} - \theta_{sj}^{\alpha_i} - F_{ij} \quad (21)$$

**Proposition 6.** *Quality standards lower the profit of constrained firms because the cost increases more than the revenues.*

Knowing that the standard is above the optimal quality of the constrained firm, the profit is lower than the case without standard. A new standard

has two effects on a firm's profit. On the one hand, higher quality imposed by the standard leads towards higher revenues. On the other hand, it increases the costs (i.e. the upgrading cost  $\theta_{sj}^{\alpha_i}$  and the marginal cost  $c = \frac{\theta_{sj}^\epsilon}{\varphi_{ij}}$  increase). To survive, the c-firm must invest in technology and labor training to improve the quality-level.

### 2.3.1.1 Optimal sales, price, and profit for the c-firm

The first-order equilibrium price is:

$$p_j^{c*} = \frac{\sigma t_{ij}}{\sigma - 1} \frac{\theta_{sj}^\epsilon}{\varphi_{ij}} \quad (22)$$

A higher QS increases the price, a higher productivity  $\varphi_{ij}$  decreases the price.

The sales of a c-firm are found using the new price index (equation 20) and the revenue (equation 10) divided by the new first-order equilibrium price (equation 22):

$$q_{ij}^{c*} = \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{(\sigma - 1)}{t_{ij}} \frac{\varphi_{ij}^\sigma}{\bar{\varphi}_{ij}^{\sigma-1}} \theta_{sj}^{-\epsilon} \quad (23)$$

The lowest productivity boundary,  $\bar{\varphi}_{ij}$  conditions the sales. As expected, they increase with  $\varphi_{ij}$  and they decrease with the trade cost  $t_{ij}$ . Sales do not depend on the willingness-to-pay for quality in the market, unlike the case without standard.

Using equations 22 and 23, the optimal exporting profit of the c-firms turns out to be:

$$\pi_{ij}^{c*} = (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} - 1 \right) \quad (24)$$

**Proposition 7.** *A higher willingness-to-pay for quality does not impact the optimal profit of the constrained firm.*

Remember that, for each c-firm, the additional cost due to a fixed QS is higher than the cost resulting from optimal quality. The imposed QS leads towards a second-best profit level; c-firms remain in the market if  $\pi_{ij}^{c*}$  is not strictly negative. The profit also depends on the distance of productivity over its lowest limit. The lowest productive c-firm is making no profit. Finally, in equation 24, notice that the relationship between  $\beta_j$  and  $\pi_{ij}^{c*}$ , which was ambiguous in the case with a zero-level standard, is absent for the constrained optimal profit.

### 2.3.2 The Unconstrained Firms problem

#### 2.3.2.1 Sales, prices, and profit for the u-firm

The u-firms choose an optimal quality which is above the standard but they follow the new price index (in equation 20). The optimal quality uses this price index and is the following.

$$\theta_{ij}^* = \left( \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right)^{\frac{1}{\alpha_i - \Lambda_j}} > \theta_{sj} \quad (25)$$

The optimal quality increases with a higher productivity.

Here are the price and the sales for the u-firms.

$$p_{ij}^{u*} = \frac{\sigma t_{ij}}{(\sigma - 1)} \left( \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right)^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{(\sigma-1)\varepsilon - \alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}} \quad (26)$$

$$q_{ij}^{u*} = \frac{\alpha_i (\sigma - 1)}{\Lambda_j t_{ij}} \left( \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right)^{\frac{\alpha_i - \varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{(\sigma-1)(\alpha_i - \varepsilon) + \alpha_i - \Lambda_j}{\alpha_i - \Lambda_j}} \quad (27)$$

The optimal quality found in equation 25 influences both results. Some differences emerge between those two equations. Productivity improves the price if and only if  $\beta_j(\sigma - 1) - \alpha_i > 0$ . However, productivity increases the sales if  $(\beta_j - \alpha_i)(\sigma - 1) - \alpha_i < 0$ .

The profit of the u-firm uses the new price index (equation 20) and the new optimal quality (equation 27):

$$\pi_{ij}^{u*} = \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left( \Lambda_j \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \quad (28)$$

$\alpha_i$  and  $\Lambda_j$  impacts on profit is unclear for the unconstrained firm.

### 2.3.3 Limit firm to become unconstrained

There exists a level of productivity for a company indifferent between the standard and her optimal quality. It is found by equalizing  $\pi_{ij}^{c*} = \pi_{ij}^{u*}$ .

$$\hat{\varphi}_{ij} = \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{\sigma-1}} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\frac{1}{\sigma-1}} \bar{\varphi}_{ij} \quad (29)$$

**Proposition 8.** *A higher willingness-to-pay for quality allows more firms to become unconstrained.*

A higher  $\Lambda_j$  (and, consequently, a higher  $\beta_j$ ) diminishes the productivity necessary to be non-constrained by the standard. Notice also that the constrained firm with the lowest productivity can become unconstrained if  $\frac{\alpha_i}{\Lambda_j} \leq \frac{\theta_{sj}^{\alpha_i} + F_{ij}}{\theta_{sj}^{\alpha_i}}$ . However, this case scenario is not studied further since it discards the needs for standards. Consequently, I continue the analysis with at least one constrained firm. Thus  $\frac{\alpha_i}{\Lambda_j} > \frac{\theta_{sj}^{\alpha_i} + F_{ij}}{\theta_{sj}^{\alpha_i}}$ .

### 2.3.4 Impacts of the standard on cutoffs

Cutoffs ( $\bar{\varphi}_{ij}$  and  $\hat{\varphi}_{ij}$ ) can be used to assess the impact of a standard on the number of firms selling in the market  $j$  for each category of firm (constrained and unconstrained).

Using the free entry condition when both unconstrained and constrained firms exist, it is possible to get a constant expression which always links the two for any price index.

$$\Psi_{ij} \equiv \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \frac{\theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma}}{\alpha_i \Lambda_j} \frac{\gamma - (\sigma - 1)}{\sigma - 1} \left( \frac{\gamma (\alpha_i - \Lambda_j)^2 \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}}}{\gamma (\alpha_i - \Lambda_j) - \alpha_i (\sigma - 1)} - \frac{\alpha_i \gamma}{\gamma - (\sigma - 1)} + \Lambda_j \right)$$

**Proposition 9.** *More unequal distribution of productivities increases the level of productivity necessary to produce and to export.*

After some developments (see appendix B.8), I find the elasticities for both cutoffs.

$$\frac{\theta_{sj}}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}} = \frac{\theta_{sj}}{\gamma} \frac{\Upsilon_{ij}}{\Theta_{ij}} \leq 0 \quad (30)$$

Where  $\Upsilon_{ij} \leq 0$  and  $\Theta_{ij} > 0$  (see in appendix B.8). The sign of  $\Upsilon_{ij}$  depends on

$$\frac{1}{\gamma} - \frac{\bar{\varphi}_{ij}}{\hat{\varphi}_{ij}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{1}{\sigma-1} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)$$

which can be either positive or negative. This means that the higher  $\frac{1}{\gamma}$ , the more likely is the effect of quality standards on productivity and exporting cutoffs going to be positive. In other words,  $\gamma$  needs to be high (less unequal distribution) to see more firm produce and/or export. In the same vein, the highest is  $\hat{\varphi}_{ij}$  compared to  $\bar{\varphi}_{ij}$ , the more likely is the effect of quality standards on productivity and exporting cutoffs going to be positive. In other words, a greater number of constrained firms compared to unconstrained ones decreases the number of firms producing and/or exporting. Finally, through  $\Lambda_j$ ,  $\beta_j$  also strengthen the negative effect of the quality standard on the number of firms able to produce and to export.

Then, I find the impact of a change in standard on the limit firm (the one indifferent between its optimal quality and the standard):

$$\frac{\theta_{sj}}{\hat{\varphi}_{ij}} \frac{\partial \hat{\varphi}_{ij}}{\partial \theta_{sj}} = \frac{\bar{\varphi}_{ij}}{\hat{\varphi}_{ij}} \left( \frac{\alpha}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{\alpha}{\sigma-1} \left( \frac{\theta_{sj}^\alpha}{\theta_{sj}^\alpha + F} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^\alpha}{\theta_{sj}^\alpha + F} \right) > 0 \quad (31)$$

The impact is always positive, meaning that a higher standard leads to more firms being constrained and fewer firms being unconstrained. Consequently, since a higher quality standard could increase both cutoffs, the impact on the number of constrained firms not clear while the effect on the number of unconstrained firms is clearly negative.

**Proposition 10.** *A higher standard leads to more constrained firms which, in turn, makes it more likely to have fewer producing and exporting firms.*

Note also that, due to the fact that both  $\pi_{ij}^{c*}$  and  $\pi_{ij}^{u*}$  depend on  $\bar{\varphi}_{ij}$ , a change of standard leads to an ambiguous impact on both types of firms' profit.

### 2.3.5 Welfare with a positive QS

I find the welfare using the method proposed by [Melitz and Redding \(2014\)](#). Thus, I use the price index from equation 20.

$$W_i = P_i^{-1} = \frac{\sigma-1}{t_{ij}\sigma} \left[ \frac{\sigma \theta_{sj}^{-\Lambda_j}}{L_i} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{1}{1-\sigma}} \bar{\varphi}_{ij} \quad (32)$$

As in [Gagné and Larue \(2016\)](#), a change in standard is leading to an ambiguous impact on welfare.

$$\frac{\theta_{sj}}{W_i} \frac{\partial W_i}{\partial \theta_{sj}} = \underbrace{\frac{\Lambda_j - \alpha_i}{\sigma-1}}_{<0} + \underbrace{\frac{\theta_{sj}}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}}_{\text{ambiguous}} \quad (33)$$

**Proposition 11.** *Welfare can only increase with higher standards if the number of producing and exporting firms decreases enough with higher standards.*

The part 1 of the equation is clearly negative. However, the second part is positive or negative. The final effect of a standard on welfare depends on the sign and weight of  $\frac{\theta_{sj}}{\varphi_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}$ . Using equation 30, I find that  $\gamma$  needs to be low (more unequal distribution) for welfare to be positive when standards increase. Also, the highest is  $\hat{\varphi}$  compared to  $\varphi_{ij}$ , the better for welfare. In other words, a greater number of constrained firms compared to unconstrained ones improves welfare. Finally, through  $\Lambda_j$ ,  $\beta_j$  improves welfare. Indeed, a country with consumers aiming at higher quality is less negatively impacted by higher standards in terms of welfare.

In the next two sections, I introduce different standards across countries and, then, I show how the welfare result above allows finding a Nash equilibrium among two countries choosing between three legal frameworks.

### 2.3.6 *Introducing different standards across countries*

Assuming that each government chooses a different standard, two scenarios exist: 1.  $\theta_{sx} < \theta_{si}$ , and 2.  $\theta_{sx} > \theta_{si}$ . In addition, when a firm can choose the best standard among domestic and foreign (regarding profit optimization), she does.

Different standards across countries lead to new definitions of the minimum productivity necessary to serve a positive quantity in the domestic market and in the foreign market:

$$\bar{\varphi}_{ii}^{\sigma-1} = \theta_{si}^{-\Lambda_i} \left( \frac{\sigma}{\sigma-1} \right)^{\sigma-1} \frac{\sigma (\theta_{si}^{\alpha_i} + F_{ii})}{L_i P_i^{\sigma-1}} \quad (34)$$

$$\bar{\varphi}_{ix}^{\sigma-1} = \theta_{sx}^{-\Lambda_x} \left( \frac{\sigma}{\sigma-1} \right)^{\sigma-1} \frac{\sigma (\theta_{sx}^{\alpha_i} + F_{ix})}{t_{ix}^{1-\sigma} L_x P_x^{\sigma-1}} \quad (35)$$

As in [Melitz and Redding \(2014\)](#), an expression links the productivity cutoff to serve the domestic and the productivity cutoff to serve foreign markets.

$$\bar{\varphi}_{ix}^{\sigma-1} = \bar{\varphi}_{ii}^{\sigma-1} \left( \frac{\theta_{si}^{\Lambda_i}}{\theta_{sx}^{\Lambda_x}} \right) t_{ix}^{\sigma-1} \frac{(\theta_{sx}^{\alpha_i} + F_{ix}) L_i P_i^{\sigma-1}}{(\theta_{si}^{\alpha_i} + F_{ii}) L_x P_x^{\sigma-1}} \quad (36)$$

Here, contrarily to [Melitz and Redding \(2014\)](#), it is not only necessary to have sufficiently high fixed and variable trade costs ( $t_{ix}^{\sigma-1} \frac{(\theta_{sx}^{\alpha_i} + F_{ix})}{(\theta_{si}^{\alpha_i} + F_{ii})} > 1$ ) to export. Now, it also depends on the level of domestic standard relative to the foreign standard  $\left( \frac{\theta_{si}}{\theta_{sx}} \right)^{\Lambda_x}$ . In conclusion, it is only when  $t_{ix}^{\sigma-1} \frac{(\theta_{sx}^{\alpha_i} + F_{ix})}{(\theta_{si}^{\alpha_i} + F_{ii})} > \left( \frac{\theta_{sx}}{\theta_{si}} \right)^{\Lambda_x}$  that only the most productive constrained firms export. Given  $\Lambda_x < \alpha_i$ ,  $F_{ix} > F_{ii}$  and  $t_{ix}^{\sigma-1} > 1$ , it can be the case even when  $\theta_{si} > \theta_{sx}$ . But, when  $\theta_{si}$  is too big compared to  $\theta_{sx}$ , even the less productive domestic firms stop selling domestically and start exporting. I assume it is not the case to obtain realistic and tractable results.

### 2.3.7 Legal trade frameworks

In a game theory framework, I now discuss the variation in welfare given the legal trade framework chosen by the two trading economies with different standards. I define the three frameworks as such:

**National Treatment** All firms selling in the local market follow the local standard (i.e. local producers and foreign exporters). There is no discrimination.

**Mutual Recognition** Exporters are allowed to take the lowest standard among origin and destination markets. Firms selling domestically stick to their home standard <sup>28</sup>.

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28. From the government perspective, too high domestic standard comparatively to foreign standard might advantage foreign exporters who can sell lower quality than domestic firms. Intuitively, it can hurt domestic firms in terms of quality cost and might bring unequal competition between local producers and foreign exporters.

**Harmonization** Both countries choose a unique standard for all exporters, different from national standards. I arbitrarily take the middle ground  $(\frac{\theta_{si} + \theta_{sx}}{2})$ <sup>29</sup>.

Considering the different standards across countries, six situations exist, which are summarized in Table 1.

Table 1 – Choice of standard by the least productive exporter producing in i

|                             | Legal framework | Standard if $\hat{\phi}_{ij} > \bar{\varphi}_{ij}$ |
|-----------------------------|-----------------|----------------------------------------------------|
| $\theta_{si} < \theta_{sx}$ | NT              | $\theta_{sx}$                                      |
|                             | MR              | $\theta_{si}$                                      |
|                             | H               | $\theta_{sh}$                                      |
| $\theta_{si} > \theta_{sx}$ | NT              | $\theta_{sx}$                                      |
|                             | MR              | $\theta_{sx}$                                      |
|                             | H               | $\theta_{sh}$                                      |

Table 1 shows that, when  $\theta_{si} < \theta_{sx}$  or when  $\theta_{si} > \theta_{sx}$ , a domestic producer has the choice between the domestic standard (in the case of mutual recognition), the international standard (in the case of harmonization) and the foreign standard (in the case of national treatment and mutual recognition). Whether it will be beneficial in terms of welfare is discussed in the next section. Indeed, all the necessary building blocks for the impact assessment of the legal trade frameworks have now been set out.

#### 2.3.7.1 Welfare analysis regarding legal frameworks

I now measure the changes regarding welfare knowing that the default case is no agreement (i.e. National Treatment, following WTO's rules). Table 2 illustrates the four possible outcomes in terms of welfare knowing the sign of the impact of QS on welfare and knowing that the domestic country has the lowest (highest) standard compared to the foreign country.

29. It is also possible to take a weighted average, to account for the country size. Taking a different proportion than the middle ground does not change the final results.

Table 2 – Welfare comparison among legal frameworks

| QS impact on welfare                                                | QS differences between partners | National welfare preferences    | Best legal framework |
|---------------------------------------------------------------------|---------------------------------|---------------------------------|----------------------|
| $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} > 0$ | $\theta_{si} < \theta_{sx}$     | $W^{MR} \prec W^H \prec W^{NT}$ | $W^{NT}$             |
|                                                                     | $\theta_{si} > \theta_{sx}$     | $W^{MR} \sim W^{NT} \prec W^H$  | $W^H$                |
| $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} < 0$ | $\theta_{si} < \theta_{sj}$     | $W^{NT} \prec W^H \prec W^{MR}$ | $W^{MR}$             |
|                                                                     | $\theta_{si} > \theta_{sx}$     | $W^H \prec W^{MR} \sim W^{NT}$  | $W^{MR} \sim W^{NT}$ |

It is already clear that each legal framework is chosen at some point, with NT and MR being chosen in two scenarios and H in one scenario.

With a game theory matrix, it is possible to identify a Nash equilibrium as long as the two partners agree on the framework. Thus, there are three possible outcomes: harmonization, mutual recognition, no agreement. In order to visualize which agreement could be reached (knowing the results of table 2), tables 3 and 4 show the two frameworks other than "no agreement" (i.e. national treatment) for the two countries. Table 3 considers the results when the QS increases welfare; Table 4 considers the results when the QS decreases welfare.

Knowing the welfare preferences given in Table 2, I categorized the welfare outcomes as follows: the least preferred framework is called  $W_{small}$ , the most preferred is called  $W_{big}$ , and the one in between  $W_{mid}$ .

Table 3 – Welfare Matrix when  $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} > 0$ 

|                           |    | Country with high standard                    |                                     |
|---------------------------|----|-----------------------------------------------|-------------------------------------|
|                           |    | H                                             | MR                                  |
| Country with low standard | H  | $W_{mid} ; \underline{W_{big}}$               | $\underline{W_{big}} ; W_{small}$   |
|                           | MR | $\underline{W_{big}} ; \underline{W_{small}}$ | $W_{small} ; \underline{W_{small}}$ |

In table 3, when standards improve welfare, a Nash equilibrium is found in (MR; H). It results in "no agreement", meaning that national treatment is the outcome. Indeed, both countries do not agree on the same terms.

Table 4 – Welfare Matrix when  $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} < 0$

|                           |    | Country with high standard                    |                                               |
|---------------------------|----|-----------------------------------------------|-----------------------------------------------|
|                           |    | H                                             | MR                                            |
| Country with low standard | H  | $\underline{W}_{mid} ; \underline{W}_{small}$ | $\underline{W}_{small} ; \underline{W}_{big}$ |
|                           | MR | $\underline{W}_{small} ; \underline{W}_{big}$ | $\underline{W}_{big} ; \underline{W}_{big}$   |

In table 4, when standards decrease welfare, a Nash equilibrium is found in (MR; MR). Thus, an agreement is found with the mutual recognition framework.

### 2.3.7.2 Prudential strategies

Using a prudential strategy<sup>30</sup>, as depicted in table 5 and table 6, shows that an agreement is found in both cases (when standards increase or decrease welfare). The harmonization framework is chosen when standards improve welfare while mutual recognition is preferred when standards decrease welfare.

Table 5 – Prudential Strategy - Welfare Matrix when  $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} > 0$

|                           |    | Country with high standard                    |                                                 | Prudential strategy     |
|---------------------------|----|-----------------------------------------------|-------------------------------------------------|-------------------------|
|                           |    | H                                             | MR                                              |                         |
| Country with low standard | H  | $\underline{W}_{mid} ; \underline{W}_{big}$   | $\underline{W}_{big} ; \underline{W}_{small}$   | $\underline{W}_{mid}$   |
|                           | MR | $\underline{W}_{big} ; \underline{W}_{small}$ | $\underline{W}_{small} ; \underline{W}_{small}$ | $\underline{W}_{small}$ |
| Prudential strategy       |    | $\underline{W}_{small}$                       | $\underline{W}_{small}$                         | Eq (H ; H)              |

30. A prudential strategy consists in choosing the maximum outcome among the minimum possible outcomes not knowing which is the choice of the other player.

Table 6 – Prudential Strategy - Welfare Matrix when  $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} < 0$ 

|                           |    | Country with high standard |                       | Prudential strategy |
|---------------------------|----|----------------------------|-----------------------|---------------------|
|                           |    | H                          | MR                    |                     |
| Country with low standard | H  | $W_{mid} ; W_{small}$      | $W_{small} ; W_{big}$ | $W_{small}$         |
|                           | MR | $W_{small} ; W_{big}$      | $W_{big} ; W_{big}$   | $W_{small}$         |
| Prudential strategy       |    | $W_{small}$                | $W_{big}$             | Eq (MR ; MR)        |

Now suppose that countries with low domestic standards are developing countries which have a hard time determining the impact of standards on welfare due to a lack of data on firms and a lack of human resources to investigate the effect on the least productive firms ( $\frac{\theta_{sj}}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}$ ). Developing countries could use the signal from developed countries to know whether a QSs improves welfare or not.

If a MR agreement is proposed by the developed economy to the developing economy, it can be assumed that  $\frac{\theta_{sj}}{W} \frac{\partial W}{\partial \theta_{sj}} < 0$ . Knowing the Nash equilibrium in this case scenario, the developing country should accept the MR agreement, being its first-best option.

If a H agreement is proposed by the developed economy, it should be taken as a signal that QSs improves welfare. Thus, the developing country would prefer no agreement in this case. However, H is still a second-best and can be a solution in the prudential strategy.

## 2.4 DISCUSSION

### 2.4.1 *Discussing the three frameworks*

#### 2.4.1.1 *Initial intuition*

Deciders use harmonization and mutual recognition to deal with the legal aspects of trade measures. On the one hand, harmonization is expected to boost trade more than mutual recognition. It is seen as an advanced

framework to facilitate trade<sup>31</sup>. Shared standards lead to higher homogeneity and substitutability between products. They also lower information costs for both firms and consumers. Mutual recognition discriminates by advantaging the exporting firms. They can prefer to lower their quality to sell in the country with the lowest standard<sup>32</sup>.

On the other hand, mutual recognition puts a high point on unnecessary obstacles to trade. It allows exporting firms from each market to choose their national standards. Harmonization can harm trade because low standard countries see an increase in upgrading costs while high standard countries can easily compete against low quality firms in the foreign market: it might hurt one trade partner more importantly. In short, it may generate compliance (i.e. adaptation) costs that vary for different markets.

#### 2.4.1.2 *Discussing the results*

Some additional explanations on each framework is helpful to understand why mutual recognition is the preferred option when standards decrease welfare.

National treatment is the "default" framework. There is no discrimination related to the origin of the selling firm (it provides uniform ruling and certification process). When  $\theta_{si} < \theta_{sx}$ , foreign exporters (the ones that are constrained) can lower their costs in terms of production of quality. However, for domestic exporters, it is the opposite. There are additional cost in terms of production of quality (along with the other costs already present: administrative work, transportation, etc.). When  $\theta_{si} > \theta_{sx}$ , domestic exporters are advantaged compared to foreign exporters.

Assuming that the NT framework is the "initial" framework, mutual recognition is always equivalent for one partner and better for the other

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31. See, for example, the Trade Facilitation Act, which promotes harmonization.

32. Also, since the WTO promotes harmonization, it allows entry into the whole regional market to third countries while it is not the case for MR agreements. Even more, mutual recognition creates trade-diversion effects for third countries (Gagné and Larue, 2016)

partner when  $\theta_{si} \neq \theta_{sx}$  when standards decrease welfare. Indeed, when  $\theta_{si} < \theta_{sx}$ , foreign exporters can still lower their costs in terms of production of quality. In addition, domestic exporters can keep their lower home standard. When  $\theta_{si} > \theta_{sx}$ , this analysis is interchanged.

Finally, harmonization is a middle ground between NT and MR. On the one hand, it is often easier and more transparent for exporters to adapt to a common rule. On the other hand, in some respects, it is still discriminatory and makes things worse for one partner. For example, when  $\theta_{si} < \theta_{sx}$ , compared to NT, both domestic and foreign exporters must adapt. While domestic exporters are confronted to a lower standard to export than with the NT framework, foreign exporters cannot lower their cost of producing quality as much as in the NT framework.

In conclusion, mutual recognition is the best-case scenario when standards decrease welfare because no partner is losing by accepting this type of framework. As with previous authors ([Lutz and Pezzino, 2012](#)), mutual recognition allows for a larger quality differentiation than harmonization. Note also that this is in line with the results of [M. X. Chen and Mattoo \(2008\)](#) who show that mutual recognition are more uniformly trade promoting than harmonization.

When standards improve welfare, there is no use reaching the lowest standard and mutual recognition does not bring any advantage.

#### 2.4.2 Limitations

Some additional remarks are important to put my results in perspective. First, it all rests on the sign of the impact of standards on the productivity and exporting cutoffs. Many conditions are necessary to get a positive or negative results including the size of  $\gamma$ , the distance between  $\alpha$  and  $\Lambda$ , and the size of the fixed costs  $F_{ij}$ .

Also, the model itself is restrictive in several ways. First, CES is not the most down-to-earth hypothesis ([Manova and Yu, 2017](#)) and my result

could lead to unrealistic outcomes. But, in terms of modeling, CES has the advantage of being tractable<sup>33</sup>.

Second, using quality in a homothetic Melitz framework brings up issues. Homotheticity implies that, in cross-sections, the rich and the poor consume goods in the same proportions (Matsuyama, 2002). But, it is not the case when inserting quality because poor consumers will incur more expenses on low-quality goods than rich consumers. While I do not want to make my model too complex and less tractable (Holloway, 2014), I partly respond to that by inserting different willingness-to-pay for quality across countries, similarly as Feenstra and Romalis (2014), Baldwin and Harrigan (2011) and Fajgelbaum et al. (2015).

Third, without a separate productivity distribution accounting for the production of quality itself, I cannot explain why some small-size high-quality firms produce. Using only the process productivity prevents discrimination based on company size<sup>34</sup>. With a two-dimension productivity, Hallak and Sivadasan (2013) show that exporters sell higher quality goods than domestic corporations, conditional on size. Some important papers from the literature on Qs also use this two-productivity assumption (Feenstra and Romalis, 2014; Gaigné and Larue, 2016).

## 2.5 CONCLUSION

Nowadays, new trade agreements increasingly account for quality standards. Building on a Melitz model with quality standards, I compare the three most used legal frameworks to find which one is the best in terms of welfare. I find two possible outcomes which are opposite: either quality

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33. especially concerning the price index

34. The observed exporter premiums (a firm has a premium in exporting if it is more productive, it sets higher wages, etc. than the non-exporting companies) could just be correlated with firm size; but tools to proxy size are also exploited to the average wage, capital intensity, output, and input prices.

standards decrease or increase welfare. It mainly rests on the distribution of productivities. A highly unequal productivity distribution is more likely to improve welfare. When higher quality standards decrease welfare, I demonstrate that mutual recognition leads to a Pareto improvement when coming from a national treatment framework. In this case, harmonization is the worst-case scenario when the trading partner has higher standards. However, when standards increase welfare, national treatment is chosen and mutual recognition is the worst-case scenario.

Using a Melitz model to compare legal frameworks is new to the previous literature ([Costinot, 2008](#); [Geng, 2019](#); [Grossman et al., 2021](#); [Lutz and Pezzino, 2012](#)) and allows refining the impact of legal frameworks. When confronted with a higher foreign standard, some exporting firms exit the foreign market and others stop producing their optimal quality and are limited by the quality standard. All remaining firms see either a decrease, a status quo or an improvement of their profit depending on the distribution of productivities. In any case, a higher standard leads to fewer unconstrained firms.

In future research, it could be interesting to link quality output, market structure, and international trade in empirical works (particularly with data from trade agreements like CETA which started on September 21st, 2017 when and if data is available). For example, it could concern how cultural heterogeneity impacts the legal framework choice, especially by making a distinction between TBT and SPS measures. Economic regions with different changes in legal settings can be compared. It requires finding moments in time when standards have improved in one country and not for its trading partners. Finally, some other sub-projects concerning Qs and legal frameworks of trade agreements can be developed and reveal themselves to be primary. The gap in quality creation partly causes the distinction between developed and developing countries. It would be interesting to find empirical proof that quality standards decrease welfare. In addition, the integration of middle to high revenue consumers in a similar model

could also bring refined results. For example, one could include the GTP utility setting to account for different willingness-to-pay for quality across consumers, as [Macedoni and Weinberger \(2022\)](#) do.

## WHEN AND WHO COMPLAINS MATTERS

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### STCS AND TBTS: EVIDENCE FROM A NEW DATABASE

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#### 3.1 INTRODUCTION

For two decades, the level of tariffs has decreased by 3% each year on average and the number of non-tariff measures (NTMs) has increased by almost 10%<sup>2</sup>. The impact of NTMs on trade is not as straightforward as for tariffs and is still debated. It is difficult to grasp the direction and size of the impacts of NTMs on trade because there exist many types of NTMs and they aim at different goals. Indeed, there are sixteen categories among NTMs going from non-technical measures which are trade-related (e.g. subsidies, quotas, anti-dumping, pre-shipment inspection, etc.) to technical measures which are product-related (e.g. technical requirements and conformity assessments)<sup>3</sup>. Among NTMs, technical barriers to trade (TBTs) are numerous and cover all types of industries: as such they are ideal to investigate the heterogeneous effects of NTMs. TBTs call for different objectives of implementation across industries, implying heterogeneous effects. Several TBTs have been found to have insignificant impacts, with

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1. F.G. Santeramo is co-author in a more specific paper focusing on timings only.

2. For tariffs, it is an average annual decrease of 3% between 1995 and 2017 (calculation based on [WorldBank \(2023\)](#)). For NTMs, it is an average annual increase of 10% between 1995 and 2022 (calculation based on [WTO \(2023\)](#)).

3. See table [22](#) for further information.

consequent dilution effect on aggregated estimates. To account for the large heterogeneity of TBTs, while having a clean approach to estimate their effect on trade, the recent literature has focused on Specific Trade Concerns (STCs) (J. C. Beghin, Maertens, et al., 2015; A.-C. Disdier, Fugazza, et al., 2020; L. Fontagné and Orefice, 2018; L. Fontagné, Orefice, et al., 2015; Francois and Hoekman, 2019; Kamal and Zaki, 2018; Orefice, 2017; Singh and Chanda, 2021).

Likewise other NTMs, TBTs must be notified at the WTO in an early stage to allow other WTO members to comment. After the commenting period, some amendments can be made. Then, the NTM is adopted, published, and six months later (or more), it enters into force. While there might be some effects due to anticipation, the new TBT is effective only after the enforcement date.

Specific Trade Concerns (STCs) are brought at the WTO to complain on (SPS or) TBT at any moment from the notification until after the entry into force<sup>4</sup>. Those complaints are called TBT STCs<sup>5</sup>. According to WTO's official data, there have been 725 TBT STCs raised between 1995 and 2021<sup>6</sup>.

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4. [Orden et al. \(2022\)](#) give several examples of STCs for both TBT and SPS regarding food labeling. They highlight the importance of the reason of complaint to grasp better the impact of TBT and SPS on trade. For example, one famous case of a long-lasting STC is the one of Indian tyres in the 133rd TBT STC raised at the WTO. On March 2006, the European Union raised a first STC against India on a newly notified tire regulation aimed at setting up a new public certification system to secure tires against warm roads conditions. While its primary objective was consumer safety, the European Union, joined later on by the United States, Japan, and other developed countries, were concerned that it discriminates against foreign tire producers. The new regulation obliges all producers to pass through a new certification system which cost nearly 35 cents per tire for foreign producers, while only 0.5 cents for the local ones. Against those concerns, India adopted the new regulation in 2010 and the concerns are still ongoing at the WTO. Concerns have been raised 37 times at the WTO against this Indian TBT.

5. One goal of STCs for the WTO is to lower the number of dispute settlement at the WTO ([Bollyky and Mavroidis, 2017](#); [Davey, 2022](#)). It also aims at facilitating trade, in line with the TFA (Trade facilitation act) ([Eliason, 2015](#)).

6. For more information, see [WTO's TBT and SPS committee website](#).

In the STC literature, it is assumed that a concern is raised because a TBT (or SPS) measure is impeding trade, hence, STCs should signal the most restrictive TBTs (J. C. Beghin, Maertens, et al., 2015; A.-C. Disdier, Fugazza, et al., 2020; L. Fontagné and Orefice, 2018; L. Fontagné, Orefice, et al., 2015; Horn and Wijkström, 2013; Kamal and Zaki, 2018; Orefice, 2017; Singh and Chanda, 2021)<sup>7</sup>. Any WTO member, on its own or with other members, can submit a STC to address several issues linked to trade barriers or not (cfr. Appendix A.2, table 23). Once a STC has been raised, it can be raised again, by the same country or by others. The different dates of complaints are recorded as follows: the "First raised date" is for the first concern raised against a specific TBT (or SPS), the "Last raised date" is the last one recorded by the WTO. Between the First and the Last raised dates, there might be several raised dates. The concern is recorded as resolved when there are no new raised dates for two years.

One strand of the STC literature (based on the WTO STC database) proves its initial intuition that STC measures slow down trade, through firm-level studies with exports (or imports) from one country. Another strand of the literature (also based on the WTO STC database) shows that TBT STCs act as substitutes for tariffs. However, the WTO STC database does not include Initiation and In Force dates and stops in 2012. Lacking information on Initiation and In Force dates, the literature makes the strong assumption that raised dates effectively proxy In Force date<sup>8</sup>. The implicit assumption is that the timing of concern is poorly relevant<sup>9</sup>. We argue that this assump-

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7. The literature distinguishes among two definitions for restrictive TBT. A loose definition of restrictiveness considers that the presence of STC is enough (as used in the recent literature (Herghelegiu, 2018)). For a stricter definition of restrictiveness, the STC must not have been withdrawn and should be In Force before the Last raised concern (Singh and Chanda, 2021).

8. Except for the small database of 7 TBT STCs of Singh and Chanda (2021), limited to the Indian case.

9. However, it obviously goes against the literature on uncertainty and trade shocks (Carballo et al., 2018; Coelli, 2018; Handley and Limao, 2015; Handley and Limão, 2017, 2022; Handley, Limão, et al., 2020; Iodice, 2019; Limão and Maggi, 2015) which suggests

tion needs to be relaxed and use a richly informative dataset with raised and In Force dates.

Using In Force dates helps solve two potential endogeneity issues. First, a STC raised date might occur a long time before or after the implementation of a TBT (i.e. In Force date). Second, as mentioned by [M. Ghodsi et al. \(2017\)](#), a TBT (potentially) affecting trade in a negative way increases the reasons to complain at the WTO, and complaints (i.e. raised dates) might impact trade. These drawbacks can be removed with more refined data that track the timings of In Force dates, Initiation dates, and raised dates<sup>10</sup>.

We contribute to the present literature in three ways. First, we build a rich dataset on TBT STCs; second, we advance the methodological approach to study TBT STCs; third, in terms of results, we provide new evidence on the impacts of TBT STCs on trade.

We built an updated STC database, going until 2021, with TBT notifications (i.e. Initiation dates), raised dates and enforcement dates, matched on a 1:1 basis.

Regarding methodology, the new database allows us to study whether the coefficients for STC raised dates significantly differ from the ones for TBT Initiation and In Force dates. It also allows us to control for all timings between dates observed at the WTO.

As for the results, we do find a significant bias when using raised dates instead of In Force dates, except for manufacturing sectors. Also, as expected, in all sectors together and in manufacturing only, TBT STCs implementation dates hit trade negatively (in the short and the long run). It is not the

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that the uncertainty of trade shocks and policy outcomes affects the economic decisions of the exporting firms and of policymakers. Indeed, we can expect that complaining to the WTO (a political choice) before or after the shock to trade caused by the new TBT does not bring the same level of uncertainty.

10. Adding In Force dates allows distinguishing two main timings: the In Force date (i.e. the policy decision and trade shock) is either before (i.e. no uncertainty included in the raised dates estimates) or after the raised dates (uncertainty included in the raised dates estimates).

case in agriculture where we find positive impacts. Looking at manufacturing and agriculture, we find that splitting TBT STCs timings is relevant. In manufacturing, a significant trade shock occurs only when the implementation precedes complains. In agriculture, In Force date and First raised date are significant when In Force is before (timing 1) or after (timing 2) First raised date. However, they are very different. Finally, we find that sectors with the highest volumes of trade are the ones hit by a TBT STCs, and that developed countries (belonging to the g20) are more significantly impacted by new TBT STCs.

The remaining of the paper presents the extant debate (section 3.2), the construction of our database and stylized facts on TBTs in several industries (section 3.3). We continue with the methodology (section 3.4) and the results (section 3.5). Section 3.6 concludes with suggestions on relevant open research questions.

## 3.2 ON THE TBT AND TBT STC LITERATURE

### 3.2.1 *TBT literature finding mixed results*

Because they cover most NTMs, researchers have shown high interest in product-related sanitary and phytosanitary measures (SPSs) and technical barriers to trade (TBTs)<sup>11</sup>. Both NTMs came into effect in 1995 after the Uruguay Round negotiations. In the SPS and TBT agreements, the intention is to protect consumers and the environment, to prevent protectionism and to help industrial standardization, giving technical boundaries for specific products<sup>12</sup>. TBTs and SPSs often apply to a product in one or several industries at once, and thus may impact a whole sector, either improving

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11. There are currently roughly 45,000 TBTs notified compared to 30,000 SPSs (measures for the period 1995-2022). See [WTO website](#) for more information.

12. Annex A.1. ([GATT, 1994a](#)) is clear on SPSs which are "any measures applied (...) to protect human or animal life or health". In the same vein, article 2.2 of TBT agreement recognizes that TBTs "ensure the quality of its exports, or for the protection of human, ani-

trade (e.g. bringing a better information and increasing trust among partners) or hurting it (e.g. increasing the compliance cost for both exporters and domestic firms and the administrative burden, such as new environmental and production process requirements)<sup>13</sup>. Since TBTs cover all types of industries contrary to SPSs and since they are more numerous, we focus on TBTs.

Concerning TBTs, the empirical literature finds mixed results on the trade impacts of TBTs. For some papers in the literature, TBTs hurt trade. For example, [Otsuki et al. \(2001\)](#) use a gravity framework to study the effect of aflatoxin European standards on the exports from African countries and find that they hinder trade. Also with a gravity framework, [Cadot and Gourdon \(2016\)](#) discover a negative effect of TBTs on trade for half of the product lines and [Wood et al. \(2017\)](#) find a negative impact of TBTs on Korean exports to China. Several authors ([Arita et al., 2017](#); [Francois, Manchin, et al., 2015](#); [Winchester, 2009](#); [Yue and J. C. Beghin, 2009](#)) simulated the trade impacts of TBTs reduction along tariff reduction through trade partnership. They show that removing TBTs improves trade.

For other papers, results are mixed. [Moenius \(2004\)](#) uses a gravity framework and he finds that manufacturing trade is favored by country-specific TBTs, mainly because TBTs bring valuable information to adapt the product to each market. On the other hand, trade in agriculture is hurt. [A.-C. Disdier, L. Fontagné, et al. \(2008\)](#) use coverage ratios to measure the trade impact of TBTs in agriculture. They find that exports from developing countries are hurt while there is no significant impact of TBTs on developed countries' exports. Some countries and products are positively impacted by TBTs. Also, EU imports are more negatively hit by TBTs than other OECD

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mal or plant life or health, of the environment, or for the prevention of deceptive practices (...)"

13. For TBT, the initial intention was to "prevent protectionism" and to allow also each member to "enact product regulations for approved (legitimate) public policy purposes". Legitimate public policy purposes is defined in the TBT Agreement ([GATT, 1994b](#)) in Article 2.2. (but not exclusive). It also includes technical harmonization and quality standards.

countries' imports. [Mangelsdorf \(2011\)](#) reports a negative shock of Chinese standards on Chinese imports but a positive effect of European standards on European imports. [Bratt \(2017\)](#) uses a disaggregated gravity framework and finds that TBTs affect trade either positively or negatively. The size of the negative impact is greater for TBTs from low-income countries.

Finally, for a group of papers, TBTs improve trade. [Bao and Qiu \(2012\)](#) look at the TBTs raised between 1995 and 2008. They find that, while the probability of export was decreased by TBT notifications, the volume of export increased. The intensive margin (the volume of export) was positively impacted while the extensive margin (the number of export markets and products) was negatively impacted. They argue that the positive effect on trade volume is due to the increased consumer confidence and to the TBT's differential effects on the fixed and variable cost of export. They also find that TBTs from developed countries affect exports from all types of countries while TBTs from developing countries only affect exports from developing countries. [L. G. Fontagné et al. \(2005\)](#) find positive impacts of TBTs on trade for manufacturing products. [M. X. Chen, Wilson, et al. \(2008\)](#) find that both quality standards and labels impact positively the volume of export (the intensive margin) and that only quality standards increase the number of export markets and products (the extensive margin). [Bao and W.-C. Chen \(2013\)](#) show that TBTs increase the volume of trade and the duration of existing trade relationships. The volume of trade is mainly increased by the extensive margin (i.e. the number of products traded). TBTs implemented by developing countries have higher positive impacts on trade volume. Using the NTM global (HS6 level)'s [Kee et al. \(2008\)](#) database, [J. C. Beghin, A.-C. Disdier, et al. \(2015\)](#) show that 39% of product lines are affected positively by TBTs. Finally, [Fernandes et al. \(2021\)](#) show that firms' exports increase for trade relationships which include more TBTs and that it is even more so for smaller firms.

### 3.2.2 *Specific Trade Concerns literature finding straightforward results*

Because of those mixed results, some part of this literature has decided to focus on the most stringent TBTs, to get more straightforward results. Using TBT STCs only, the impact of TBTs on trade is expected to be negative. The STC literature mainly proves its initial intuition that STC measures slow down trade. It uses firm-level databases with exports or imports from one specific country and with the initial WTO STC database which does not include Initiation and In Force dates and stops in 2012. [L. Fontagné and Orefice \(2018\)](#) study the impact of TBT STCs on different margins of trade using firm-level data from French exporters. The proxy for trade impact is the interval  $[t-1;t+1]$  around all the raised dates (not the In Force dates since it is not available in the initial WTO STC database)<sup>14</sup>. They show that export participation drops even more for multi-destination firms. A TBT is taken as an additional cost burden and many firms will divert trade towards a destination with no restrictive TBTs. They also measure the aggregate impacts at the sector level, finding heterogeneous impacts across sectors. Sectors composed of similar firms in terms of size are more roughly hit by TBT STCs. [L. Fontagné, Orefice, et al. \(2015\)](#) produce a similar study on SPS STCs and export. They show that large firms are less negatively impacted by a new SPS STC than small and medium size firms. [Kamal and Zaki \(2018\)](#) find similar results using the same dummy for TBT STCs with Egyptian firms. They also find that TBTs change firms' product diversification heterogeneously across industries. It increases the diversity of agricultural goods while having mixed effects on non-agricultural products. Finally, another interesting work on intermediate Indian firms is from [Singh and Chanda \(2021\)](#). Taking only 7 concerns raised against India, they manage to add the information on the In Force date using the date of notification in the Gazette of India. They show that TBT STCs are significantly de-

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14. Since all STCs can be withdrawn without notification, they assume that their dummy goes back to 0 two years after the last concern.

creasing imports for OECD countries only. It suggests that stricter TBTs are lessening the access of non-OECD countries to high-quality inputs. They find that TBTs lead importers to decrease their markups more than non-importers (concerning intermediate inputs producers) with no significant impact on prices.

Another part of the literature shows that TBT STCs act as substitutes for tariffs. Again, the old WTO STC database is used. The proxy for trade impact is not the In Force date but the interval  $[t-1; t+1]$  around a specific period around raised dates. [Orefice \(2017\)](#) uses the interval  $[t-1; t+1]$  around All raised dates and makes a distinction between sectors to study if TBT STCs (manufacturing) and SPS STCs (agriculture) are substitute for tariffs and find stronger and more significant results in manufacturing (table 4) but he does not compare those sectors and do not study them within TBT STCs. He also adds details concerning the level of development of trade partners. Countries with similar development complain more after a tariff reduction than pairs with different levels of development (developed - developing country pairs). [Herghelegiu \(2018\)](#) finds that only TBTs raised as STCs are substitutes for tariffs. She uses the interval  $[t-1; t+1]$  around the raised date. [Beverelli et al. \(2019\)](#) use the TBT STC First raised date in year  $t$  and show that TBT STCs are replacing tariffs only in developed economies.

Finally, a sector-level study from [M. Ghodsi et al. \(2017\)](#) investigates the trade impact of each NTM. They look inside manufacturing sector into different industries (hs2 level) and also find heterogeneity while often negatively impacting trade. They find opposite and heterogeneous results specifically when comparing TBT STCs across industries. Interestingly, TBT STCs impact positively trade at the mean but negatively at the median, suggesting that big exporters benefit from TBT STCs contrarily to most other firms.

In conclusion, the literature tries to focus on the most stringent TBTs by looking at TBT STCs. But, lacking information on Initiation and In

Force date, the literature makes the strong assumption that raised dates effectively proxy In Force date<sup>15</sup>.

### 3.2.3 *In Force dates must be taken into account*

As it is explained by [L. Fontagné and Orefice \(2018\)](#), the dummy TBT (or SPS in [L. Fontagné, Orefice, et al. \(2015\)](#)) reflects "the existence at time  $t$  of an ongoing (unresolved) TBT (...) turns to zero when the TBT concern is solved" (p.650). However, they also make the case that they only observe raised dates (at the WTO). As they say, it assumes that "a STC is raised the same year of the underlying TBT measures"(p.650). Thus, the literature relies on the assumption that the raised dates at the WTO effectively signal the trade shocks brought by TBTs (or SPSs).

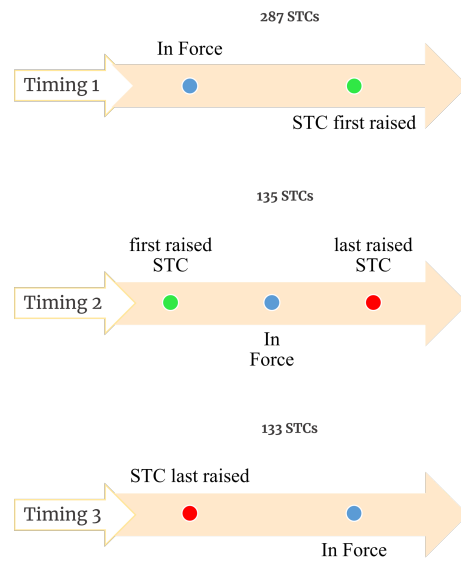
However, the timings may be very different across STCs (see figure 1). Not accounting for timings between Initiation, In Force, and raised dates disregards the results from the literature on uncertainty and trade shocks ([Carballo et al., 2018](#); [Coelli, 2018](#); [Handley and Limao, 2015](#); [Handley and Limão, 2017, 2022](#); [Handley, Limão, et al., 2020](#); [Iodice, 2019](#); [Limão and Maggi, 2015](#)). For example, [Coelli \(2018\)](#); [Handley and Limao \(2015\)](#); [Handley and Limão \(2017\)](#) show that firms tend to postpone their investment or technology upgrading (e.g. to enter a new foreign market) when there is trade uncertainty (around the entry into force of new trade agreements). [Iodice \(2019\)](#) shows that it is also the case when new TBT STCs are initiated and implemented<sup>16</sup>. Having raised concerns before or after the In Force date is a new distinction that can be made to study the role of uncertainty on trade. Indeed raising concerns before the In Force date is a sign of uncertainty (compared with raising them after).

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15. Except for the small database of 7 TBT STCs of [Singh and Chanda \(2021\)](#).

16. Specifically, she makes the distinction between notified and unnotified TBT STCs to show the effect of uncertainty.

Figure 1 – Classification of timings observed across TBT STCs



Notes: authors' calculations. The distribution of timings is 51.7% when the implementation is before the concern, 24.3% when the implementation is between the raised dates, 24% when the implementation is after the Last raised date.

But more importantly, using raised dates brings up two potential issues. Using the updated STC database, we solve both using the interval  $[t-1; t+1]$  around the In Force date (i.e. the year before, the same year or the year after) directly. It is the date that previous researchers were aiming at in the previous literature but not able to use<sup>17</sup>

A first endogeneity issue is that a STC raised date might be misleading. It can occur a long time before or after the TBT trade shock. It could bias the estimation. Out of the 555 STCs for which we have the information on the In Force date, 30.6% are raised at least two years before or after the In Force date. It drops to 12.4% for STCs raised at least 4 years before or after

17. L. Fontagné and Orefice (2018) do acknowledge the fact that the "In Force" date is the one that needs to be studied when saying "a STC is raised the same year of the underlying TBT measures" (p.650).

the In Force date but it remains non-negligible and a potential source of measurement error<sup>18</sup>.

A second issue is that, as mentioned by [M. Ghodsi et al. \(2017\)](#), raised dates might bring endogeneity because a TBT affecting trade negatively increases the reasons to complain at the WTO and complaints might impact trade positively (negatively) in return, as if hope (fear) for change could boost (hinder) trade. Using only STCs might be biased in the positive (negative) direction. Knowing the timings between In Force dates, Initiation dates, and raised dates, we can control this potential simultaneity bias (see figure 2). We can examine whether raised dates effectively measure the impact of TBTs (or SPSs). Then, we give a representative picture of TBTs (SPSs) impact on trade. We can also control the different timings separately (see figure 1, keeping only the STCs raised before (during, and after) the In Force date: 51.7% (24.3%, and 24% respectively) out of the ones for which we know the In Force dates.

### 3.3 CONSTRUCTION OF A MERGED DATABASE OF STCS AND GRAVITY DATA

In order to measure the impact of TBT on trade, we merged data from 5 different databases: bilateral export flows from the ITPD-E database, the updated STC database, the WIIW dataset, the Dynamic Gravity Dataset, and TRAINS bilateral tariffs. After the merging, we are left with 178 countries and 131 industries for the period 2000-2016 (the ITPD-E time period).

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18. In their study, [Beverelli et al. \(2019\)](#) show that 88.7% of STCs (among 291 STCs with information on the Initiation date and on the hs4 products linked to the TBT) were introduced in the year of Initiation of the corresponding TBT or the year before. In our own calculation with the updated STC database, it drops to 72.7% out of 578 STCs with information on the Initiation date and on the hs4 products. While it reveals a majority of new STCs, as it is called by [Beverelli et al. \(2019\)](#), it does not consider the In Force date. Neither does it dig into the case of "old" STCs (the STCs raised at least two years before or after the In Force or Initiation dates).

The database considers importer-sector and exporter-sector pairs for which at least one TBT STC occurs<sup>19</sup>.

The ITPD-E database has the advantage of including domestic trade, and it built from reported administrative data (Borchert et al., 2021). ITPD-E combines ISIC industries into 170 sectors (agriculture, mining and energy, manufacturing, and service) and gives the most precise data at the sectoral level of aggregation.

We complete our database with other important explanatory variables proxying trade cost. The tariffs come from the UNCTAD TRAINS (Trade Analysis Information System) through the WITS portal (World Integrated Trade Solution). TRAINS contains information on tariffs for over 160 countries. Missing years have been replaced by the nearest year available<sup>20</sup>. Tariffs are AVEs AHS (Ad Valorem Equivalent weighted average of effectively applied rates) and take the UNCTAD 2 method for AVEs, which uses HS-6 digits import statistics of all OECD countries and keeps the margin of preference in the preferential tariff. AHS rates with UNCTAD 2 method work as follows: tariff statistics are weighted by import values<sup>21</sup>. The effectively applied tariff takes either the lowest available preferential tariff if available, or the MFN (Most Favored Nation) applied tariff. One reason for using AHS rates instead of simple average MFN tariffs is that it varies by partner and through time. It allows taking tariffs into account with a simple PPML (Poisson Pseudo Maximum Likelihood) approach with several FEs (fixed effects).

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19. Unless a complaint is filed against a specific member of the EU, we aggregate European countries into the EU in terms of trade flows. Indeed, the EU complains as a whole and most concerns from non-EU countries are against the EU as a unique entity.

20. We check the box "earlier year wins ties" to avoid missing observations.

21. This is subject to caveats: extreme values bias the results. Indeed, a very high tariff likely implies small imports and, hence, it has a low weight. It might lead to prohibitive tariffs having the same weight as zero tariffs. However, taking the simple average tariff (i.e.: not weighted) would also bring some issues. Some goods with very high import levels will have the same impact regarding tariffs as a good with very low import levels. That is if they have both the same tariff level.

We add information on other NTMs from WIIW (The Vienna Institute for International Economic Studies). The WIIW NTM database is an augmented WTO's I-TIP (Integrated Trade Intelligence Portal) database. It provides more HS 6-digit codes (missing codes dropped by 55% to 22.3%) and more details on the NTM types. Compared to the WIIW database, our update of the STC database has three times higher number of observations on TBT STCs<sup>22</sup>.

The Dynamic Gravity Dataset provides demographics, country characteristics such as distance, colonial ties, GDP, or preferential agreements, etc (Gurevich and Herman, 2018). One version of this dataset was made to fit the ITPD-E database in the same time span (2000-2016). The Dynamic Gravity Dataset includes data for the European Union as a whole and updates its composition through time<sup>23</sup>.

TBT STC data comes from the STC database for information on raised dates. It comes from the I-Tip NTM database for information on the Initiation and In Force dates, and it records 725 concerns raised at the TBT committee between 1995 until 2021. It provides information on the objectives, the issues raised, the HS2017 4 digits codes<sup>24</sup>, the First raised date and all subsequently raised ones, the complaining and the maintaining coun-

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22. WIIW database has 35,686 observations at the sectoral level, on TBT STCs. We rely on 99,302 observations, included those in the WIIW dataset.

23. We study the EU with the 15 first members since it allows avoiding jumps in trade when integrating new members. As a result, we created a country "EU-15" based on both Dynamic Gravity Dataset and ITPD-E data.

24. We compute the corresponding ITPDE code which are at the ISIC 3.1 level using the correspondence table provided by Borchert et al. (2021) and a correspondence table which we build for HS2017 4 digits codes. Note also that we do not use the HS6 level because, first, it will not change the result of aggregation needed to match the ISIC codes, and, second, because, in any case, the TBT IMS website gives HS4 level is available for 88.98% of the TBT STCs (while HS6 is available only for 16.53% of the TBT STCs). Indeed, no HS code is given for 11.02% of the database. Figure 15 shows the number of HS4 lines used in TBT STCs through time and figure 16 shows the distribution of HS lines present in TBT STCs.

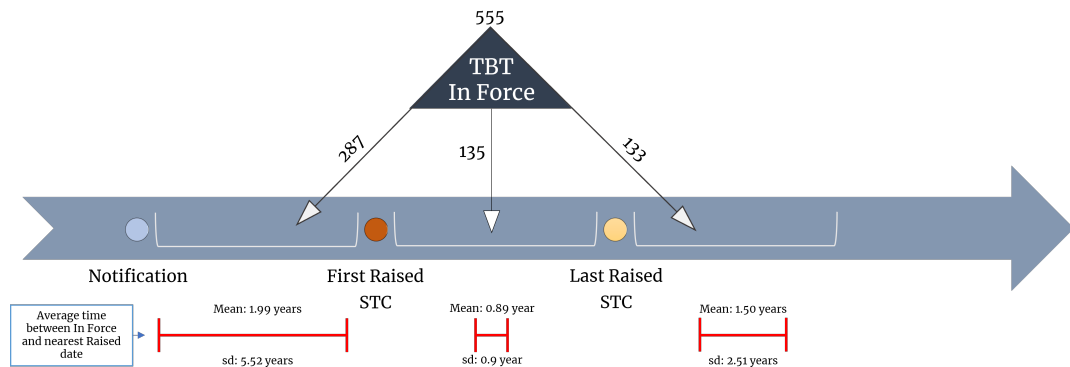
try(ies). We match the STC unique codes (i.e. the identifiers available on the TBT IMS [website](#)) with the notification codes available in the I-Tip NTM database. We filled some missing dates manually using the online TBT IMS database and recorded meetings minutes<sup>25</sup>. Having the Initiation, In Force, and raised dates allows us to compute information on the duration of the STC issue, and on the timing of In Force and Initiation dates regarding complaining dates. As shown in figure 2, while all TBT STCs have an Initiation date before a First and Last raised date, the In Force date might occur at any point before, between, or after raised dates. Put differently, countries may complain either before or after the TBT has been implemented.

Table 7 presents descriptive statistics on the time distance between Initiation and In Force dates (in the top subtable), and between First and Last raised dates (in the bottom subtable). The time for implementing a new measure is longer for TBTs (13 months) than for all NTMs (almost 10 months on average). TBTs with concerns take even more time (almost 16 months). Differences are also observed for TBTs with concerns before or after the implementation. When the raised dates are before the implementation date, it takes more time (26 months) to implement a new TBT than when the raised dates are after the In Force date (9 months). Unconditional average time span between the First and the Last raised dates is 16 months. However, when concerns are made after the implementation of a new TBT, the duration of concerns is three times longer. Early complaints are associated with a shorter duration of the complaint process. Complaints after the implementation are twice more numerous than complaints before implementation (296 vs 133 STCs). Figure 3 shows that it is constantly the case, except in 2020.

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25. In the same vein as [Iodice \(2019\)](#). However, note that she did not use the I-Tip database nor extended the number of TBT STCs covered in the previous STC database used in the literature. Also, her database supplements ours in the sense that it also includes adoption dates, which we do not account for knowing it is always included in the time period around the In Force date  $[t-1; t+1]$ .

Figure 2 – Time distance between implementation and concern



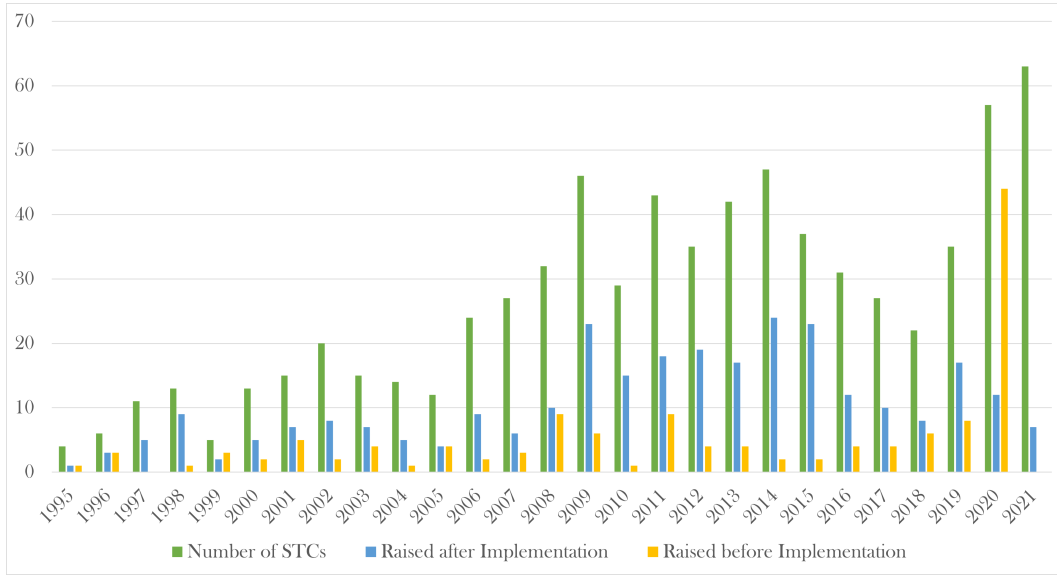
This timeline illustrates the three timings occurring in the TBT STCs process. For almost half of STCs with available In Force dates, they follow the In Force date. Then, they split evenly between concerns raised before the In Force date or for which the In Force dates are between different raised dates. Each case must be interpreted separately. Also noted are the mean and the standard deviation of the time distance between In Force date and nearest raised date against a TBT STC. Two similar tables (table 27 and 28) compare initiation and in force dates. Table 29 studies the average time span between first and last raised dates of a STC. Finally, table 30 looks at the average number of raised dates per timing.

Table 7 – Length of TBT implementation and length of complaint

| Time distance between Initiation and In Force date in months |      |      |      |      |      |             |              |
|--------------------------------------------------------------|------|------|------|------|------|-------------|--------------|
| Measure                                                      | Mean | s.d. | p25  | p50  | p75  | Nb. Of Obs. | Source       |
| NTMs                                                         | 9.5  | 12.9 | 0.0  | 7.8  | 13.6 | 9423        | WIIW         |
| TBTs                                                         | 13.1 | 17.3 | 3.6  | 7.8  | 14.9 | 2080        | WIIW         |
| TBT STCs All Timings                                         | 15.5 | 22.4 | 2.4  | 8.0  | 20.2 | 463         | STC database |
| STCs after Implementation                                    | 9.4  | 16.6 | 0.1  | 2.9  | 9.2  | 207         | STC database |
| STCs before Implementation                                   | 25.9 | 29.0 | 8.7  | 17.6 | 29.8 | 130         | STC database |
| STCs around Implementation                                   | 14.6 | 19.0 | 3.8  | 8.0  | 16.7 | 126         | STC database |
| Time distance between First and Last raised dates in months  |      |      |      |      |      |             |              |
| Measure                                                      | Mean | s.d. | p25  | p50  | p75  | Nb. Of Obs. | Source       |
| All Timings                                                  | 16.2 | 26.1 | 0.0  | 6.0  | 19.6 | 555         | STC database |
| Concern after Implementation                                 | 12.2 | 19.8 | 0.0  | 4.4  | 16.5 | 286         | STC database |
| Concern before Implementation                                | 4.8  | 9.0  | 0.0  | 0.0  | 6.0  | 133         | STC database |
| Concerns around Implementation                               | 35.7 | 36.6 | 11.0 | 24.0 | 50.1 | 136         | STC database |

Source: Author's calculations on the updated STC database for 2000-2021 period. Notes: In the bottom part the of the table, only STCs with In Force date available are taken into account

Figure 3 – Growth of STCs splitting in terms of timings



Notes: Author's calculations based on the updated STC database.

### 3.4 EMPIRICAL STRATEGY WITH GRAVITY FOR SECTOR LEVEL ESTIMATION

Theoretically, the framework builds from the [Melitz \(2003\)](#) and [Chaney \(2008b\)](#) models of firm heterogeneity, as in chapter 2. TBTs impact trade through the quality standard (fixed minimum quality cost)  $\theta_{ij,t}^k$  present in the modified gravity equation derived by [Gaigné and Gouel \(2022\)](#) from the initial gravity equation ([Yotov, 2022](#)):

$$X_{ij,t}^k = \frac{Y_{i,t}^k E_{j,t}^k}{Y_t^k} \left( \frac{\tau_{ij,t}^k}{\Pi_{i,t}^k P_{j,t}^k} \right)^{-\gamma^k} \left( E_{j,t}^k \right)^{\frac{\gamma^k}{\sigma^k-1}-1} \left( \theta_{ij,t}^k \right)^{1-\frac{\gamma^k}{\sigma^k-1}+\frac{\gamma^k(\beta^k-1)}{\alpha^k}} X_{ij,t}^k \quad (37)$$

where:  $i$  and  $j$  are the exporting and importing countries, respectively,  $k$  is the industry, and  $t$  is the year.  $X_{ij,t}^k$  is the nominal export (in levels) from  $i$  to  $j$  in industry  $k$  at time  $t$ ,  $Y$  is the production at price factory and  $E$  is the expenditure in the importing country.  $\tau_{ij,t}^k$  denotes the bilateral trade frictions between  $i$  and  $j$  in industry  $k$  at time  $t$  (such as tariffs, distance, different languages, etc.).  $\theta_{ij,t}^k$  is the quality standard. As described by [Gaigné](#)

and Gouel (2022), it covers the minimum cost necessary to be allowed to sell in one destination market. It includes the NTMs, the TBTs, and TBT STCs (which are viewed as quality standards).  $\Pi$  is the outward and  $P$  is the inward multilateral resistance of Anderson and Van Wincoop (2003).  $\chi_{ij,t}^k$  is a function of exogenous parameters distinct from trade costs.  $\sigma^k$  is the elasticity of substitution between the varieties in  $k$ . Since we use industry-level estimates, the above gravity model implies that the TBT STCs are industry specific. Also, the FEs are of the country-industry-year dimension.

An interesting idea of this model is that trade reacts positively or negatively with a change of  $\theta_{ij,t}^k$  because  $1 - \frac{\gamma^k}{\sigma^k - 1} < 0$  and  $\frac{\gamma^k(\beta^k - 1)}{\alpha^k} > 0$ . All in all, these means that fewer firms will be serving the destination market (through  $\gamma$ <sup>26</sup>), exports increase with more varieties (through  $\sigma$ ), love-for-quality improves the positive link between  $\theta$  and  $X$ , and the quality elasticity of fixed cost ( $\alpha$ ) does the opposite.

We consider that a bias is the distance with the In Force date estimation (which is the benchmark). We test the impact of TBT STCs on trade flows using the gravity framework with two econometric models: OLS (Ordinary Least Squares) and PPML methods proposed by Silva and Tenreyro (2006). Theory and empirics strongly support the gravity framework<sup>27</sup>. For both models, we control for the internal trade as suggested by Yotov et al. (2016).

Following Silva and Tenreyro (2006), PPML panel FEs give the preferred estimates when using a gravity model. It partly answers an endogeneity issue since it controls for country-pair-time FEs and studies the within country-pair dimension. The PPML method avoids the strong heteroscedasticity present with OLS estimates. Besides, it considers zero trade flows, contrarily to OLS.

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26. This is the dispersion parameter of the Pareto distribution.

27. A broad class of trade models converges to the gravity framework, as Arkolakis et al. (2012) showed it.

My model tests if a STC in an industry (ISIC level) affects the export from  $i$  to  $j$  at a specific time  $t$  (short-term impacts)<sup>28</sup>. We ask whether exports hit by a STC differ significantly from exports not hit by a STC for an industry. We test the impact of the choice of proxy for the TBT STC with five dates: Initiation, In Force, First raised, the period between the First raised and Last raised dates, and Last raised. To compare our results, we performed five regressions, one for each date of interest.

While we regress our empirical equation for all industries at once first, we also regress it for broad sectors such as agriculture and manufacturing. They regroup several industries from ITPD-E given our selection of 131 industries. Agriculture contains 16 industries and Manufacturing contains 110 industries. We estimate at the broad sector level to obtain more exploitable results regarding policies as it avoids too heterogeneous results which are found when looking at specific industries. We still provide a sample of industry-level results in the appendix (see 31). Separate estimations for each industry also allows the FEs to vary with the elasticity of substitution<sup>29</sup>.

We study the following gravity equation:

$$X_{ij,t}^k = d_{ij}^k \times \exp \left[ c_{ij,t}^k + \beta_7^k \text{TBTstc}_{ij,t}^k + \beta_8^k \text{TBTstc}_{i,t}^k + \mu_{ij}^k + \pi_{i,t}^k + \phi_{j,t}^k \right] \times \varepsilon_{ij,t}^k \quad (38)$$

with

$$d_{ij}^k = \exp \left[ \beta_1^k \ln(\text{DIST}_{ij}) + \beta_2^k \text{CNTG}_{ij} + \beta_3^k \text{LANG}_{ij} + \beta_4^k \text{CLNY}_{ij} \right]$$

and

$$c_{ij}^k = \beta_5^k \text{TAR}_{ij,t}^k + \beta_6^k \text{NTM}_{ij,t}^k + \sum_i \beta_9^k \text{SMCTRY}_{ij}$$

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28. To be in line with the previous literature, the word "sector" is equivalent to industry and we use the word "broad sector" for more aggregate definition.

29. It considerably facilitates the interpretation of the results. In fact, it does not force us to have an estimation of the elasticity of substitution to estimate the trade costs (for example with the Ad Valorem Equivalent)

where  $X_{ij,t}^k$  is the trade flow.  $NTM_{ij,t}^k = TBT_{ij,t}^k + \text{non}TBT_{ij,t}^k$  with TBT being all non-STCs and nonTBT being all the other NTMs. SMCTRY denotes the dummy equal to 1 when the exporter is the importer. It brings in the internal trade dimension to the model.  $TAR_{ij,t}^k = \ln(1 + \text{tar}_{ij,t}^k)$  gives the elasticity of substitution as in (Yotov et al., 2016).  $TBTstc_{ij,t}^k$  signals the presence of a TBT STC in the measured industry. For our short-term analysis, it is equal to 1 when the trade year is in the  $[t - 1; t + 1]$  interval of the TBT STC date of interest<sup>30</sup>. For the long-term analysis,  $TBTstc_{ij,t}^k$  is equal to 1 from the period  $t - 1$  until the last period. The dates of interest are the Initiation date, the In Force date, the First raised date, the period between the First raised date and the Last raised date, and the Last raised date. NTM is a dummy equal to 1 around the NTM In Force date period (in  $[t - 1; t + 1]$ ). It controls for all NTMs other than  $TBTstc_{ij,t}^k$ .  $d_{ij}$  are the bilateral trade costs. Finally,  $TBTstc_{i,t}^k$  is the interaction between SMCTRY and  $TBTstc_{ij,t}^k$ <sup>31</sup>.  $\mu_{ij}^k$ ,  $\pi_{i,t}^k$ , and  $\phi_{j,t}^k$  are country sector pair, importer-year and exporter-year fixed effects, respectively. They account for the multilateral resistance terms in the theoretical model of gravity from Anderson and Van Wincoop (2003) and they give much more explanatory power than without them (higher R-squared) as well as discard most endogeneity<sup>32</sup>. Specification (38) (with pair sector FEs) will present our main results. It is true that it comes with the issue that we cannot estimate the variables

30. To measure the impact of TBTs on trade flows, we choose to use dummy variables because they assume the stringency of the TBTs (F. G. Santeramo and Lamonaca, 2019). The interval  $[t - 1; t + 1]$  accounts for the time to adapt and the potential bias coming from the aggregation of dates from day format to year format. Dolabella (2020) and Herghelegiu (2018) recommend using lag values.

31. While for typical policy variables it creates a variation across FE dimensions and allows estimating the standard gravity variables, our  $TBTstc_{ij,t}^k$  already varies through time and we do not need this interaction to estimate its impact on trade with a standard PPML framework.

32. However, we did not include pair-sector-country FEs because they remove all the variables varying in the same dimension as the FEs (which are collinear) and leaves us with almost none variability and no explanatory power.

varying in the same dimension as pair FE:  $\text{var}_{ij}^k$ . But,  $\text{var}_{ij}^k$  component are not the variables of interest of our paper. We need to include them in the regression but we cannot obtain their estimates. Finally, our standard errors are robust and clustered at the pair country sector level.

We have two reasons for implementing internal trade. First, it is advised by [Yotov \(2022\)](#) because it renders more accurate gravity estimates. Second, it allows identifying potential discrimination between domestic and foreign producers. Since this last reason is secondary to our main point, we deal with that in the appendix<sup>33</sup>.

We expect the  $\text{TBTstc}_{ij,t}^k$  estimates ( $\beta_7$ ) to be negative or positive, depending on the sector. If we follow the literature, the total sector estimation could give positive results according to [M. Ghodsi et al. \(2017\)](#) because some sectors with higher trade levels show strong positive impacts, moving the total effect in the positive area even though TBT STCs potentially affect many sectors negatively. Intuitively, it is more obvious to think of TBT STCs as hitting trade flows negatively. Indeed, it makes sense that a negative trade shock would cause a complaint to be issued at the WTO. However, a positive TBT could also be brought to the WTO TBT committee if the reasons for the complaint are for clarity reasons more than trade barriers reasons. It is also possible that countries invoke trade barriers at the WTO only to add political pressure on the maintaining member. Finally, and maybe more importantly, complains are intuitively more likely to be made for sectors with important trade flows. Those sectors are more politi-

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33. We expect a TBT will lead to a higher compliance cost for both exporters and domestic firms. We can measure whether the exporters' compliance cost is lower or higher. We do so by looking at significant changes in trade volumes after introducing a TBT STC (knowing we assume TBT STCs select significant TBTs). If the estimate of  $\text{TBTstc}_{i,t}^k$  on the exported quantities is negative (positive), then exporters are better (worse off) than domestic producers in terms of profits. A similar analysis can be done with price: if the resulting increase of the import price is lower (higher) than the one of the domestic price, then exporters are better (worse off) than domestic producers regarding profits. However, we do not observe price in the ITPDE database.

cally decisive. As a result, a positive impact is not especially due to the TBT itself but rather the proof that trade is in action. We propose to discuss this in our results. We will also be interested to look at the size and significance of the estimates.

The coefficients  $\beta_7$  for the  $TBTstc_{ij,t}^k$  variable give the expected decrease or increase of log export quantities when there is a TBT STC. A simple operation gives the percentage change in exports.

$$TVE = \Delta T = (e^{\beta_7^k} - 1) * 100 \quad (39)$$

Trade volume effects (TVE) are computed following [Yotov et al. \(2016\)](#).  $\beta_7^k$  are the TBT STC dummies coefficient of interest.

Finally, we wish to find the potential bias that is caused by the use of the wrong date (i.e. the raised date). The bias  $\zeta = \beta_{\text{raised}}^k - \beta_{\text{inforce}}^k$  will be significant only when either  $\beta_{\text{inforce}}^k$  and/or  $\beta_{\text{raised}}^k$  are significant, a non-significant results leading to no trade effect.

### 3.5 RESULTS

The results of the gravity equation specified in equation 38 are shown in tables 8, 9, and 10.

We first look at the short-term impacts of TBT STCs<sup>34</sup>. Without distinction in timings, in tables 8, 9, and 10, we compare proxies used previously in the literature with the new observed variables for In Force and Initiation dates. Then, we test the bias of using raised dates<sup>35</sup> to proxy In Force dates (to answer the two endogeneity bias potentially present in the literature when using raised dates to measure the effect of TBTs on trade flows)<sup>36</sup>. Still looking at the short-term impacts, we also look at whether when and

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34. A discussion on the standard gravity estimates and different fixed effects specification is provided in the appendix section [A.2.1](#)

35. We select the most intuitive one for our research question: First raised dates.

36. I.e. a. raised dates inadequately proxy the trade shock occurring at the In Force date and b. industries might react to a complaint defending them at the WTO.

who complains matter. We focus on the influence of timings on our results (in table 14) and we look at what are the characteristics of complainers (in tables 15 and 16). Finally, we look at the long-term impacts of TBT STCs. Long-term impacts show how TBT STCs structurally change the volume of trade.

### 3.5.1 Short-term TBT STC impacts

#### 3.5.1.1 Impact of our different dates of interest

**Result 1.** *Across all specifications, In Force date impacts trade more significantly and with larger impacts than the other dates.*

Through all three tables (8, 9, and 10), we constantly find that In Force date impacts trade more significantly and with larger impacts than the other dates. It makes sense that the moment when the TBT is implemented is the most trade impacting. In addition, Initiation, when significant, is the less significant date of interest and renders the lowest impact on trade.

**Result 2.** *For all sectors together and for manufacturing, around the In Force date, trade decreases significantly.*

We first look at the short-term impacts when taking all sectors together in table 8. The two variables used in the literature to proxy In Force dates (i.e. First raised and All raised) are not significantly impacting trade at this level of aggregation. On the other hand, In Force (the true estimate) is significantly impacting trade, in a negative way. Around the In Force date, trade is decreasing by 2.76%, on average (using  $TVE = \Delta T = (e^{\beta_k} - 1) * 100$ ). In terms of intranational trade, it decreases only by 0.4%. Note that for other gravity variables such as tariffs and the other NTMs, we also find a significant impact on trade. The tariff estimates are the elasticity of substitution ( $-\sigma$ ) (Yotov et al., 2016): an increase of one percent of tariff is decreasing trade by 0.223%. NTMs which are not TBT STCs are, on

average, increasing trade by 0.3%. Note that those results seem to be robust when checking for reverse causality. Indeed, in table 26 in the appendix, we look at the effect of lead and lags of the variable TBT STC and we find no significant impact before and after 1 year around the date of interest (as assumed by the previous literature).

Table 8 – Average short-term impact of TBT STC dates in all sectors

|                             | (1)                  | (2)                  | (3)                  | (4)                  |
|-----------------------------|----------------------|----------------------|----------------------|----------------------|
| In Force                    | -0.028<br>(0.013)**  |                      |                      |                      |
| [First raised; Last raised] |                      | -0.003<br>(0.009)    |                      |                      |
| First raised                |                      |                      | -0.014<br>(0.01)     |                      |
| Initiation                  |                      |                      |                      | -0.006<br>(0.01)     |
| TBT dummy x Intra           | -0.004<br>(0.001)*** | -0.002<br>(0.001)**  | -0.001<br>-0.001     | -0.003<br>(0.001)*** |
| Other NTMs                  | 0.003<br>(0.001)**   | 0.003<br>(0.001)*    | 0.003<br>(0.001)*    | 0.003<br>(0.001)*    |
| Tariffs                     | -0.223<br>(0.083)*** | -0.243<br>(0.083)*** | -0.242<br>(0.083)*** | -0.243<br>(0.083)*** |
| No. Of Observations         | 20 657 436           | 20 657 436           | 20 657 436           | 20 657 436           |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs. 555 STCs are used (those for which we do have information on both In Force and First raised dates.)

Looking at table 9, we find that trade in manufacturing sectors is hit negatively around the TBT STC dates of interest. It is significant for all dates except for the initiation date. These results are in line with the previous literature looking at the impact of TBT STCs in manufacturing (e.g. [L. Fontagné and Orefice \(2018\)](#)). As in the literature, we find a negative impact experienced during the enforcement and a negative impact during the raised

dates. It reveals that norms in the manufacturing are costly for firms willing to export more than improving consumers' demand for higher-quality goods.

Table 9 – Average short-term impact of TBT STC dates in manufacturing

|                             | (1)                  | (2)                  | (3)                  | (4)                  |
|-----------------------------|----------------------|----------------------|----------------------|----------------------|
| In Force                    | -0.028<br>(0.014)**  |                      |                      |                      |
| [First raised; Last raised] |                      | -0.018<br>(0.009)**  |                      |                      |
| First raised                |                      |                      | -0.025<br>(0.010)**  |                      |
| Initiation                  |                      |                      |                      | -0.014<br>(0.011)    |
| TBT dummy x Intra           | -0.004<br>(0.001)**  | 0.000<br>(0.001)     | 0.001<br>(0.001)     | -0.003<br>(0.001)*** |
| Other NTMs                  | 0.003<br>(0.002)**   | 0.003<br>(0.002)**   | 0.003<br>(0.001)*    | 0.003<br>(0.002)**   |
| Tariffs                     | -0.304<br>(0.099)*** | -0.304<br>(0.099)*** | -0.304<br>(0.099)*** | -0.306<br>(0.099)*** |
| No. Of Observations         | 19 337 192           | 19 337 192           | 19 337 192           | 19 337 192           |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs. 489 STCs are used (those for which we do have information on both In Force and First raised dates.)

**Result 3.** *For agriculture, around the In Force date, trade increases significantly.*

In table 10, we find that the results for agriculture go in the opposite direction compared to manufacturing. Indeed, all dates are significantly increasing trade volumes. Trade is improved by 30.34% around the In Force date, by 12.52% around the First raised date, and by 9.47% around the Initiation date.

This result might seem counterintuitive. Like in the two previous tables, we took several fixed effects (importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs) to ensure these positive results are not due to the size of trading partners nor to the trade volumes across partners-sector relationships. In fact, the only variability left is through time. This result is in line with [J. C. Beghin, A.-C. Disdier, et al. \(2015\)](#) who also find that agriculture is more impacted than other sectors<sup>37</sup>. It is common to find positive results from TBTs, at least for part of the studied sample. Indeed, as explained in section 3.2, the literature finds either opposite results between manufacturing and agriculture ([Moenius, 2004](#)) or opposite results given the level of development of the exporting country ([Bao and W.-C. Chen, 2013](#); [Bratt, 2017](#); [A.-C. Disdier, L. Fontagné, et al., 2008](#); [Mangelsdorf, 2011](#)). Also, other authors find positive results of TBTs on trade ([Bao and W.-C. Chen, 2013](#); [J. C. Beghin, A.-C. Disdier, et al., 2015](#); [M. X. Chen, Wilson, et al., 2008](#); [Fernandes et al., 2021](#); [L. G. Fontagné et al., 2005](#)). However, except for the draft paper from [M. Ghodsi et al. \(2017\)](#), no work in the literature has found positive impacts of TBT STCs. Also, agriculture sectors' trade has not been studied directly in previous papers on TBT STCs<sup>38</sup>.

We acknowledge that positive results in agriculture might be explained by at least three reasons specific to agriculture sectors. [Bao and Qiu \(2012\)](#) explains that a positive effect found on the intensive margin (i.e. the export volume or value of each exporting country) is due to (1.) the increased consumer confidence and (2.) to the TBT's differential effects on the fixed and variable cost of exports. We argue that [Bao and Qiu \(2012\)](#)'s statement is specifically true for agriculture. Another source of difference between agriculture and manufacturing is (3.) the types of STC raised.

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37. The impact of NTMs on agriculture is investigated in detail in many previous work of the NTM literature such as in [Grant and Arita \(2017\)](#).

38. Only [Orefice \(2017\)](#) investigates the duality between manufacturing and agriculture for substitutability between tariffs and TBT STCs. He finds that results are more negative and much more significant for manufacturing through all specifications. However, again, he does not studies the same question.

On point (1.), TBTs gives information on health, safety and other issues. This encourages imports because consumers are more confident. In other words, TBTs help to correct incomplete information issues. This increases intensive margin<sup>39</sup>. We believe that consumers are much more concerned by the health and environmental issues linked to foods than standard manufacturing products.

On point (2.), as [Bao and Qiu \(2012\)](#) put it, TBTs increase both fixed costs (through higher need for inspection equipment, examination, coordination of experts, etc.) and variable costs (because of higher-quality products needed). Consequently, both costs lower the intensive margin<sup>40</sup>. However, they also find that the value of exports is raised by higher quality, leading to a dual effect on the intensive margin. Indeed, on the one hand, it costs more for producers to produce high quality products and they export less, but, on the other hand, the value of exports is improved with higher quality. Finally, with higher volumes, the fixed cost deficit becomes less important. We find that the mean value of trade, through all country-sector-year, is 31.45 million USD for agriculture while it is of 16.29 million USD for manufacturing (in our database). Following our argument, agriculture would be less impacted by the TBTs fixed costs.

Finally, another source of difference among sectors is (3.) the types of STC raised. In table 11, we show the different reasons invoked at the WTO to raise a STC. In the last two columns, we find that reasons are not the same for agriculture and manufacturing. A higher part of reasons invoked in agriculture are linked to misunderstanding on the new TBT while a larger part of reasons invoked in manufacturing are linked to perceived trade barriers or lack of time to adapt. This might explain the more negative results for manufacturing.

**Result 4.** *Stringent TBTs discriminate in favor of domestic firms.*

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39. And also the extensive margin (i.e. the number of exporting countries).

40. And also the extensive margin (i.e. the number of exporting countries).

Table 10 – Average short-term impact of TBT STC dates in agriculture

|                             | (1)        | (2)       | (3)       | (4)      |
|-----------------------------|------------|-----------|-----------|----------|
| In Force                    | 0.265      |           |           |          |
|                             | (0.058)*** |           |           |          |
| [First raised; Last raised] |            | 0.116     |           |          |
|                             |            | (0.046)** |           |          |
| First raised                |            |           | 0.118     |          |
|                             |            |           | (0.056)** |          |
| Initiation                  |            |           |           | 0.09     |
|                             |            |           |           | (0.046)* |
| TBT dummy x Intra           | 0.000      | 0.001     | 0.001     | 0.001    |
|                             | (0.001)    | (0.001)*  | (0.001)** | (0.001)* |
| Other NTMs                  | -0.005     | -0.003    | -0.003    | -0.003   |
|                             | (0.005)    | (0.005)   | (0.005)   | (0.005)  |
| Tariffs                     | 0.003      | 0.007     | 0.011     | 0.016    |
|                             | (0.104)    | (0.103)   | (0.104)   | (0.104)  |
| No. Of Observations         | 992 923    | 992 923   | 992 923   | 992 923  |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs. 58 STCs are used (those for which we do have information on both In Force and First raised dates.)

Table 11 – Stated concerns for TBTs raised at the WTO

| Type of concern                             | Number<br>of concerns | Proportion<br>in all STCs (in %) | Agriculture<br>(in %) | Manufacturing<br>(in %) |
|---------------------------------------------|-----------------------|----------------------------------|-----------------------|-------------------------|
| Further Information                         | 395                   | 17.75                            | 62.22                 | 37.5                    |
| Unnecessary barrier to trade                | 364                   | 16.36                            | 62.22                 | 58.63                   |
| Transparency                                | 342                   | 15.37                            | 62.22                 | 37.85                   |
| Other issues raised                         | 289                   | 12.99                            | 2.22                  | 1.23                    |
| International standards                     | 242                   | 10.88                            | 60                    | 16.2                    |
| Rationale, legitimacy                       | 225                   | 10.11                            | 95.56                 | 15.67                   |
| Discrimination                              | 178                   | 8.00                             | 4.44                  | 14.44                   |
| Time to adapt, "reasonable interval"        | 127                   | 5.71                             | 0                     | 42.25                   |
| Non-product related and procedural measures | 42                    | 1.89                             | 62.22                 | 24.3                    |
| Special and differential treatment          | 17                    | 0.76                             | 60                    | 0.7                     |
| Technical assistance                        | 4                     | 0.18                             | 0                     | 0.88                    |

Source: Author's calculations on the STC database for 2000-2021 period, WTO. Note: Each STC can have more than one objective. The total number of STCs raised in this database is 725.

We also address the potential discriminatory issue brought by TBTs. TBTs can be set up to favor domestic industries. However, they are supposed to be non-discriminatory according to the WTO rules. Following the work from [Yotov et al. \(2016\)](#), we include internal trade flows to measure the potential discrimination. We add an interaction between the TBT variable and a variable equal to one for intra-national trade observations (TBTdummy  $\times$  Intra). Through all three tables ([8](#), [9](#), and [10](#)), we find that discrimination is present, in majority favoring the domestic firms. Indeed, even when negative and significant, the impact of TBTdummy  $\times$  Intra is less important than the impact of the TBT STC date of interest.

### 3.5.1.2 Trade Volume Effects

Now, we measure the trade volume effect of the different dates of TBT STCs in column 2 of table [12](#). It is computed using equation [39](#) for the estimated coefficient found in the three previous tables on impacts ([8](#), [9](#), and [10](#)). In column 3, we use those results multiplied by the mean export value of all sectors, agriculture, and manufacturing to find the average

value effect in millions of USD. Columns 4 and 5 show the minimum and maximum value in millions of USD.

The decrease in export due to the arrival of a new TBT STCs (In Force date) costs 0.64 million USD during the three years around implementation. Manufacturing and agriculture differ by much, as we show in this table 12: agriculture sectors encounter a positive impact leading to a surplus of 30.34 million USD around the In Force date. Around the First raised date, it drops to +12.54 million USD. However, in manufacturing, sectors face a drop of almost 0.5 million USD in trade volume, on average, around both In Force and First raised dates.

Table 12 – Trade volume effects of TBT STC measures

|                            | Estimated<br>coefficient | Trade<br>volume<br>effect (%) | Average<br>Value<br>(mln USD) | Min<br>(mln USD) | Max<br>(mln USD) |
|----------------------------|--------------------------|-------------------------------|-------------------------------|------------------|------------------|
| All Sectors                |                          |                               |                               |                  |                  |
| In Force All sectors       | -0.028                   | -2.76                         | -0.64                         | -0.95            | -0.34            |
| First raised All sectors   | -0.014                   | -1.39                         | -0.32                         | -0.56            | -0.09            |
| In Force Agriculture       | 0.265                    | +30.34                        | 9.54                          | 7.66             | 11.42            |
| First raised Agriculture   | 0.118                    | +12.52                        | 3.94                          | 2.13             | 5.75             |
| In Force Manufacturing     | -0.028                   | -2.76                         | -0.45                         | -0.68            | -0.22            |
| First raised Manufacturing | -0.025                   | -2.5                          | -0.40                         | -0.57            | -0.24            |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs.

### 3.5.1.3 Bias

**Result 5.** *Raised dates are biased and differ significantly from the In Force date estimates.*

Now, we look at the bias created by using the wrong date to proxy In Force date. Remember that the bias  $\zeta = \beta_{\text{raised}}^k - \beta_{\text{inforce}}^k$  will be significant only when either  $\beta_{\text{inforce}}^k$  and/or  $\beta_{\text{raised}}^k$  are significant, a non-significant results leading to no trade effect. Consequently, in table 13, we find a

significant positive bias taking either all sectors, and a negative bias when looking at agriculture. There seems to be no bias for manufacturing.

Table 13 – Bias in the short-term of using First raised dates to proxy In Force date

|      | All sectors | Agriculture | Manufacturing |
|------|-------------|-------------|---------------|
| Bias | 0.014***    | -0.147***   | 0.003         |

Source: Author's calculations from estimates in tables 8, 9, and 10 and using one tail t-test method to calculate significance.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs.

### 3.5.1.4 When to complain matters

Knowing that a complaint can be filed before or after the TBT is in force, we look at whether it influences our results. Table 14 shows the distinction between complains filed before and after across all sectors, agriculture and manufacturing.

Table 14 – Average short-term impact of TBT STC dates when the implementation is either before or after the concerns

|                     | Implementation before concern |             |               | Implementation after concern |             |               |
|---------------------|-------------------------------|-------------|---------------|------------------------------|-------------|---------------|
|                     | All sectors                   | Agriculture | Manufacturing | All sectors                  | Agriculture | Manufacturing |
| In Force            | -0.021                        | 0.257       | -0.031        | 0.042                        | 0.902       | 0.024         |
| Robust std. Err.    | (0.018)                       | (0.077)***  | (0.019)*      | (0.029)                      | (0.173)***  | (0.042)       |
| First Raised        | -0.012                        | 0.15        | -0.024        | 0.025                        | -0.099      | -0.003        |
| Robust std. Err.    | (0.011)                       | (0.073)**   | (0.011)**     | (0.016)                      | (0.041)**   | (0.013)       |
| No. Of Observations | 20 620 852                    | 989 206     | 19 409 411    | 20 583 116                   | 984 236     | 19 278 431    |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs.

Intuitively, we could expect that complaining after a TBT is implemented, the negative impact would be more stringent than when complaining occurs before the TBT is implemented. Taking all sectors together, we do not find any significant impact of dates when splitting them in two timings. However, looking at manufacturing and agriculture sectors separately, we do find some effects of timings.

**Result 6.** *In manufacturing and agriculture, we find that complaining before or after the implementation is not similar in terms of size and significance of the results.*

For manufacturing, the negative impacts of the dates of interest are significant only when complains occurs after the In Force date. When complains are all filed before the TBT is already implemented, we only find insignificant impacts across all dates variables.

For agriculture, a TBT is impacting trade positively around the In Force date for both timings, with a larger effect when In Force is made after all the concerns. It makes sense since all potential issues of the TBT have been discussed previously during the concern period. To be more specific, trade improves by 29.30% around the In Force date when concerns are filed after, while it improves by 146.45% when concerns are filed before (the In Force date). Another interesting result is that concerns seem to affect trade in opposite directions given the timing. Indeed, when concerns are before the In Force date, the trade volume around the First raised date is improved by 16.18% while it decreases by 9.42% when concerns are after the In Force date (both results are significant). It is as if concerns made after the In Force date reveal some information that leads export to decrease while concerns made before help trade. It could confirm part of the intuition of [Possada et al. \(2020\)](#) who explains that "STC raised at the draft stage of notification are less likely to end up to a formal dispute" (p.412).

#### 3.5.1.5 *Who complains matters*

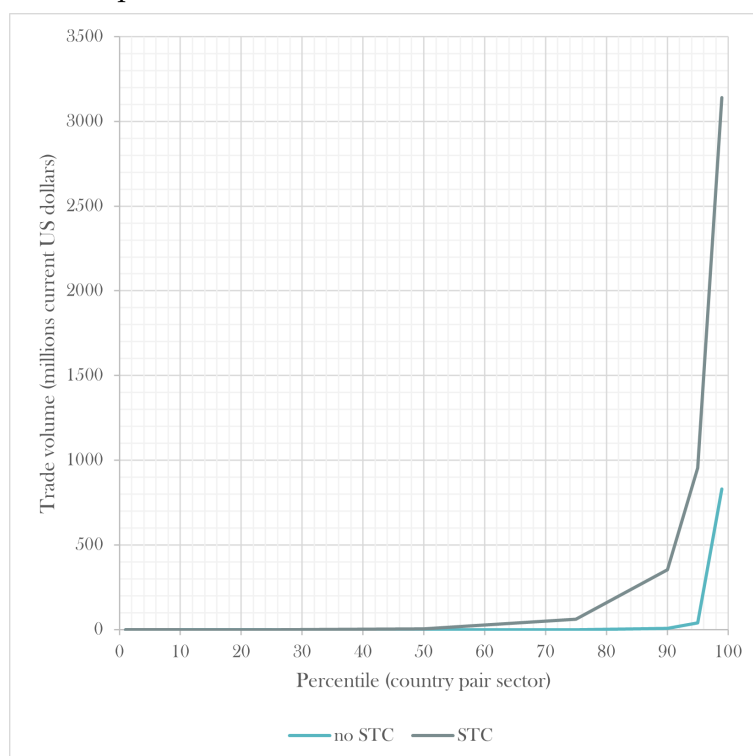
We now investigate whether there exists some characteristics present in the complaining countries to explain why they complain. We find a pre-established distinction between sectors subjects to STCs and those for which it is not the case. To investigate this, we first look at descriptive data from our database and then test this with a regression similar to the one used in equation 38 but with country-pair fixed effects instead of country-pair sec-

tor fixed effects (table 15). Not using the latter allows catching variabilities in terms of both timing and sectors. Finally, we also test samples of our data categorized by level of development (table 16).

**Result 7.** *Big countries and big sectors use more STCs. G20 and non-G20 countries differ in terms of sign and significance of the impact of TBT STCs.*

**DESCRIPTIVE ANALYSIS ON "WHO COMPLAINS"** First, using descriptive data from our database, it seems that TBT STCs are raised when the volume of trade is more important as we show in figure 4. Indeed, before a TBT is implemented, volumes of trade for industries later subject to TBT with STCs are always well above those for industries with standard TBT without STCs.

Figure 4 – Trade volume distribution according to TBT with or without concerns before implementation



Notes: Calculations using the updated STC database, taking the percentiles of the distribution for all years - all sectors - all countries.

Still with simple statistical analysis on our data, taking the mean trade of all exporting-sector pairs subject to a TBT, the average trade is more than three times higher when at least one STC is raised than when there is no STC raised (108.8 versus 27.7 million USD). This is also the case when looking at median trade for those same exporter-sector pairs. We also checked the probability to raise a STC knowing the volume of trade with a probit regression. We find that higher volume of trade raises the probability to raise a STC (significant at the 1% level).

REGRESSIONS ANALYSIS ON "WHO COMPLAINS" We can estimate the effect of TBT STCs on trade as being the difference between sectoral trade with and without TBT STCs as in [Dolabella \(2020\)](#) (see its equation 1, 2, 3 and annex 1). It can be done by using country-pair fixed effects instead of country-pair sectors fixed effects. In table 15, we confirm our intuition that sectors with large volume of trade are more hit by new TBT and complain more at the WTO against those TBTs. Indeed, we find that (country-pair) sectors subject to TBT STCs trade 15.49% more than sectors not subject to TBT STCs at the same dates. Looking at the First raised dates, we confirm this pattern since sectors with TBT STCs trade 5.44% more than sectors without TBT STCs around the First raised dates.

Two scenarios seem to be occurring when looking more specifically at timings. We find that the distinction in size of sectors is only true around the date that occurs first and this leads to two possible explanations.

First, when In Force is first in timeline, sectors with TBT STCs have higher volumes of trade by 16.42% around the In Force date, but no significantly higher volumes around the First raised date which occurs later. It means that TBTs with STCs hit more high volumes of trade at the In Force date and, later, all volume of trade complain.

Second, when First Raised is first in timeline, sectors with TBT STCs have higher volumes of trade by 9.86% around the First raised date, but no significant differences exist around the In Force date. It means that when

Table 15 – Which sectors are impacted by TBT STCs

| Variables    | All Timings         | All Sectors                               |                                          | Specific Sectors    |                  |
|--------------|---------------------|-------------------------------------------|------------------------------------------|---------------------|------------------|
|              |                     | TBT imple-<br>mentation<br>before concern | TBT imple-<br>mentation<br>after concern | Agri-<br>culture    | Manu-<br>facture |
| In Force     | 0.144<br>(0.039)*** | 0.152<br>(0.056)***                       | 0.196<br>(0.146)                         | 0.212<br>(0.068)*** | 0.050<br>(0.036) |
| First raised | 0.053<br>(0.028)*   | 0.030<br>(0.032)                          | 0.094<br>(0.038)**                       | 0.048<br>(0.072)    | 0.034<br>(0.026) |
| No. Of STCs  | 555                 | 287                                       | 133                                      | 58                  | 489              |
| No. Of Obs.  | 20 656 038          | 20 624 935                                | 20 587 205                               | 993 443             | 19 340 399       |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and country-pair FEs.

no TBT is In Force yet, complains are due to the high volume of trade. Then, once the implementing country acknowledges these complaints, he implements the TBT and no distinction in volumes of trade is found.

In table 15, we also look at agriculture and manufacturing. For agriculture, we find that a distinction between low and high volumes sectors is only present around the In Force date. For manufacturing, sectors complaining do not differ in terms of volume of trade at any date of interest.

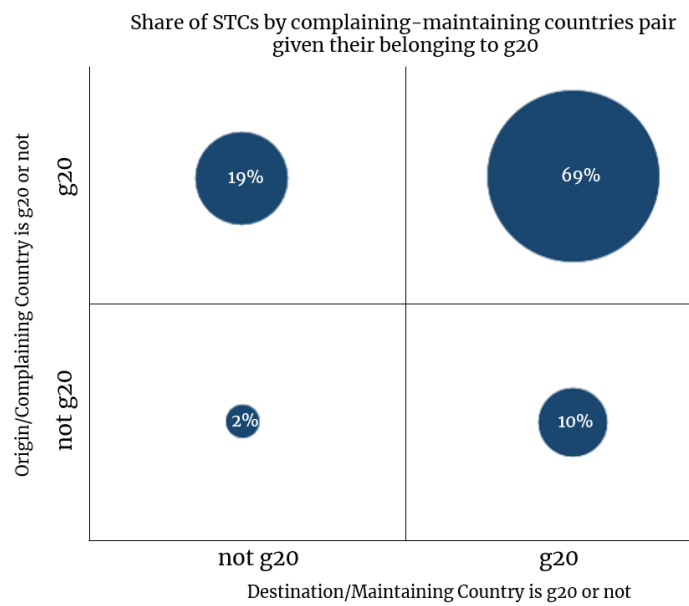
### 3.5.1.6 Distinction across level of development

We now turn to table 16 where we categorized countries according to their belonging to the G20. In table 16, we check whether results differ in terms of who raises the concern against which country. Classifying countries according to their G20 membership is used because G20 countries are the ones complaining the most and having the most complaints against, as figure 5 shows.

Significant and positive impacts of complaining (the policy effect) hold only when the destination country (i.e. maintaining) is in G20. On the other

hand, significant and positive impacts of raising concern (the concern effect) hold only when origin country (i.e. complaining) is in G20. Also, the effect of raising concern against a non-G20 is much more effective than when raising concern against a G20 country. Finally, raising concerns from origin-destination couples which are both non-G20 leads towards a negative trade impact.

Figure 5 – G20 belonging for each concerned-maintaining pair



Notes: proportions being the number of STC raised by each country and each specific industry times 3 (because of the interval  $t-1$ ;  $t+1$ ). Hence, while there are 555 stcs between 2000 and 2016, some are raised by multiple countries and in multiple industries.

Table 16 – Average short-term impact of TBT STC dates according to origin-destination being G20 or not

| Variables           | G20                 | G20                 | not G20            | not G20            |
|---------------------|---------------------|---------------------|--------------------|--------------------|
|                     | - G20               | - not G20           | - G20              | - not G20          |
| In Force            | -0.033<br>(0.016)** | -0.042<br>(0.036)   | 0.107<br>(0.045)** | -0.241<br>(0.127)* |
| First Raised        | -0.032<br>(0.014)** | 0.192<br>(0.054)*** | 0.097<br>(0.063)   | -0.395<br>(0.211)* |
| No. Of STCs         | 431                 | 106                 | 93                 | 23                 |
| No. Of Observations | 1 886 087           | 6 271 901           | 4 126 667          | 7 877 783          |

Source: Author's calculations on the STC database for 2000-2021 period, WTO.

Notes: Results include importer-sector-time, exporter-sector-time FEs, and pair country sector FEs.

### 3.5.2 Structural impacts of TBT STCs

We now dive into the study of the long-term effects of TBT STCs. The distinction with the previous section is that we look at the permanent jump in trade from a specific date of interest while we were only focused on the shock previously.

**Result 8.** *Our results hold in the long-term.*

Looking at table 17, we still find a negative structural impact of the In Force dates dummy. Implementing a new TBT (associated before or after with a STC) permanently decreases trade by -3.34%, on average. The First raised date does not impact trade in the long run.

As shown in table 17, the First raised date does not impact trade. This is in line with Shepotylo (2016) who finds that STCs correct themselves after a two-year period.

Table 17 – Average long-term impact of TBT STC dates

|                     | (1)                 | (2)                 |
|---------------------|---------------------|---------------------|
| In Force            | -0.034<br>(0.014)** |                     |
| First raised        |                     | -0.015<br>-0.01     |
| TBT dummy x Intra   | -0.002<br>(0.001)** | -0.001<br>(0.001)   |
| Other NTMs          | 0.03<br>(0.012)**   | 0.031<br>(0.012)**  |
| Tariffs             | -0.185<br>(0.084)** | -0.186<br>(0.083)** |
| No. Of Observations | 20 621 722          | 20 621 722          |

*Source:* Author's calculations on the STC database for 2000-2021 period, WTO. Each TBT STC dummy takes the value of 1 from the year before the date of interest until the last period of the dataset. *Notes:* Results include importer-sector-time, exporter-sector-time FEs, and country-pair sector FEs.

### 3.6 CONCLUSION

To expose the potential endogeneity present in the literature on TBT studying Specific Trade Concerns at the WTO, we updated an old Specific Trade Concerns database by matching it with their respective TBT notifications on the Initiation and In Force dates. We implemented this database in the ITPD-E database to study disaggregated impacts at the sectoral level.

While the literature uses the raised dates to measure the effect of TBTs on trade flows, they might bring biased results because i) raised dates inadequately proxy the trade shock occurring at the In Force date and ii) industries might react to a complaint defending them at the WTO. In order to identify those two issues, we used the gravity model with a PPML approach, and we distinguish between timings because the In Force dates happen either before, during, or after a STC is raised. Making the distinction in timings allows us to identify whether industries react positively to a complaint defending them at the WTO and to discuss the quality of STCs as proxies for stringent TBTs (as some argue in the literature).

We show that timings of implementation and concerns are both needed to obtain a complete picture of the impact of TBT STCs on trade flows in agriculture and manufacturing sectors, although they are not needed when taking all sectors together. Using only raised dates leads to biased estimates (with the exception of manufacturing), either underestimating (in absolute value) the impact of the implementation of a new TBT (in agriculture) or overestimating it (taking all sectors together). Considering that a bias is the distance with the In Force date estimation (which is the benchmark), raised dates seem accurate to measure TBT impacts on trade in the manufacturing sector. In agriculture, we do find a negative and significant bias when not taking In Force date directly to measure the impact of a TBT with a STC.

We also find that TBT STCs are negatively associated with trade, except for the broad agricultural sector. Our results are in line with the previous literature which also finds a negative impact of TBT STC on trade and

mixed results when differentiating across manufacturing and agriculture or between countries belonging to different levels of development. We find positive impacts of TBTs on agricultural trade because the improved consumer confidence and the high volume (value) of trade in agriculture more than offset the higher variable and fixed costs linked to higher standards. We argue it is less the case for manufacturing sectors.

To our knowledge, we are the first to consider In Force date in a large TBT STC dataset. Our updated version of the STC database invites further research into the cause of heterogeneous impacts of TBT STCs on trade flows such as on the reasons why country complain at the WTO. We also acknowledge some limitations due to the aggregation of the sample which would be more accurate when looking at firm-level data.

## DO STCS OIL THE CHAINS?

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### ANALYSIS OF THE MOST STRINGENT TBTS ON GVCS

#### 4.1 INTRODUCTION

For decades, world trade has been facing continuous transformations towards more global value chain trade, less tariff protectionism<sup>1</sup>, and more non-tariff measures (NTMs).

##### 4.1.1 *Sectoral trade evolution: GVCs*

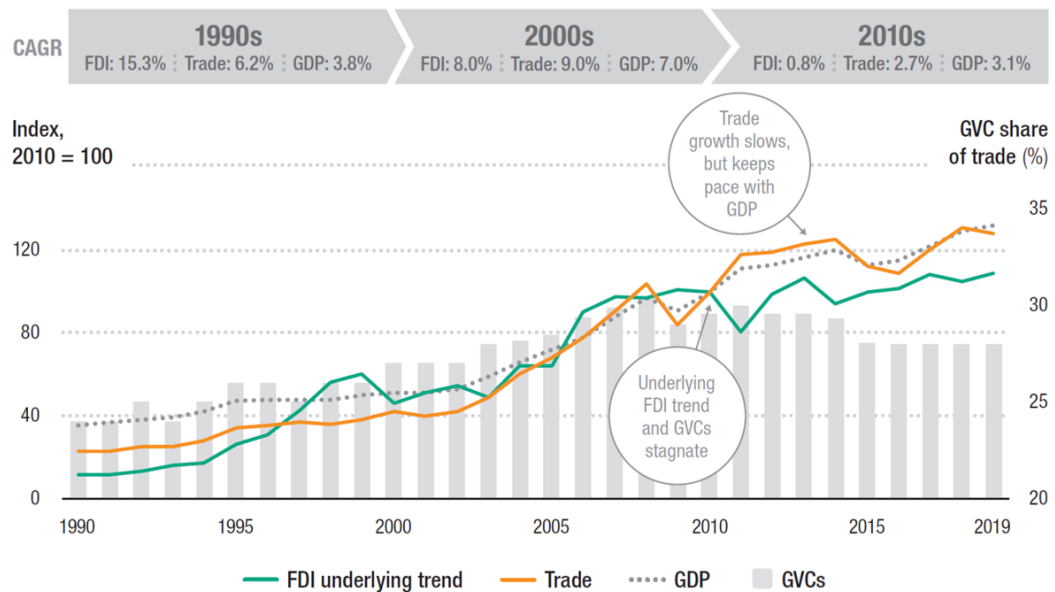
Trade is no longer a matter of just trading between two countries. In the last decades, companies have reorganized their way of producing goods due to three main factors: the digitalization of data has made the tracking of goods more manageable; the lowering of tariffs has allowed to lower transportation costs; and the fall of communism led to the opening and the liberalization of new labor markets ([Hillberry, 2011](#)). Exporting firms have moved towards a new way of trading: GVCs (global value chains). Figure 6 shows the increasing importance of GVCs in global trade after the 90s.

With GVCs, trade between countries is made of raw, intermediate, and final products. Although more complex than with final goods only, it is possible to measure GVC trade share in total trade. The integration of a country or sector into the GVCs can be measured by the increasing proportion of FVA (foreign value added) compared to DVA (domestic value

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1. Tariffs decreased annually by 3% between 1995 and 2017 (calculation based on [World-Bank \(2023\)](#)) on average.

Figure 6 – GVCs: increasing importance in global trade



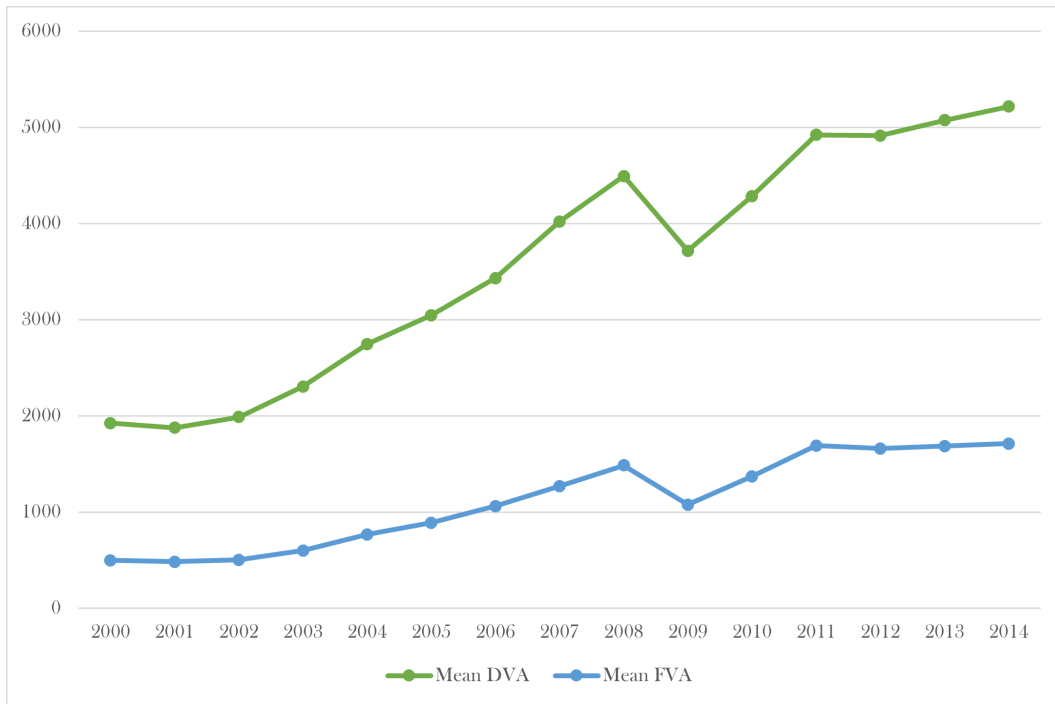
Source: [UNCTAD \(2020\)](#). CAGR is the compound annual growth rate.

added) in the gross trade. More foreign value added means that a trading economy is more integrated into the GVCs. More domestic value added means the opposite. Intuitively, one country wishing to promote national economic growth should favor domestic value added. However, as argued by [Dollar et al. \(2019\)](#), it might force domestic firms to use low local inputs instead of qualitative inputs proposed by international producers. Consequently, the integration into a GVC network goes along growth (see figure 6)<sup>2</sup>.

Figure 7 puts in evidence the increasing importance of both types of origin in the composition of value added, DVA (domestic value added) being the most important one. However, looking at their proportion through time in figure 8, FVA (foreign value added) is gaining ground over DVA.

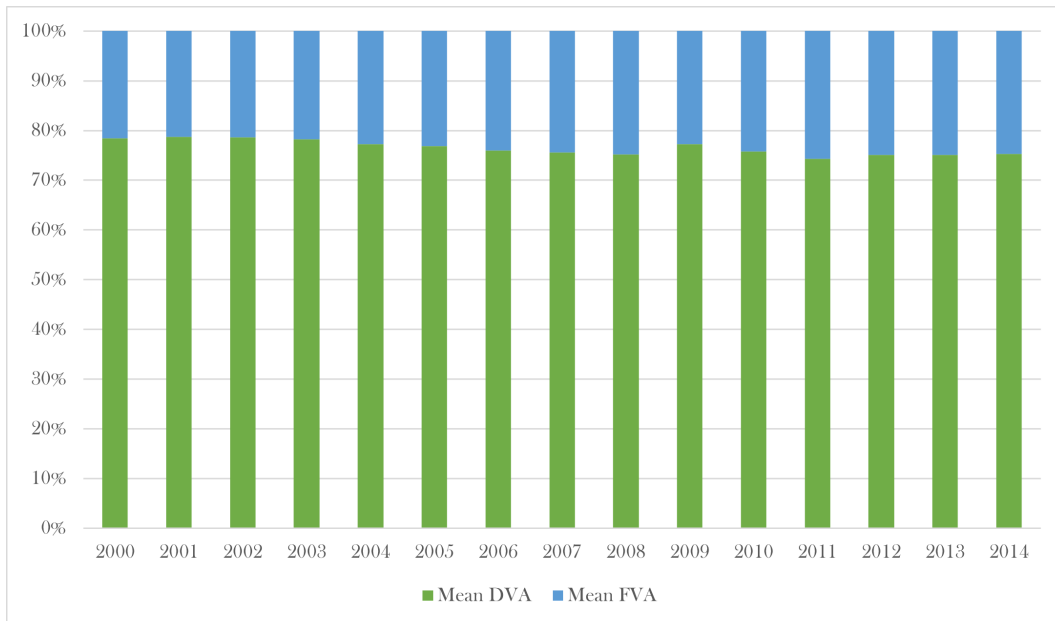
2. But it is also important to understand the interdependence between countries created by this growth in GVCs. Indeed, in a way, too much fragmentation of the production is impeding trade when an outside event, such as Covid19, breaks the chain.

Figure 7 – Growth of Foreign Value Added and Domestic Value Added per year  
(mean value in mln USD)



Notes: Author's calculations based on the WIOD dataset.

Figure 8 – Change of the GVC trade composition in terms of Foreign Value Added and Domestic Value Added per year



Notes: Author's calculations based on the WIOD dataset.

#### 4.1.2 *NTMs, a tool to protect*

After the failure of the Doha Round, the number of multilateral trade agreements has dropped. Developed countries, followed later by some developing countries, concluded more bilateral agreements that contained more non-tariff barriers (NTBs), which were later renamed NTMs (non-tariff measures)<sup>3</sup>. There is an opposition between the different objectives of these NTMs. Some are trade-binding measures such as anti-dumping duties or quotas. But others are "anti-protectionist" NTMs. For example, licensing, packaging and labeling requirements, technical rules, and sanitary rules must be established with non-protectionist objectives (i.e. protecting the environment, animals, and consumers) according to WTO rulings. While they aim at protecting consumers and the environment, they can either favor trade by improving consumer confidence (Bao and Qiu, 2012) or impede trade by increasing the adaptation and administrative costs leading to the exit of exporters from the market implementing a new NTM.

Just looking at the meta-analysis from Li and J. Beghin (2012) and F. G. Santeramo and Lamonaca (2019), it is clear that NTMs have either a positive or negative effect on trade. Regarding GVC trade, intuitively, the effects of new NTMs depend on the industry and the company's place in the production chain. The closer one gets to the consumer, the more it is affected by standards. The firm supports more cost to adapt to new TBTs when it is close to consumers since most TBTs are made to protect consumers<sup>4</sup>. This intuition should be reflected even more if a product passes many times through a country with many standards.

The literature explains that NTMs have a negative impact on GVCs but acknowledges that there is a lack of classification among NTMs. Kor-

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3. Most NTMs are notified at the WTO by developed countries.

4. It is also possible that all standards implemented upward in the value chains impact firms downstream but not in terms of adaptation costs directly, rather in terms of value-added price

watanasakul and Baek (2021) measure NTMs by taking the ACRI (Additional Compliance Requirement Indicator) tool developed by Nabeshima and Obashi (2021) which measures the additional cost in administrative weight to export to a given country. They use the OECD-ICIO table to implement the share of FVA (foreign value added), the DVA (domestic value added) and the GVC participation. They find a negative impact of NTMs on GVC participation and on FVA. But they do not find any impact on DVA. They also find that the impact is greater than the one from tariffs. Wu et al. (2022) also look at the impact of NTMs on DVA. Using the World Input Output Database (WIOD), Wu et al. (2022) show that TBTs do not have a significant impact on gross exports but do have a negative impact on domestic value added, particularly for developing countries and high-tech products<sup>5</sup>. In their study on South American countries using OECD TiVA input-output tables, Cadestin et al. (2016) explains that a negative impact of NTMs on GVC participation may be due to the lack of harmonization of the standards, to the administrative costs, and to the adaptation costs involved. Thus, there may be advantages to the introduction of NTMs in a mutual recognition or harmonization framework. They show that small businesses are the losers of these new regulations. Yang, Otsuki, et al. (2020) look at the effects of NTMs at the firm level. Results are different depending on the position of the firms in the value chain. Firms farthest from consumers are disadvantaged while those close to consumers are advantaged by new non-tariff measures. However, the conclusion of Yang, Otsuki, et al. (2020) is that more detail is needed in the NTMs to differentiate those that are "useful and progressive" from those that are "ineffective and protectionist".

Because of the ambiguous goals of NTMs, "the relevant policy debates are about sorting the NTMs that are essential from those that are inefficient and protectionist and about how to make NTMs more transparent" (J. C. Beghin, Maertens, et al. (2015), p. 443). Consequently, to be able to

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5. Boffa et al. (2019) study also the impact on DVA and FVA, but from the point of view of preferential trade agreements and bilateral investment treaties.

get policy relevant results, my study focuses on TBTs (technical barriers to trade), the largest category of NTMs with more than 45.000 notifications at the WTO between 1995 (Uruguay Round) and 2021. The TBTs are of particular interest as they are more likely to be present in several stages of the production chain. Indeed, they cover many sectors: agriculture, services, manufacturing, mining and energy. TBTs may have several different purposes, as mentioned in table 18.

#### 4.1.2.1 TBTs: *pro or against trade?*

TBTs frame new rules for specific products such as new sizes for tires, processed food compositions, manufacturing methods, and other technical measures related to the production and sale of a given product. TBTs are supposed to be non-protectionist (i.e. created with the objective of standardization and trade facilitation<sup>6</sup>). As explained above for NTMs, there might be some additional costs due to new TBTs which lead to a negative impact on trade. However, it would be an indirect and involuntary impact. Still, some TBTs could voluntarily lead to trade impeding effects. For example, Iodice (2019) finds that 40% of TBTs have not been notified before being implemented, with 22% of them which were never notified. Without notification, trade partners are voluntarily disadvantaged compared to domestic producers. Also, until recently, there was a lack of transparency in many TBTs. As the International Trade Center Deputy Executive Director, Ms D. Tembo (2022), puts it, "companies struggle to make sense of the multitude of health and safety requirements, product regulations, testing and certification procedures and other measures necessary to reach international markets" (WTO, 2022)<sup>7</sup>.

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6. see TBT Agreement GATT (1994b) in Article 2.2.

7. On the 13th of July 2022, the improved ePing platform aiming at reducing obstacles to trade due to a lack of transparency was launched with the collaboration of the United Nations, the WTO, and the ITC (International Trade Center). ePing gives information on TBTs and SPSs, as well as on their respective Specific Trade Concerns (TBT STCs and SPS STCs).

Similarly to NTMs, the literature confirms the heterogeneous effects of TBTs regarding trade. However, no focus is made on GVCs. The topicality of non-tariff measures such as TBTs has led many researchers to take an interest in it. Studies have shown that a positive or negative impact on trade very much depends on the method and object used to measure the effect of a TBT. Some authors find positive impacts of TBTs on trade (Bao and W.-C. Chen, 2013; Bao and Qiu, 2012; J. C. Beghin, A.-C. Disdier, et al., 2015; M. X. Chen, Wilson, et al., 2008; Fernandes et al., 2021; L. G. Fontagné et al., 2005; Moenius, 2004) while others find the opposite (Arita et al., 2017; Cadot and Gourdon, 2016; Francois, Manchin, et al., 2015; Otsuki et al., 2001; Winchester, 2009; Wood et al., 2017; Yue and J. C. Beghin, 2009). Also, some authors find mixed results depending on the level of development of trade partners (Bratt, 2017; A.-C. Disdier, L. Fontagné, et al., 2008; Mangelsdorf, 2011) and on the sector studied (Moenius, 2004).

#### 4.1.2.2 *Specific Trade Concerns*

To find more intuitive results, a part of the literature focuses on TBT STCs (Technical Barriers to Trade with Specific Trade Concerns), which are seen as the most restrictive TBTs. Arguably, they are the best indicators of the hidden protectionist goal of some TBTs<sup>8</sup>.

A TBT STC is a complaint at the WTO which can be raised by one or several countries against a TBT for a variety of reasons. Once it has been raised, it can be raised again by the same countries or by new ones at the next meetings. It can be done by one or several member countries at any moments from the draft of a TBT until after its entry into force. Most STCs

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8. M. M. Ghodsi (2018) discusses determinants of TBT STCs (their objectives, as in table 18). Covering the period 2000-2011 of the WTO TBT STC database, he argues that countries can complain because some TBTs are illegitimate. Some are set to protect specific domestic industries instead of protecting the environment or the health. Using a fixed effect Poisson regression, he tests whether a TBT is imposed to retaliate another trade measure such as tariffs from a trade partner. He finds that protectionism is a significant reason for raising TBT STCs.

are raised by developed countries belonging to the G20 economies (see figure 9). The top-6 complainers are the EU, China, India, Egypt, South Korea, and the US (see figures 20 and 21). They complain at the WTO TBT Committee on a regular basis (see figures 23 and 22). STCs are present in many industries. As shown by figure 24, food, chemical, machinery, and electronic products are the main industries concerned by STCs. It also seems like the amount of STCs is growing even more lately in those industries.

Between 1995 and 2021, 725 complaints (i.e. STC) were filed against TBTs. An increasing number of TBTs have been subject to complaints under the protocol established by the WTO to challenge maintaining countries (i.e. the ones setting new TBTs). Table 18 illustrates how any type of TBT can be subject to complaints, regardless of its original purpose. However, it should be noted that the majority of TBTs that are subject to complaints are related to environmental, health, and consumer protection.

Intuitively, TBT STCs hit trade flows negatively. Indeed, a complaint (STC) is usually filed because of past or expected negative trade shock due to a TBT. However, a "positive" complaint could be brought to the WTO TBT committee: if the reasons for the complaint are for clarity more than trade barriers reasons (Possada et al., 2020). At last, it is also possible that countries invoke trade barriers at the WTO only to add political pressure on the maintaining member.

Mostly, the literature on TBT STCs finds negative results. L. Fontagné and Orefice (2018) study the impact of TBT STCs on different margins of trade using firm-level data from French exporters and the WTO STC database<sup>9</sup>. They show that different firms are not equally equipped to face new regulations. Export participation is hurt more for multi-destination firms, when

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9. While L. Fontagné and Orefice (2018) do not dig into the firm size heterogeneity in the TBT STC literature, a previous study from the same authors discusses this in the SPS STC literature. L. Fontagné, Orefice, et al. (2015) look at the impact of SPS STCs on firms of different sizes and the channel through which export is falling. They find that the negative impact is lessened for larger firms.

controlling for size. Additionally, it hurts for sectors composed of many small firms exporting a large proportion of the total export of a given sector. TBTs are taken as additional costs burden and many firms will divert trade towards a destination without restrictive TBTs. [Kamal and Zaki \(2018\)](#) find similar results using the same database on TBT STCs with Egyptian firms. They also find that TBTs modify firms' product diversification heterogeneously across sectors. This modification increases the diversity of agricultural goods while having mixed effects on non-agricultural products. Another interesting work from [Singh and Chanda \(2021\)](#) looks at the impact of TBT STCs on imports. With intermediate Indian firms, [Singh and Chanda \(2021\)](#) show that TBT STCs are significantly diminishing imports for OECD countries only. However, this is limited to India. It suggests that stricter TBT regulations in a developing country are lessening the access of non-OECD countries to high quality inputs. Moreover, they find that TBTs motivate importers to decrease their markups more than non-importers (concerning intermediate inputs producers) with no significant impact on prices.

Another part of the literature focuses on the link between TBT STCs and tariffs. [Herghelegiu \(2018\)](#) studies TBTs and TBT STCs as potential substitute for tariffs. She finds that only TBTs with STCs reveal to be substitutes for tariffs. [Beverelli et al. \(2014\)](#) and [Orefice \(2017\)](#) both find similar results but add more insights by looking at the level of development of trade partners<sup>10</sup>.

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10. There also seems to be differences in the impact of TBT STCs across the level of development. [Beverelli et al. \(2014\)](#) explains that TBT STCs are replacing tariffs only in developed economies. However, [Orefice \(2017\)](#) finds otherwise: similar countries regarding the level of development tend to complain more after a tariff reduction than pairs with different levels of development (developed - developing country pairs). Interestingly, it shows that the level of development is an important characteristic to consider when looking at TBT STCs. It also highlights the importance of considering tariffs in the analysis of TBT STCs.

Finally, contrarily to the rest of the literature, two unpublished papers look at the trade impact at the sector-level. [M. Ghodsi et al. \(2017\)](#) initially investigate the trade impacts of each NTM using the WIIW dataset. They look inside manufacturing sector into different industries (hs2 level) and find that TBT STCs impact trade positively at the mean but negatively at the median. While this might be due to endogeneity or reverse causality, it could also be the case that big exporters benefit from TBT STCs contrarily to most other firms<sup>11</sup>. In the chapter 3 of this thesis, we use the updated STC database along with the sectoral level (ITPD-E database). We find heterogeneous results. In manufacturing, TBT STCs hurt trade while in agriculture, trade is improved significantly.

While the results of the literature are almost all negative, there are still some positive results and [A.-C. Disdier, Fugazza, et al. \(2020\)](#) advise looking into the reasons of complaints.

#### 4.1.2.3 TBT STCs: various reasons to complain

As explained by [A.-C. Disdier, Fugazza, et al. \(2020\)](#) in their guide to the analysis of NTMs (and as it is shown in table 19), some TBT STCs do not fit into the "restrictive" category used by the literature: "not all concerns raised relate to perceived trade restrictions, as countries sometimes only seek clarification on a measure adopted by a partner, or remind a partner of missing notifications." (p. 25). The two reasons which are the most frequent do not reflect the same kinds of issues regarding TBTs. "Unnecessary barrier to trade" clearly refers to protectionist TBTs that do not respect the guidelines initially set by the WTO. On the other hand, "further information" emphasizes the incomplete aspect of a TBT and does not specifically mean that the TBT is protectionist.

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11. Intuitively, big firms are advantaged by this upgrading; while small firms tend to exit the market: this might lead to the creation of an oligopoly, and smaller quantity and higher prices (see chapter 2).

While the literature on TBT STC does not dive into the reasons of complaints, [Singh and Chanda \(2021\)](#), in their analysis of the impact of TBT STCs on imports, explain that issues linked to clarification (transparency, legitimacy, rationale, clarifications) are resolved when relevant information is shared. Thus, they implicitly assume that the concern is restrictive only when the following complaints are raised: unnecessary barriers to trade, discrimination, and non-acceptance of international standards<sup>12</sup>.

Table 18 – Stated objectives for TBT concerns

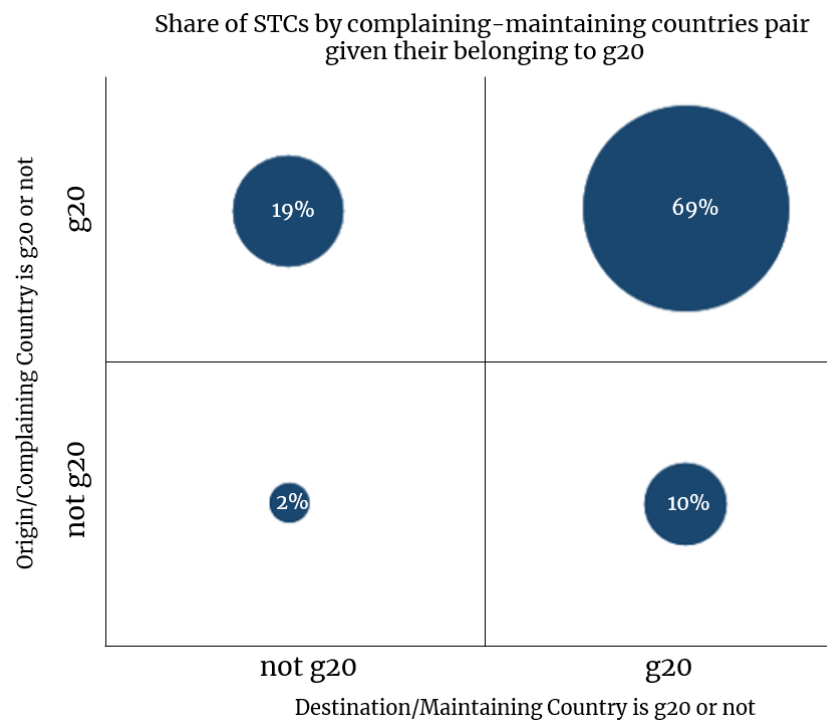
| Objective                            | Number of concerns | Proportion in all STCs (in %) |
|--------------------------------------|--------------------|-------------------------------|
| Protection of Human health or safety | 334                | 29.98                         |
| Protection of the environment        | 179                | 16.07                         |
| Consumer protection                  | 132                | 11.85                         |
| Consumer information, Labeling       | 130                | 11.67                         |
| Other                                | 113                | 10.14                         |
| Not Specified                        | 94                 | 8.44                          |
| Quality requirements                 | 60                 | 5.39                          |
| Harmonization                        | 28                 | 2.51                          |
| Protection of animal or plant life   | 23                 | 2.06                          |
| National security requirements       | 19                 | 1.71                          |
| Facilitating trade                   | 2                  | 0.18                          |

*Source:* Author's calculations on the NTC database for 2000-2021 period, WTO. *Note:* Each STC can have more than one objective. The total number of STCs raised in this database is 725.

Table 19 gives the reasons of complaints against TBTs. Reasons are heterogeneous and more or less restrictive, intuitively. Looking at columns 3 and 4 of table 19, we observe that reasons invoked in manufacturing and agriculture are not in the same proportions. Unsorted reasons (i.e. "other

12. Also, in a tentative to explain the determinants of TBT STCs, [Herghelegiu \(2018\)](#) shows the significant role of lobbies at STC meetings. Their presence at the recorded meetings illustrates their influence in the adoption of new NTMs. Possibly also, but it has never been investigated, big firms, more keen to lobby ([Blanga-Gubbay et al., 2021](#); [Kim, 2017](#)), could be less disadvantaged by TBT STCs. It would be interesting to investigate further whether specific sectors and countries tend to lobby more ([Hiscox, 2002](#)).

Figure 9 – G20 belonging for each concerned-maintaining pair



Notes: proportions being the number of STCs raised by each country and each specific industry times 3 (because of the interval  $t-1$ ;  $t+1$ ). Thus, while there are 555 STCs between 2000 and 2016, some are raised by multiple countries and in multiple industries.

reasons"), "transparency", "further information", and "unnecessary barrier to trade" are the most frequently raised in agriculture sectors. Manufacturing sectors raise complaints mostly for "unnecessary barrier to trade" and "time to adapt" reasons.

Table 19 – Stated concerns for TBTs raised at the WTO

| Type of concern                             | Number<br>of concerns | Proportion<br>in all STCs (in %) | Agriculture<br>(in %) | Manufacture<br>(in %) |
|---------------------------------------------|-----------------------|----------------------------------|-----------------------|-----------------------|
| Further Information                         | 395                   | 17.75                            | 62.22                 | 37.5                  |
| Unnecessary barrier to trade                | 364                   | 16.36                            | 62.22                 | 58.63                 |
| Transparency                                | 342                   | 15.37                            | 62.22                 | 37.85                 |
| Other issues raised                         | 289                   | 12.99                            | 2.22                  | 1.23                  |
| International standards                     | 242                   | 10.88                            | 60                    | 16.2                  |
| Rationale, legitimacy                       | 225                   | 10.11                            | 95.56                 | 15.67                 |
| Discrimination                              | 178                   | 8.00                             | 4.44                  | 14.44                 |
| Time to adapt, "reasonable interval"        | 127                   | 5.71                             | 0                     | 42.25                 |
| Non-product related and procedural measures | 42                    | 1.89                             | 62.22                 | 24.3                  |
| Special and differential treatment          | 17                    | 0.76                             | 60                    | 0.7                   |
| Technical assistance                        | 4                     | 0.18                             | 0                     | 0.88                  |

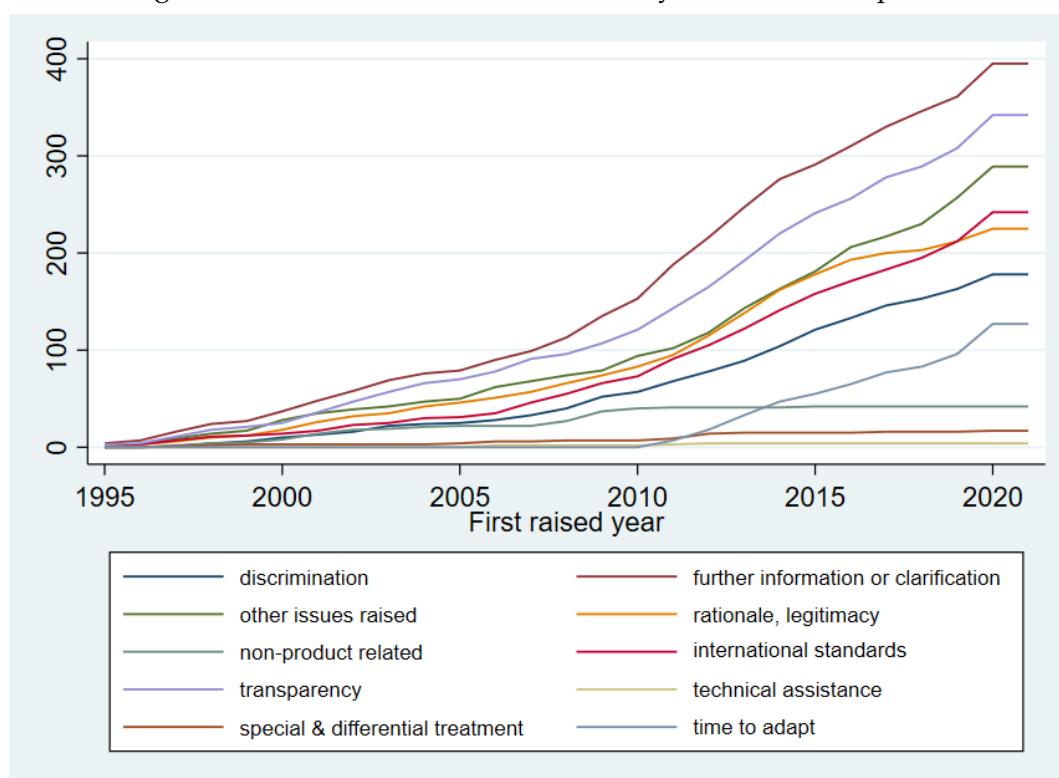
Source: Author's calculations on the STC database for 2000-2021 period, WTO. Note: Each STC can have more than one objective. The total number of STCs raised in this database is 725.

Figure 10 illustrates the growing importance, from 2010, of "time to adapt" reasons, while "non-product related" issues are not used anymore.

#### 4.1.3 Contributions

In order to dig further into those various impacts of TBTs, a solution might be to establish a scale based on their restrictiveness (A.-C. Disdier, Fugazza, et al., 2020). Focusing on TBT STCs, I use the information available in an updated STC database to study restrictiveness. The duration of concerns and dummies accounting for the reasons of concerns (see section 4.3) provide insights on the restrictive character of TBT STCs. On the one hand, no study has studied the impact of TBT STCs on GVC trade before. In addition, to the best of my knowledge, only two studies have looked at

Figure 10 – Growth in number of STCs by reasons of complaint



Based on the updated STC database

determinants of TBT STC impacts and it was not focused on the reasons of concerns (M. M. Ghodsi, 2018; Herghelegiu, 2018). My results show that TBT STCs with the longest duration of concerns are the one hurting trade the most. Except for reasons linked to unclear content inside TBTs which favor trade, the reasons of concerns do not bring any significant impact on trade.

The remainder of this paper is as follows. Section 4.2 explains the data, with a particular focus on STC reasons for complaints and GVC measures. It also describes the construction of the variables of interest. Section 4.3 gives the methodology with my empirical specification. Section 4.4 shows and comments on the results. Section 4.5 concludes.

## 4.2 DATABASE

For the econometric analysis, I have created a panel database composed of four elements: the update of the WTO STC database; the input-output tables from WIOD (Timmer et al., 2015); the tariffs from World Bank WITS; and the NTMs from WIIW dataset (M. Ghodsi et al., 2017).

To measure the impact of TBT STCs on GVCs, I built an updated database on TBT STCs. Most databases on NTMs such as WTO's I-TIP or TRAINS only show STC presence without more information. Also, the only relevant source to measure the impact of STC at a certain point in time is the WTO STC database. It is constructed from data on TBT and SPS Specific Trade Concerns in the WTO IMS (Information Management System)<sup>13</sup>. However, it stopped being updated in 2013. Thus, it lacks a comparable proxy to control for all the other TBTs without STCs, which use the In Force or the Initiation date. Indeed, the WTO STC database does not give any information on the notification process of the TBT with a STC.

I built the update of this database matching the latest update of the WTO STC database on the WTO website with I-TIP and WIIW datasets. Matching

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13. However, I have not constructed the SPS database yet.

the minutes raised codes available in the STC database, in the I-TIP and in WIIW NTM databases (M. Ghodsi et al., 2017), I find the duration of the STC issue. The updated STC database covers 725 concerns raised at the TBT committee between 1995 until 2021. The updated STC database provides information on the First Raised date and all subsequently raised ones, knowing the complaining as well as the maintaining country(ies). In addition to the previous content, the updated STC database includes the In Force and Initiation dates. Among other information, the objectives, the reasons of issues raised, the HS2017 4 digits codes, and the ISIC 3 codes are listed<sup>14</sup>. The reasons for complaints are generally the lack of information, the mismatch with other standards, or the creation of barriers to trade (see table 19)<sup>16</sup>.

The dependent variables on GVC measures are constructed from data on the input-output tables from WIOD 2016. The WIOD input-output table focuses on developed countries (56 sectors and 43 economies). Contrarily to other IO databases, such as Eora or TiVA, WIOD is focused on countries with the most precise data (43 but which represents most of the world trade flows). It avoids the extrapolation of missing statistics<sup>17</sup>. It is also particularly suited to study the G20 members, as shown in table 32. G20 members are the ones complaining the most at the WTO against TBTs, as shown in figure 9. WIOD gives the bilateral trade flows between each country-sector pair. It also renders total flows per country and sector from 2000 to 2014 and other satellite accounts. It is fully balanced. Input-output data makes it possible to calculate value-added and double-counting errors in the gross

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14. The objectives for the concerns and the underlying TBTs that were implemented are shown in table 24<sup>15</sup>. Graph 15 shows the distribution of STC by HS-chapter. The most frequent objectives cited are the protection of health and the environment.

16. I-TIP and the WIIW datasets provide the missing information for most of the data. The WIIW NTM database is an augmented WTO's Integrated Trade Intelligence Portal (I-TIP) database. It provides less missing HS 6-digit codes (dropped by half to 22.3%).

17. This information comes directly from national statistics.

output for each country. Importantly, for our analysis, the gross fixed capital formation (GFCF), used as an explanatory variable, is provided.

The tariffs are Ad Valorem Equivalent weighted average of MFN rates from the UNCTAD TRAINS (Trade Analysis Information System)<sup>18</sup> through the WITS portal. The UNCTAD 2 method for AVEs is applied<sup>19</sup>.

The WIIW NTM dataset gives information on other NTMs which could have both impacted trade and could be correlated with TBTs. The WIIW NTM database is an augmented WTO's I-TIP (Integrated Trade Intelligence Portal) database which provides less missing HS 6-digit codes (dropped by 55% to 22.3%) and more details on the NTM types and NTM effects<sup>20</sup>.

Demographics and GDP are provided by the Dynamic Gravity Dataset (Gurevich and Herman, 2018). Compared to CEPII gravity dataset, the Dynamic Gravity Dataset gives similar results, as Gurevich and Herman (2018) demonstrate in their paper.

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18. TRAINS contains information on tariffs and non-tariff measures for more than 160 countries.

19. It uses HS-6 digits imports statistics of all OECD countries. MFN rates with UNCTAD 2 method work as follows: tariff statistics are weighted by import values. It is subject to caveats: extreme values will bias the results. Indeed, a very high tariff likely implies small imports and, thus, it will have a low weight. It might lead to prohibitive tariffs having the same weight as zero tariffs. However, taking the simple average tariff (i.e.: not weighted) would also bring some issues. Some products with very high import levels will have the same impact regarding tariffs as products with very low import levels. That is if they have both the same tariff levels. Also, missing years are replaced by nearest year available (earlier year wins ties).

20. However, this database does not integrate many details on STC. In particular, it lacks precision on TBT STC. Indeed, two distinct variables account for their presence and are not stackable (STC is a dummy equal to one if STC is present, NTM gives the NTM type including TBT STC. All TBT STC should have  $STC = 1$ , it is not the case). Also, it is not updated with the most recent STC data and does not give any information about the types of TBT STC. Compared to the WIIW database, the updated STC database increases the number of TBT hit by an STC. Note that all the TBT STC from WIIW are covered by the ones in the STC database.

### 4.3 METHODOLOGY

#### 4.3.1 *Empirical specification*

This paper is studying unilateral trade exports across partner (a framework similar as the one proposed by [Kee et al. \(2008\)](#)). The objective is to give a general answer to policy-makers willing to understand the role and impacts of TBTs in their country's exports and imports<sup>21</sup>.

Here is the empirical framework to study the impact of TBT stringency on GVC trade.

$$\begin{aligned} \ln \text{GVC trade}_{ikt} = & \beta_1 \text{TBT SI}_{ikt} + \beta_2 \text{NTM PR}_{ikt} \\ & + \beta_3 \ln(1 + \text{Tariffs}_{ikt}) + \beta_4 \ln \text{GFCF}_{ikt} + \mu_{ik} + \varepsilon_{ikt} \end{aligned} \quad (40)$$

Where  $i$ ,  $k$ ,  $t$  are the importer country, the sector, and the year, respectively.  $\mu_{ik}$  are the country-sector fixed effects (FEs), they control for the potential endogeneity of the NTM and TBT STC variable. They also respond to potential issues caused via VA instead of gross trade: GDP does not adequately reflect import and supply ([Baldwin and Taglioni, 2011](#)). Those FEs deal adequately with several endogeneity issues<sup>22</sup>.  $\varepsilon_{ikt}$  is the error term (robust standard errors are clustered at the country sector level).

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21. Taking bilateral trade flows should be equivalent because TBT impact all partners similarly without discrimination. However, it asks for much heavier data resources. It could be tested in a further robustness test, as discussed in conclusion.

22. First, it deals with the omitted variable bias. For example, there might be some unobservable country-specific characteristic linked to GVC-related trade (the dependent variable) and with the policy to enforce a new TBT (an independent variable). The fixed effects deal with that. However, note that this link is unlikely to happen for the type of explanatory variable used (i.e. TBT) which is not country specific but applies to all exporters and to the importing country itself. Concerning reverse causality, there might be lobbying for TBT or TBT STC from specific firms and specific sectors. It is more likely the case if those firms and sectors are already the biggest in terms of GVC trade ([Blanga-Gubbay et al., 2021](#)). However, again, sector-year fixed effects discard this.

My main variable of interest is TBT  $SI_{ikt}$ , the TBT Stringency Index. It is discussed in detail below in section 4.3.3. The dependent variable GVC trade includes three classic GVC measures described in subsection 4.3.2 below<sup>23</sup>. In addition to the main variable of interest, I control for three important explanatory variables which have been shown to impact trade in the previous literature. The NTM  $PR_{ikt}$  is the prevalence ratio (see section 1.0.2). It controls for all the NTMs which are not TBT STCs. Indeed, many NTMs might impact trade in a variety of ways, either positively or negatively. Controlling for it discards an important source of omitted variable bias.  $tariffs_{ikt}$  are simple average MFN applied tariff rates. It is important to include them because, as shown in the literature, they are substitute of non-tariff measures (Looi Kee et al., 2009), especially TBT STCs, as shown by Orefice (2017). Also, Cheng et al. (2015) find that they impact GVC participation negatively. In the strand of the NTM literature,  $GFCF_{ikt}$  (the gross fixed capital formation) is used to proxy the FDI (Foreign Direct Investment), an important explanatory variable for GVC measures, as in Korwatanasakul and Baek (2021)<sup>24</sup>.

#### 4.3.2 GVC measures

I want to find the impact of TBT on the maintaining country regarding GVC trade flows. I look at three GVC flows: foreign value added (FVA),

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23. I use the ICIO Stata module from Belotti et al. (2021) to measure the impact on GVC exports, on foreign and domestic value added, as well as on upstreamness and downstreamness measures.

24.  $GDP_{it}$  is an important explanatory variable of trade volumes and is a must use in standard trade flows analysis (for example in the gravity framework). It also helps to control across different sizes of countries. However, it is also highly correlated with GFCF. Thus, I discard the GDP variable. I show the correlation matrix for the variables of the model in the appendix table 38.

domestic value added (DVA), and GVC participation<sup>25</sup>. FVA and DVA are related to complementary contents of gross exports since they are part of foreign content (FC) and domestic content (DC) as explained in figure 19.

$$\begin{aligned}\text{Gross Exports} &= \text{FC} + \text{DC} \\ &= \text{DVA} + \text{domestic double counted} + \text{FVA} + \text{foreign double counted}\end{aligned}$$

FVA is measuring the volume of foreign content in local exports (in other words, it gives the foreign import content of domestic export). It is a measure of the backward linkages of GVCs. An important FVA means a higher integration into the GVC (Dollar et al., 2019). In order to understand the change in the composition of export, I take the proportion of FVA in gross exports, as in Korwatanasakul and Baek (2021).

$$\text{pFVA}_{ikt} = \frac{\text{FVA}_{ikt}}{\text{GE}_{ikt}} \quad (41)$$

$\text{GE}_{ikt}$  is the gross exports for the importing country-sector pair in a given year.

DVA is the domestic part of export and explores the forward linkages of GVCs. I also study it in proportion of gross exports. A high proportion of DVA means less integration into the GVC compared with a low proportion.

$$\text{pDVA}_{ikt} = \frac{\text{DVA}_{ikt}}{\text{GE}_{ikt}} \quad (42)$$

Finally, I look at global exports belonging to GVCs. I take the measure from Borin and Mancini (2019). It includes goods crossing at least two different national borders. This definition is restrictive enough to capture trade belonging to an international value chain. It is defined by the following equation:

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25. I use the complete matrix framework from Borin and Mancini (2019) to obtain those GVC measures.

$$GVC_{ikt} = GE_{ikt} - DAVAX_{ikt} \quad (43)$$

Where  $i$  is the domestic (and exporting) country.  $GE_{ikt}$  are the gross exports from  $i$  to all the other countries for sector  $k$  and year  $t$ .  $DAVAX_{ikt}$  are the traditional exports, crossing borders only once to get to final demand.

#### 4.3.3 TBT stringency indexes

My TBT stringency indexes are three dummies accounting for the stringency of TBTs<sup>26</sup>. (1) The presence of a TBT STC, (2) the duration of a concern, and (3) the reason of concern. The goal of this methodology is to disentangle which element of stringency is driving the TBT significant impact, if any.

First, I use the dates available for TBT STCs. Many countries can complain many times against the same TBT raised by another WTO country. I focus on the presence of a STC raised against a specific sector-country pair in a given year. As explained by [Beguin and F. Santeramo \(2023\)](#) (in chapter 3), the First raised date is not measuring the impact of the TBT but the impact of raising a concern<sup>27</sup>. Consequently, I focus on the In Force date of the TBT for which there is a STC. However, the First raised date estimates will also be tested as a reference point because it is the date used in the previous literature.

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26. Unlike [Korwatanasakul and Baek \(2021\)](#), I do not use the ACRI (Additional Compliance Requirement Indicator) method to measure the impact of TBTs on GVC. That is mainly because the ACRI method is not made for TBT STCs but for NTMs in general. TBT STCs, in a way, already measure the impact of stringent TBTs.

27. While it is used in the previous literature to study the impact of TBT STCs, First Raised date results are not comparable to a stringency measure of a TBT ([Beguin and F. Santeramo, 2023](#)). Indeed, First Raised date of a concern is not accounting for the impact of the TBT itself but for the impact of the new concern.

A second information is the duration of a STC process. A First raised concern can be raised again later, several times until the Last raised date is recorded. Taking the time between First and Last raised dates could be a good hint that the TBT is problematic, intuitively. Since it builds on the In Force date, it is more restrictive and more refined than the previous index. A longer complaining time is expected to proxy stricter TBTs.

A third information available in my database is the reason of complaints. WTO members complaining can give one or several reasons of concerns like shown in table 19. I categorized all the specific reasons into four categories in table 20. Three categories of reasons are analyzed: unclear, wrong, and trade barrier content<sup>28</sup>. Complaints with unclear content relate to a need for clarification on a specific measure or a lack of transparency. It is not obvious that these technical measures will cause a break on trade in the medium term. Indeed, it is a question of giving more details to facilitate it. Then, complaints for wrong content refer rather to the fact that a technical measure does not respect international legislation (i.e. for example, certain standards or the non-discrimination principle). In that case, this non-respect towards international standards could have consequences on the exports of foreign firms. A third category is trade barriers reasons. Partner countries identify trade barrier complaints as barriers to trade. Therefore, a significant negative effect on exports is expected. Finally, other reasons contain unique reasons, too specific to classify.

To summarize, I study three types of stringency indexes: *Presence TBT STC*, *Duration TBT STC*, and *Reason TBT STC*.

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28. According to [Singh and Chanda \(2021\)](#), issues linked to clarification (transparency, legitimacy, rationale, clarifications) are resolved when relevant information is shared. They assume that the concern is restrictive only when the following complaints are made: unnecessary barriers to trade, discrimination, and non-acceptance of international standards. However, it will not be possible to disentangle the impact of concerns raised for trade barriers from those raised for clarification, for example. Indeed, one STC raised for clarification can also be raised for trade barriers.

Table 20 – Types of TBT concerns

| Issues           | Number of STCs raised | Proportion among all STCs |
|------------------|-----------------------|---------------------------|
| Unclear contents | 515                   | 71.03                     |
| Wrong contents   | 382                   | 52.69                     |
| Barrier to trade | 457                   | 63.03                     |
| Other            | 289                   | 39.86                     |

Source: Author's calculations on the updated STC database for 2000-2021 period, WTO. Note: Some STC contain several reasons of complaints. The classification merges transparency, technical assistance and clarification to build "unclear contents", standards, wrong products, legitimacy and rationale as being so-called "wrong contents", and, finally, "barrier to trade" is composed of barrier to trade, discrimination, time to adapt, special and differential treatment.

## 4.4 RESULTS AND DISCUSSION

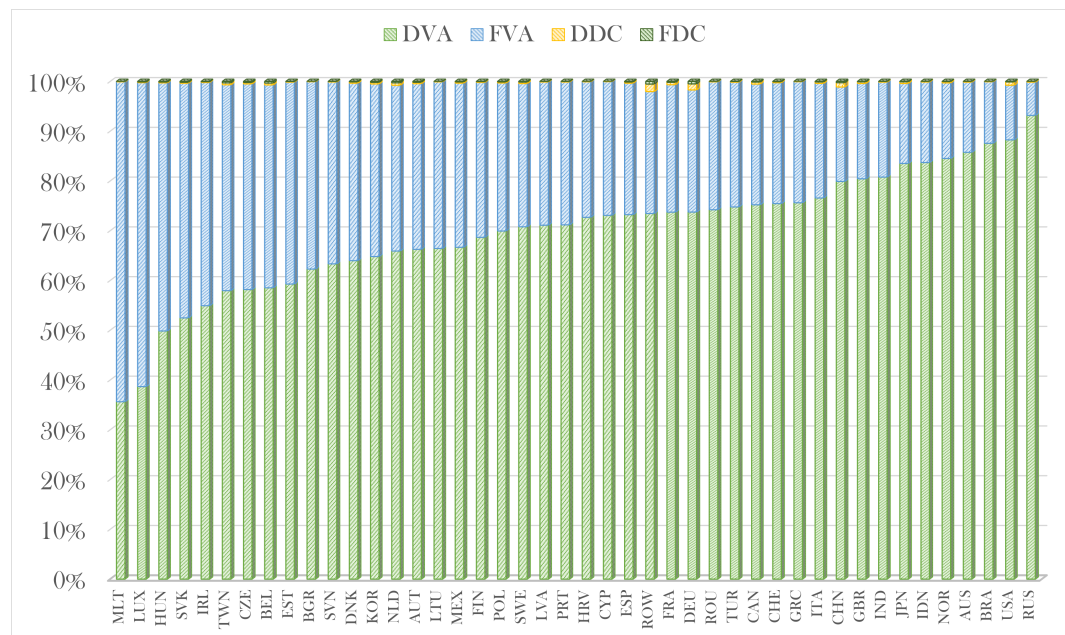
### 4.4.1 Descriptive results on GVC measures

Before I begin the analysis of the results related to the equation 40, I examine some descriptive results related to the DVA and FVA dependent variables. Figure 11 shows the proportion by country of DVA and FVA in gross exports. Clearly, small countries have larger shares of FVA (e.g. Malta, Luxembourg, Belgium, Ireland, etc.). Indeed, they are more anchored in the international market due to their small size, which requires trading to get to a sufficient level of development (contrarily to countries such as the US or China). On the other hand, large countries, such as the US, China, Brazil, and Russia, have a higher share of DVA<sup>29</sup>. These results are coherent with the fact that big economies can be mostly self-sufficient.

Similarly, Figure 12 gives the proportion of DVAs and FVAs for the different sectors in the WIOD database. Again, there is significant sectoral heterogeneity, even within the manufacturing sector. For example, the industry of coke and refined petroleum products (C19) has almost 50 percent FVA, while the manufacture of food products, beverages and tobacco prod-

29. Those large countries have larger volume of exports as shown in figure 25 in the appendix. Germany is one of the few "big" country to have an important FVA.

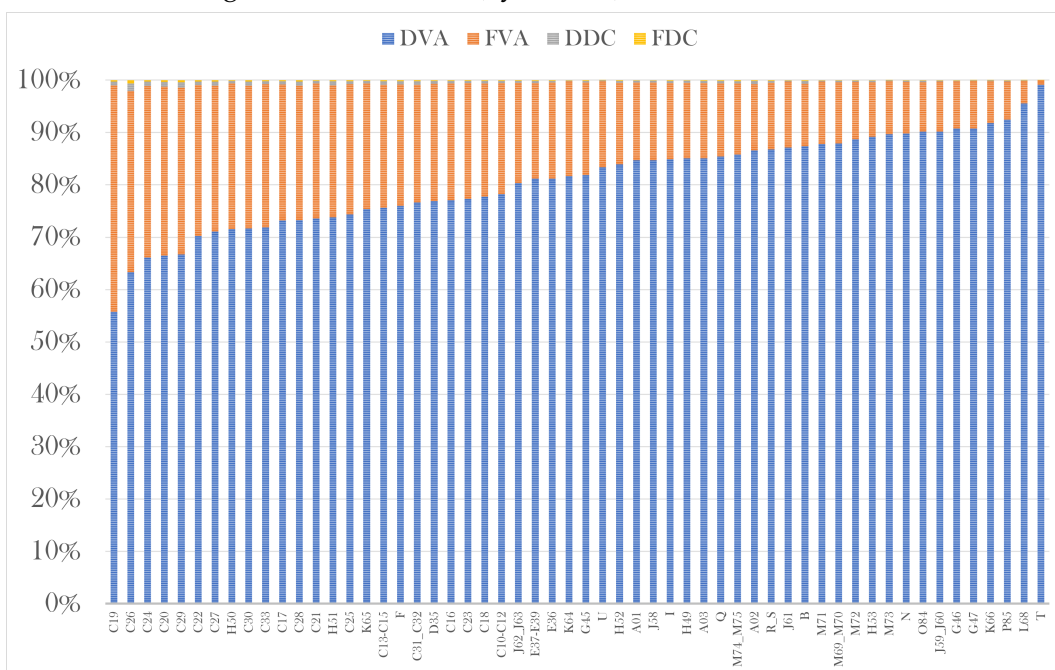
Figure 11 – Gross exports share split into DVA, FVA, Domestic double counted, Foreign double counted (by country)



Notes: Author's calculations based on the WIOD dataset.

ucts (C10-C12) has just over 20 percent FVA. Most services, ranging from letter G to letter U NACE codes, have a proportion of VAS below 20 percent.

Figure 12 – Gross exports share split into DVA, FVA, Domestic double counted, Foreign double counted (by sectors)



Notes: Author's calculations based on the WIOD dataset. Sectors description is in table 33.

#### 4.4.2 *Main Results*

Results from equation 40 are in table 21. Note that the results presented below must be taken with caution since the data is aggregated to the sector level and considers unilateral trade flows. The results only aim at bringing more insights on this unknown subject. Table 21 shows the impact of TBT STCs on GVC trade, specifically considering their stringency features. 5 dummies try to grasp the most stringent TBTs. Those measures are the In Force date, the Unclear content, the Wrong content, the Trade barrier, and the Duration. The First Raised date is also present because it is the one used in the previous literature to account for the stringency of TBT STCs. Columns 1, 2, and 3 respectively presents the Forward GVC participation (i.e. the Domestic Value Added), the Backward GVC participation (i.e. the Foreign Value Added), and the GVC share in total exports. Tables 34, 35, and 36 (in the appendix) show other explanatory variables important to consider in order to measure GVC trade. Those variables are NTMs (taking the value 1 if there is at least one NTM implemented in a given country-sector pair), tariffs, and Inward FDI (proxied by gross fixed capital formation).

Looking at the table 21 at a glance, some general results are noticeable. In column 1, TBT with STCs impact forward GVC, backward GVC and global GVC participation either positively or negatively (when significant) depending on the dummy used. Backward GVC participation is the most impacted of the three GVC measures through all TBT dummies.

#### 4.4.3 *First Raised and In Force dates*

Let us now look more precisely at the stringency indexes used. In the first two rows are the estimates for the presence of STC according to two dates: First Raised and In Force dates.

Table 21 – The effects of different stringency measures for TBTs on GVC participation

| TBT STC Dummy ↓     | (1)<br>Forward GVC<br>participation | (2)<br>Backward GVC<br>participation | (3)<br>GVC share<br>in Total Exports |
|---------------------|-------------------------------------|--------------------------------------|--------------------------------------|
| First Raised date   | -0.028<br>(0.005)***                | 0.049<br>(0.010)***                  | 0.043<br>(0.008)***                  |
| In Force date       | 0.005<br>(0.003)*                   | -0.012<br>(0.005)***                 | -0.011<br>(0.004)***                 |
| Unclear content     | -0.004<br>(0.006)                   | 0.020<br>(0.010)**                   | 0.018<br>(0.008)**                   |
| Wrong content       | -0.008<br>(0.007)                   | -0.007<br>(0.012)                    | -0.009<br>(0.010)                    |
| Trade barrier       | -0.002<br>(0.004)                   | 0.001<br>(0.007)                     | 0.002<br>(0.005)                     |
| Duration            | 0.003<br>(0.001)***                 | -0.007<br>(0.002)***                 | -0.005<br>(0.001)***                 |
| N                   | 34 054                              | 33 630                               | 33735                                |
| Country-Industry FE | Yes                                 | Yes                                  | Yes                                  |

Source: Author's calculations on the updated STC database for 2000-2021 period merged with the WIOD Input-Output data. Dependent variables are calculated using the ICIO tool proposed by [Borin and Mancini \(2019\)](#).

Notes: Each dummy is a new regression including the other explanatory variables present in the specification described in the methodology. These other variables are shown in tables [34](#), [35](#), and [36](#).

First Raised are studied to fit in the literature (Beverelli et al., 2019; Herghelegiu, 2018). The presence of a first concern impacts positively foreign VA and global GVC participation in exports. A First Raised concern increases the backward participation (i.e. the foreign VA share in total exports) by 4.9% while global GVC participation improves by 4.3% in the share of total exports. First Raised date impacts forward participation negatively (i.e. the domestic VA) by 2.8%. Those results are expected as long as one thinks of complaints as tools to help exporters trade better after a negative shock due to a new stringent TBT. Considering this, it makes sense that foreign VA is favored and domestic VA is not.

On the contrary, Foreign VA and GVC share in exports decrease with TBT STCs in force. It is expected if one thinks of TBT STCs as the TBTs that hurt trade the most. Indeed, one should expect a new TBT STC to negatively hit foreign VA. Indeed, remember that TBT First raised date accounts for the concern while In Force date accounts for the policy (two different things, intuitively).

The In Force date is always before the First Raised date in my merged database with WIOD<sup>30</sup>. Consequently, there might be some impact coming from the In Force date also captured in by First Raised date dummy<sup>31</sup>. In other words, the In Force dates are less subject to bias of interpretation<sup>32</sup>.

#### 4.4.4 *Reason and Duration*

I now investigate rows 3 to 6 of table 21. The reasons invoked by complaining countries (rows 3-5) and the duration between First Raised dates

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30. I discard the other timings since it would complexify the interpretation of the results and the difference across timings is not the aim of this paper.

31. It is likely that a new TBT In Force is going to still have some effect years later, biasing the impact measured on First Raised dates.

32. I study the In Force date also because I want to measure the impact of TBTs which are the most stringent (i.e. with concern), not the impact of the concern of the most stringent TBTs.

and Last Raised dates (row 6) are dummies built with the In Force dates as a basis.

I find that only Unclear content is significantly impacting trade. Also, it is only significant for backward GVC trade and GVC share of total exports. The presence of Unclear content in a TBT STC leads to an increase of foreign value added by 2% and an increase of GVC share in exports by 1.8%. Note that Unclear content reacts in the same direction as for First raised dates.

The duration index gives lower estimates in absolute value than the In Force dummy, but of the same sign. Duration captures well the restrictive content of a TBT STC when considering our results using In Force dates. Indeed, an additional year of complaint is leading to 0.3% increase of domestic value added, and to a drop of 0.7% of foreign value added. In addition, it leads to a decrease of 0.5% of GVC participation on average.

#### 4.4.5 Discussion

DVA in exports tend to decrease recently, reflecting the expansion of GVCs (see figure 7). It is argued by Dollar et al. (2019) that countries should not wish to replace foreign inputs by domestic ones if that means replacing them with inferior inputs. It would lead towards a lower total value added in exports at the end. Dollar et al. (2019) claims that both tariffs and non-tariff measures could be used to improve DVA and hinder total value added. My results show that it is the case for non-tariff measures such as TBT with a STC, even more when selecting only the most restrictive ones (i.e. the concerns with the longest duration)<sup>33</sup>.

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33. However, my results are opposite to Wu et al. (2022) who also use WIOD but concentrate on TBT. It has been shown in the literature, many times, that TBTs tend to lead towards more positive results on aggregate database taking all TBTs together. It is not astonishing that taking the TBTs which are the most stringent (i.e. TBT STCs), I find different signs.

My results show that TBT STCs are favoring domestic value-added in export rather than foreign value-added when accounting for the date of implementation of the new TBT and the duration of complaints. The country implementing a new TBT should realize it will disadvantage foreign companies at the profit of local companies. Domestic firms seem to be positively impacted compared to foreign firms. Consequently, TBTs with STC do act like protectionist measures *de facto*. In addition, new TBTs pushes down trade in the GVCs, at the mean, for all sectors.

I find that STC In Force date is a good proxy for the most restrictive TBTs. It is not the case of First Raised dates which do not capture the "stringentness" of TBTs but rather the reaction to a negative impact. It is not surprising that it leads to different results. Moreover, it seems to indicate that complaints work. Therefore, the literature using First Raised dates ([Beverelli et al., 2019](#); [L. Fontagné and Orefice, 2018](#); [Herghelegiu, 2018](#); [Kamal and Zaki, 2018](#); [Orefice, 2017](#); [Singh and Chanda, 2021](#)) could include In Force dates to measure the true policy impact of stringent TBTs instead of the impact of the complaint.

In terms of policy, STCs raised for unclear (lack of information, transparency, or lack of technical assistance) impact trade in the opposite direction compared with the implementation of a new TBT. However, wrong reasons (i.e. lack of rationale, do not fit international standards, or procedural measures) and trade barrier reasons do not impact GVC trade. In other words, policy-makers could use this information to act differently at the TBT committee. First, complaints for unclear reasons really help exporters. However, the other reasons do not seem to be useful. Indeed, the country implementing the new TBT does not seem to intervene when wrong and trade barrier reasons only are invoked.

The causality of my results could be put into perspective by the fact that I take one-sided trade flows for a small number of countries and at a relatively aggregated level of NACE sectors. Also, the reasons of complaints are difficult to disentangle because one complaint can be filed for multiple

reasons at the same time. However, my results say at least three things: 1. the impact of even the most restrictive TBTs are expected; 2. the complexity of international trade, with value chains and firms of different sizes, still leads to the expected aggregate result; 3. taking supplementary information such as the duration or the reasons of complaints is providing more insights on the stringency of TBT STCs.

#### 4.5 CONCLUSION

There is a recent complication of trade relations with the increasing presence of GVCs (global value chains) and of NTMs (non-tariff measures). How to give decision makers the information they need to implement fair and effective regulations for the domestic economy? This paper aims at answering these questions. I study the impact of TBTs on GVC trade in regard to the choice of the stringency index for TBTs.

Recently, the TBT literature has focused on STCs to capture the most stringent TBTs, using raised dates as a proxy for In Force dates. My updated STC database enables me to find In Force dates, which are more accurate. It is also possible to control for the duration of the future complaints. I can also categorize complaints at the WTO between three main categories: unclear content, wrong content, and trade barriers.

I find that TBTs which are subject to longer complaints at the WTO hurt more GVC trade. Also, STCs raised for trade barrier or wrong reasons are not significantly impacting trade flows. However, some TBTs with STCs are favoring trade: when the complaints are linked to unclear reasons (i.e. not clear content, lack of information). First Raised dates are also showing that complaints help foreign exporters in this way.

My findings are subject to caveats. First, I look at GVC trade using only unilateral trade flows. A further analysis using bilateral trade flows should provide similar results, but it must be checked. Second, I limit my study to rich economies belonging to the WIOD database. It excludes a major

part of the economy and results are likely to be enriched when using both developed and developing countries. Third, I do not look at specific sectors or specific countries. Finally, SPS STCs could be measured in the same way as TBT STCs in this work, but I leave that to future research.

## GENERAL CONCLUSION

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The concomitant rise of global value chains and non-tariff barriers has been accompanied by a fall in multilateralism. In this context, it seems necessary to reexamine the role of the WTO. With the failure of Doha negotiations, one can see a clear introduction of the WTO into the precautionism era. The subprime crisis directly followed Doha failure. As a matter of fact, the WTO delayed the return of protectionism which would have been the logical consequence of this drawback, when looking back at the consequence of the Great Recession. Indeed, the WTO introduced several monitoring systems for its members to facilitate the implementation of agreements and to mitigate the negative effects of the financial crisis.

However, soon after, with the election of President Trump in the US in 2016, signs of protectionism have reappeared. This was reinforced by the Covid crisis and the war in Ukraine, which also showed the shortcomings of being too dependent on global value chains<sup>1</sup>. In some sense, the original Ricardo/Malthus debate on free trade has reappeared. Malthus's thought is relevant again: "unrestricted free trade would lead towards too important dependence on foreign imports".

It is necessary to find effective ways to conclude new international agreements and to implement precautionist standards that will allow developing countries as well as developed countries, small businesses as well as large ones, producers as well as consumers, to really benefit from free trade. The

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1. It is also important to understand the interdependence between countries created by this growth in global value chains. Indeed, in a way, too much fragmentation of the production is impeding trade when an outside event, such as Covid19, breaks the chain.

arrival of standards can be seen as protectionist, but it can also be seen as favorable to trade, without negative externalities for all actors.

Some, like [Bollyky and Mavroidis \(2017\)](#), argue that the WTO should allow business players to attend TBT and SPS committee, and facilitate plurilateral agreements. This would favor fewer wars and better living standards. However, as I suggest implicitly in this thesis, there is also a need for a better monitoring. In this way, trade can become favorable to both the producers and the consumers, and, hopefully, lead to a world without unrestricted free trade and without harmful protectionism.

This doctoral thesis contributes to a better understanding of international trade issues affecting the WTO. In the three essays proposed, different elements are brought to bear on this, both at the theoretical and empirical levels. The main conclusion is expected: non-tariff measures such as quality standards and the most stringent technical barriers to trade hurt welfare and trade in most of the cases. Still, another important finding is that they can also be beneficial to trade or welfare under specific conditions on the distribution of firms and when they are in the agriculture sector. Reasons for this result is not yet crystal clear and is a nice avenue of future research.

## APPENDIX



## ADDITIONAL TABLES AND FIGURES APPENDIX

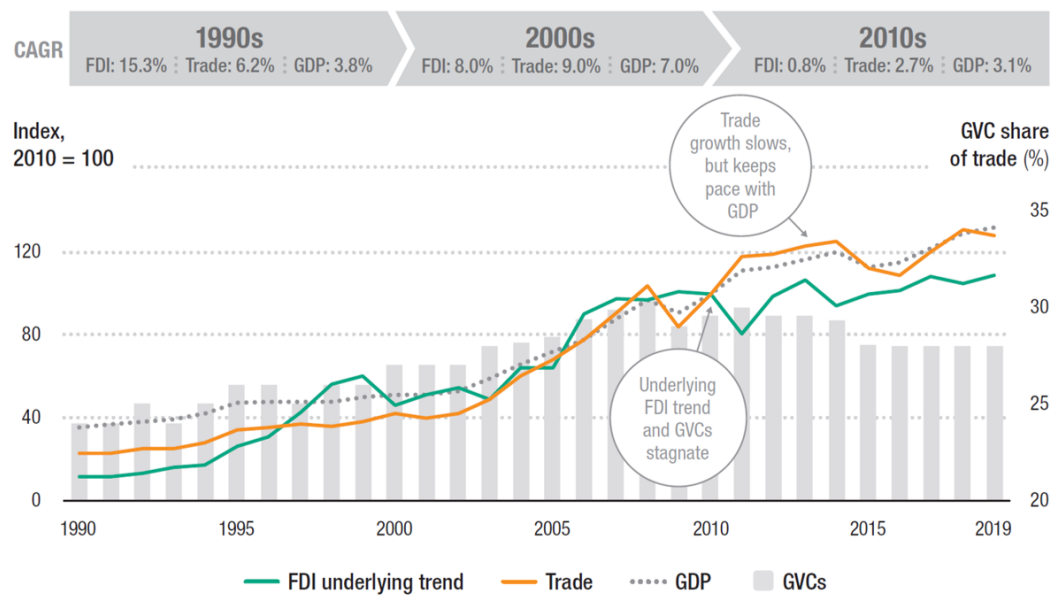
### A.1 APPENDIX CHAPTER 1

Table 22 – Non tariff measure classification by chapter

|         |                         |         |                                                                       |
|---------|-------------------------|---------|-----------------------------------------------------------------------|
| IMPORTS | TECHNICAL MEASURES      | A       | SANITARY AND PHYTOSANITARY MEASURES                                   |
|         |                         | B       | TECHNICAL BARRIERS TO TRADE                                           |
|         |                         | C       | PRE-SHIPMENT INSPECTION AND OTHER FORMALITIES                         |
|         |                         | D       | CONTINGENT TRADE-PROTECTIVE MEASURES                                  |
|         |                         | E       | NON-AUTOMATIC LICENSING, QUOTAS,<br>PROHIBITIONS AND QUANTITY-CONTROL |
|         |                         |         | MEASURES OTHER THAN FOR SPS OR TBT<br>REASONS                         |
|         |                         | F       | PRICE-CONTROL MEASURES, INCLUDING<br>ADDITIONAL TAXES AND CHARGES     |
|         |                         | G       | FINANCE MEASURES                                                      |
|         | NON TECHNICAL MEASURES  | H       | MEASURES AFFECTING COMPETITION                                        |
|         |                         | I       | TRADE-RELATED INVESTMENT MEASURES                                     |
|         |                         | J       | DISTRIBUTION RESTRICTIONS                                             |
|         |                         | K       | RESTRICTIONS ON POST-SALES SERVICES                                   |
|         |                         | L       | SUBSIDIES (EXCLUDING EXPORT SUBSIDIES UNDER P7)                       |
|         |                         | M       | GOVERNMENT PROCUREMENT RESTRICTIONS                                   |
|         |                         | N       | INTELLECTUAL PROPERTY                                                 |
|         |                         | EXPORTS | O                                                                     |
| P       | EXPORT-RELATED MEASURES |         |                                                                       |

Source: UNCTAD

Figure 13 – Global value chains: increasing importance in global trade

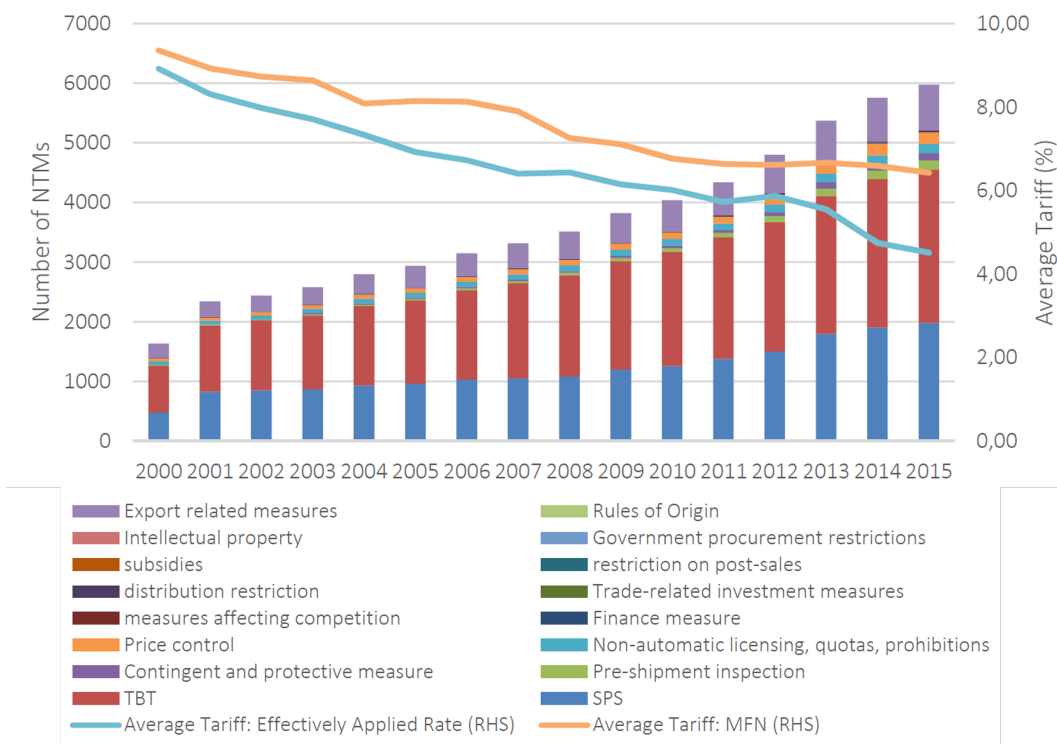


Source: [UNCTAD \(2020\)](#). CAGR is the compound annual growth rate.

## A.2 APPENDIX CHAPTER 3

### Tables

Figure 14 – NTMs: increasing importance in global trade



Source: [Ing et al. \(2016\)](#). Data from the ASEAN-ERIA-UNCTAD-TRAINS Database for the period 2000-2015.

Table 23 – Stated concerns for TBTs raised at the WTO

| Concerns                               | Number of STCs raised | Proportion in all STCs |
|----------------------------------------|-----------------------|------------------------|
| Further Information, Clarification     | 395                   | 17,75                  |
| Unnecessary barrier to trade           | 364                   | 16,36                  |
| Transparency                           | 342                   | 15,37                  |
| Other issues raised                    | 289                   | 12,99                  |
| International standards                | 242                   | 10,88                  |
| Rationale, legitimacy                  | 225                   | 10,11                  |
| Discrimination                         | 178                   | 8,00                   |
| Time to adapt, "reasonable interval"   | 127                   | 5,71                   |
| Non-product related & procedural meas. | 42                    | 1,89                   |
| Special and differential treatment     | 17                    | 0,76                   |
| Technical assistance                   | 4                     | 0,18                   |

*Source:* Author's calculations on the STC database for 2000-2021 period, WTO.

*Notes:* Each STC can have more than one objective. The total number of STCs raised in this database is 725.

Table 24 – ITPDE industries cumulatively covering more than 50% of TBT STCs

| ITPDE Code | ITPDE                                      | Number of STCs      | Number of STCs | Percent coverage               | Percent coverage               |
|------------|--------------------------------------------|---------------------|----------------|--------------------------------|--------------------------------|
|            |                                            | in 2000-2016 period | in 1995-2021   | 2000-2016<br>(out of 256 STCs) | 1995-2021<br>(out of 725 STCs) |
| 48         | Wines                                      | 36                  | 94             | 14%                            | 13%                            |
| 87         | Soap cleaning & cosmetic preparations      | 34                  | 89             | 13%                            | 12%                            |
| 47         | Distilling rectifying & blending of sp..   | 32                  | 82             | 13%                            | 11%                            |
| 88         | Other chemical products n.e.c.             | 31                  | 86             | 12%                            | 12%                            |
| 128        | Accumulators primary cells and batteries   | 30                  | 38             | 12%                            | 5%                             |
| 49         | Malt liquors and malt                      | 29                  | 70             | 11%                            | 10%                            |
| 46         | Other food products n.e.c.                 | 29                  | 80             | 11%                            | 11%                            |
| 38         | Dairy products                             | 25                  | 71             | 10%                            | 10%                            |
| 34         | Processing/preserving of meat              | 23                  | 61             | 9%                             | 8%                             |
| 35         | Processing/preserving of fish              | 22                  | 50             | 9%                             | 7%                             |
| 153        | Other manufacturing n.e.c.                 | 21                  | 62             | 8%                             | 9%                             |
| 19         | Eggs                                       | 18                  | 39             | 7%                             | 5%                             |
| 138        | Motor vehicles                             | 18                  | 54             | 7%                             | 7%                             |
| 36         | Processing/preserving of fruit & veget..   | 18                  | 50             | 7%                             | 7%                             |
| 50         | Soft drinks; mineral waters                | 18                  | 48             | 7%                             | 7%                             |
| 52         | Textile fibre preparation; textile wea..   | 18                  | 46             | 7%                             | 6%                             |
| 37         | Vegetable and animal oils and fats         | 18                  | 49             | 7%                             | 7%                             |
| 44         | Cocoa chocolate and sugar confectionery    | 17                  | 45             | 7%                             | 6%                             |
| 39         | Grain mill products                        | 17                  | 46             | 7%                             | 6%                             |
| 7          | Other oilseeds (exc. peanuts)              | 17                  | 45             | 7%                             | 6%                             |
| 40         | Starches and starch products               | 17                  | 46             | 7%                             | 6%                             |
| 132        | TV / radio transmitters; line comm. appa.. | 17                  | 55             | 7%                             | 8%                             |
| 42         | Bakery products                            | 16                  | 44             | 6%                             | 6%                             |
| 123        | Domestic appliances n.e.c.                 | 16                  | 62             | 6%                             | 9%                             |
| 13         | Fresh vegetables                           | 16                  | 41             | 6%                             | 6%                             |
| 43         | Sugar                                      | 16                  | 38             | 6%                             | 5%                             |
| 8          | Animal feed ingredients & pet foods        | 15                  | 32             | 6%                             | 4%                             |
| 129        | Lighting equipment and electric lamps      | 15                  | 45             | 6%                             | 6%                             |
| 45         | Macaroni noodles & similar products        | 15                  | 41             | 6%                             | 6%                             |
| 6          | Soybeans                                   | 15                  | 34             | 6%                             | 5%                             |

Source: Author's calculations on the updated STC database for 2000-2021 period, WTO.

Notes: we calculate the percent coverage based on the 725 STCs available for the entire period. For the 2000-2016 period, 256 STCs are available. While there is not a big difference in terms of ranking, Accumulators primary cells and batteries cover 12% of the STCs in this period and only 5% for the entire time period.

### A.2.1 *Complete gravity results*

Table 25 gives us the baseline results without any TBT STC covariate, comparing different included FEs. The idea here is to first look at TBTs as the subset included into NTMs without accounting for STCs (the baseline) and then look at STCs as the subset of TBTs itself subset of NTMs.

Let us look at standard gravity estimates, which accounts for the trade cost, in column (1) to convince the reader of the strength of our results for TBT STC dates in the next paragraph. Column (1) does not include pair fixed effects in order to be able to estimate those gravity variables. As noted by Borchert et al. (2021), the ITPD-E gives very strong estimates for distance, contiguity, language, and colony variables. The signs and size are the same as in the literature. Colonial ties is the only variable which gives non-significant results. It is caused by the fact that most countries complaining and getting complains are OECD countries which do not have colonial ties, as shown in figure 5. Tariff is a standard gravity covariate when testing the impact of a NTM. The impact of tariff is an elasticity: an increase of one percent of tariff is decreasing trade by 1.788%. Concerning the "TBTs without STCs", "Other NTMs than TBTs" and "NTMs including TBTs" variables<sup>1</sup>, we find the following results: in column (1), "TBTs without STCs" decrease exports by \*\*\*23.9%<sup>2</sup>. This is expected: most TBTs hurt trade because of the time and cost to adapt. Other non-TBTs NTMs increase exports by \*\*\*34%. There are many NTMs and while some are intuitively more likely to hinder trade, on average, it favors it.

The literature on the gravity framework (Yotov et al., 2016) advises the use of country pair fixed effects because it discards the potential endogene-

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1. In column (1), those variables are respectively written as follows: TBTs w/o STCs for "TBTs without STCs" accounts for all TBTs except TBT STCs, NTMs w/ TBTs for "Other NTMs than TBTs" accounts for all NTMs except TBTs and TBT STCs.

2. For the readability, stars on the left-hand side of an estimate are denoting significance levels: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

ity created by omitted variables<sup>3</sup>. However, in column (2) it still integrate variability in terms of sector and time. Thus, some endogeneity is present due to the size of sectors. Significance levels and signs are similar in column (2) compared with column (1). Column (3) controls for country-pair sector FE. With country-pair sector FE, only time variability is remaining.

#### A.2.2 *The effects for a sample of industries*

In order to show that there is an important heterogeneity across industries and that results in the literature can be found with more disaggregated data, we show here the results for a set of industries.

Table 31 presents the results for the industry-level gravity estimates for a sample of sectors. Our selection criteria are: 1) at least one industry per sectors, and 2) industries with either a low or a high number of STCs (based on table 24).

In four sectors belonging to the 10th decile of the distribution of sectors given the number of STCs (see figure 18), the results are already heterogeneous. Two of them belong to the food industries: “34 - Processing/preserving of meat” and “48 - Wines” are not hit similarly by the different dates studied. The in-force date hits positively and significantly Wines but negatively Processing/preserving of the meat industry. TBTs affect positively the “87 - Soap and cosmetic” sector when looking at raised dates, while “88 - Other chemical products” not significantly impacted. In conclusion, TBTs impact very heterogeneously the “largest” industries in terms of STCs.

We now look at industries which are less often hit by a STC. “30 - Mining of iron ores” industry (first decile) is negatively impacted by the raised dates (trade drops by 84.2%) but positively by the in force date. Another interesting case is the “151 - Sports goods” industry. Trade is impacts first positively with initiation, in force and first raised dates but then it becomes negative after the last concern. Finally, in the “162 - Telecom, computer,

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3. For example, bilateral policies other than the one we wish to study.

and information services “ industry, the impact is positive and significant at after several dates of concerns, but it was strongly negative at the in force date. Again, it illustrates the heterogeneity across industries and the importance of controlling for the timing to interpret our results in the best conditions.

#### A.2.3 *Sensitivity Analysis*

Table 25 – Baseline TBT impacts for all sectors (PPML)

| Dep. var.: exports      | (1)                           | (2)                    | (3)                    |
|-------------------------|-------------------------------|------------------------|------------------------|
| ln_tariff               | -1.788<br>(0.236)***          | -1.094<br>(0.129)***   | -0.173<br>(0.082)**    |
| TBT                     | -0.273<br>(0.050)***          | -0.127<br>(0.035)***   | -0.014<br>-0.014       |
| nonTBT                  | 0.295<br>(0.043)***           | 0.175<br>(0.035)***    | 0.045<br>(0.012)***    |
| SMCTRY                  | 2.781<br>(0.071)***           | 0<br>(.)               | 0<br>(.)               |
| ln_DIST                 | -0.874<br>(0.022)***          | 0<br>(.)               | 0<br>(.)               |
| contiguity              | 0.377<br>(0.047)***           | -0.16<br>-0.156        | -0.268<br>(0.163)*     |
| common_language         | 0.165<br>(0.037)***           | 0<br>(.)               | 0<br>(.)               |
| colony_ever             | 0.046<br>-0.041<br>(0.361)*** | 0<br>(.)<br>(0.017)*** | 0<br>(.)<br>(0.013)*** |
| Importer-sector-time FE | Yes                           | Yes                    | Yes                    |
| Exporter-sector-time FE | Yes                           | Yes                    | Yes                    |
| Country-Pair FE         | No                            | Yes                    | No                     |
| Country-Pair Sector FE  | No                            | No                     | Yes                    |
| Pseudo R <sup>2</sup>   | 0.9766                        | 0.9827                 | 0.9951                 |
| No. Of Observations     | 20819320                      | 20617494               | 20613468               |

*Notes:* Here is the report of estimates for all 131 sectors from ITPD-E which have been hit in at least one period and in one exporting country. In column (1), those variables are respectively written as follows: TBTs w/o STCs for "TBTs without STCs" accounts for all TBTs except TBT STCs, NTMs w/o TBTs for "Other NTMs than TBTs" accounts for all NTMs except TBTs and TBT STCs. In the other columns, NTMs w/TBTs w/o STCs is for "NTMs including TBTs excluding TBT STCs" accounts for all NTMs other than TBT STCs. In parentheses are the standard errors. The intranational variables are averages across all country-specific intranational estimates. Standard errors in parentheses \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. See text for further details.

Table 26 – Effect of the TBT STC leads and lags by 1 to 3 years around the In Force date

| All Timings All sectors |          |        |        |          |        |        |
|-------------------------|----------|--------|--------|----------|--------|--------|
| Variables               | lead 1   | lead 2 | lead 3 | lag 1    | lag 2  | lag 3  |
| In Force                | -0.027   | -0.008 | -0.014 | -0.026   | -0.001 | -0.017 |
| Rob std. Err            | (0.015)* | -0.02  | -0.015 | (0.013)* | -0.022 | -0.019 |

Notes: The estimates above were obtained by running the standard regression in equation 38. We only show the results for leads and lags as TBT estimates were always of the same size and level of significance.

Table 27 – Time length between initiation and in force dates among several non-tariff measures

| Time length between Initiation and In Force date in years |        |                    |     |     |                     |              |
|-----------------------------------------------------------|--------|--------------------|-----|-----|---------------------|--------------|
| Measure                                                   | Mean   | Standard deviation | Min | Max | Nb. Of Observations | Source       |
| NTMs                                                      | 0.582  | 1.174              | -19 | 16  | 11594               | WIIW         |
| TBTs                                                      | 0.826  | 1.605              | -19 | 13  | 2502                | WIIW         |
| TBT STCs All Timings                                      | 1.005  | 2.032              | -11 | 16  | 549                 | STC database |
| TBT STCs Implementation before Concern                    | 0.3475 | 1.685              | -11 | 12  | 282                 | STC database |
| TBT STCs Implementation after Concern                     | 2.191  | 2.515              | 0   | 16  | 131                 | STC database |

| Time length between Initiation and In Force date in days |         |                    |       |      |                     |              |
|----------------------------------------------------------|---------|--------------------|-------|------|---------------------|--------------|
| Measure                                                  | Mean    | Standard deviation | Min   | Max  | Nb. Of Observations | Source       |
| NTMs                                                     | 217.257 | 407.84             | -6820 | 5907 | 11594               | WIIW         |
| TBTs                                                     | 302.368 | 560.052            | -6820 | 5059 | 2502                | WIIW         |
| TBT STCs All Timings                                     | 352.383 | 730.255            | -4108 | 5936 | 549                 | STC database |
| TBT STCs Implementation before Concern                   | 124.755 | 618.814            | -4108 | 4383 | 282                 | STC database |
| TBT STCs Implementation after Concern                    | 783.008 | 882.609            | -3    | 5936 | 131                 | STC database |

Source: Author's calculations on the updated STC database for 2000-2021 period, WTO and on the WIIW dataset (M. Ghodsi et al., 2017).

Table 28 – Time length between initiation and in force dates among several non-tariff measures (discarding initiation after in force dates)

| Time distance between Initiation and In Force date in years |       |                    |     |     |                     |              |
|-------------------------------------------------------------|-------|--------------------|-----|-----|---------------------|--------------|
| Measure                                                     | Mean  | Standard deviation | Min | Max | Nb. Of Observations | Source       |
| NTMs                                                        | 0.786 | 1.126              | 0   | 16  | 9423                | WIIW         |
| TBTs                                                        | 1.102 | 1.507              | 0   | 13  | 2080                | WIIW         |
| TBT STCs All Timings                                        | 1.322 | 1.914              | 0   | 16  | 463                 | STC database |
| TBT STCs Implementation before Concern                      | 0.763 | 1.385              | 0   | 12  | 207                 | STC database |
| TBT STCs Implementation after Concern                       | 2.21  | 2.517              | 0   | 16  | 130                 | STC database |
| TBT STCs Implementation between Concerns                    | 1.325 | 1.584              | 0   | 8   | 126                 | STC database |

| Time distance between Initiation and In Force date in days |         |                    |     |      |                     |              |
|------------------------------------------------------------|---------|--------------------|-----|------|---------------------|--------------|
| Measure                                                    | Mean    | Standard deviation | Min | Max  | Nb. Of Observations | Source       |
| NTMs                                                       | 288.301 | 392.295            | 0   | 5907 | 9423                | WIIW         |
| TBTs                                                       | 397.788 | 526.743            | 0   | 5059 | 2080                | WIIW         |
| TBT STCs All Timings                                       | 470.283 | 682.388            | 0   | 5936 | 463                 | STC database |
| TBT STCs Implementation before Concern                     | 285.242 | 503.883            | 0   | 4383 | 207                 | STC database |
| TBT STCs Implementation after Concern                      | 789.054 | 883.296            | 0   | 5936 | 130                 | STC database |
| TBT STCs Implementation between Concerns                   | 445.389 | 578.312            | 0   | 2901 | 126                 | STC database |

Source: Author's calculations on the updated STC database for 2000-2021 period, WTO and on the WIIW dataset (M. Ghodsi et al., 2017).

Notes: The STCs with Initiation dates after In Force dates were discarded from the above statistics to obtain positive time lengths only.

Table 29 – Length of complaint between First and Last raised dates according to different timings

| Time length between First and Last raised dates of TBT STCs in years |       |                    |     |     |                     |              |
|----------------------------------------------------------------------|-------|--------------------|-----|-----|---------------------|--------------|
| Measure                                                              | Mean  | Standard deviation | Min | Max | Nb. Of Observations | Source       |
| All Timings                                                          | 1.094 | 1.936              | 0   | 15  | 725                 | STC database |
| Implementation before Concern                                        | 1.014 | 1.603              | 0   | 12  | 286                 | STC database |
| Implementation after Concern                                         | 0.414 | 0.808              | 0   | 6   | 133                 | STC database |

| Time length between First and Last raised dates of TBT STCs in days |         |                    |     |      |                     |              |
|---------------------------------------------------------------------|---------|--------------------|-----|------|---------------------|--------------|
| Measure                                                             | Mean    | Standard deviation | Min | Max  | Nb. Of Observations | Source       |
| All Timings                                                         | 408.756 | 718.347            | 0   | 5719 | 725                 | STC database |
| Implementation before Concern                                       | 371.245 | 602.163            | 0   | 4620 | 286                 | STC database |
| Implementation after Concern                                        | 146.331 | 272.900            | 0   | 2242 | 133                 | STC database |

Source: Author's calculations on the updated STC database for 2000-2021 period.

Table 30 – Number of raised dates by STC by Timing

| Number of raised dates by STC by Timing             |       |                    |     |     |                     |
|-----------------------------------------------------|-------|--------------------|-----|-----|---------------------|
| All Timings                                         | Mean  | Standard deviation | Min | Max | Nb. Of Observations |
| All Timings (only STC with In Force date available) | 3.825 | 4.841              | 1   | 38  | 725                 |
| Implementation before Concern                       | 3.489 | 3.753              | 1   | 33  | 284                 |
| Implementation after Concern                        | 2.038 | 1.573              | 1   | 10  | 133                 |
| Implementation between Concerns                     | 8.61  | 7.757              | 2   | 38  | 136                 |

Source: Author's calculations on the updated STC database for 2000-2021 period.

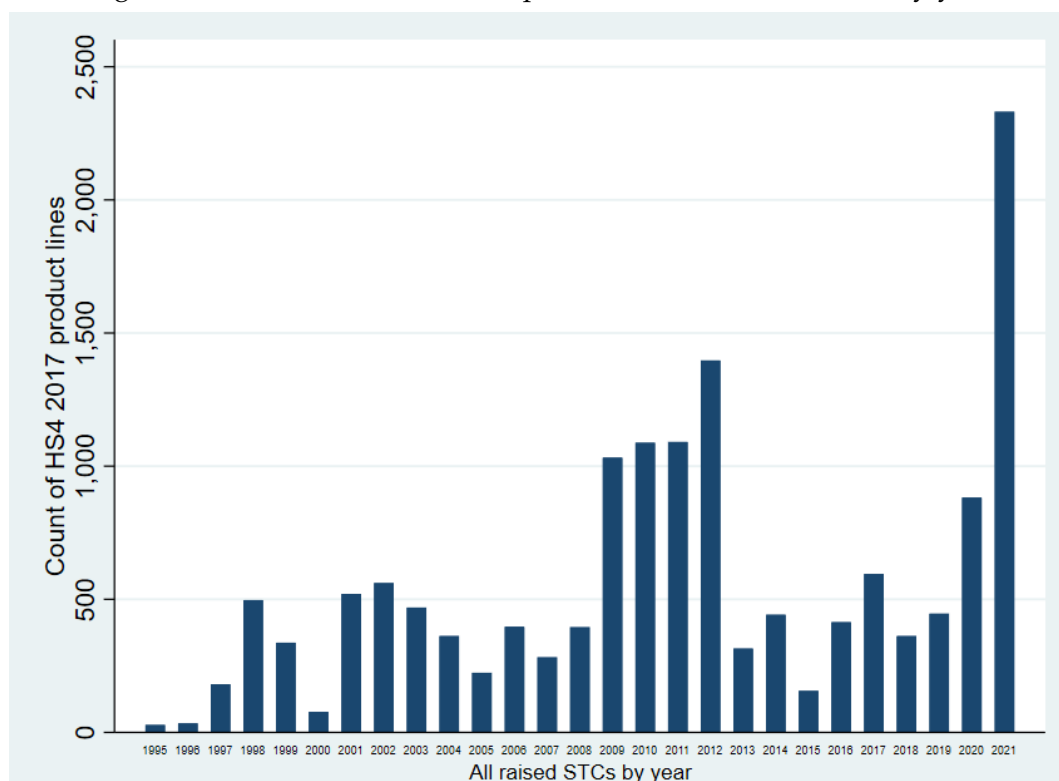
Table 31 – Industry-Level Gravity Estimates for a sample of industries, PPML, 2000-2016

|                                          | In Force   | All Raised | First Raised | Initiation | N      | STCs |
|------------------------------------------|------------|------------|--------------|------------|--------|------|
| 7                                        | 0.137      | 0.073      | -0.027       | -0.059     |        | 45   |
| Other oilseeds (exc. peanuts)            | (0.130)    | (0.105)    | (0.116)      | (0.126)    | 98839  |      |
| 30                                       | 0.417      | -1.157     | -1.157       | 0.135      |        | 2    |
| Mining of iron ores                      | (0.143)*** | (0.151)*** | (0.151)***   | (0.161)    | 24796  |      |
| 34                                       | -0.167     | -0.164     | -0.093       | -0.050     |        | 34   |
| Processing/preserving of meat            | (0.097)*   | (0.056)*** | (0.064)      | (0.060)    | 156256 |      |
| 48                                       | 0.088      | 0.001      | 0.023        | 0.027      |        | 94   |
| Wines                                    | (0.027)*** | (0.025)    | (0.036)      | (0.037)    | 116646 |      |
| 49                                       | -0.024     | 0.064      | 0.060        | 0.053      |        | 70   |
| Malt liquors and malt                    | (0.065)    | (0.064)    | (0.068)      | (0.066)    | 97375  |      |
| 50                                       | -0.022     | -0.044     | -0.055       | 0.008      |        | 48   |
| Soft drinks; mineral waters              | (0.073)    | (0.065)    | (0.067)      | (0.066)    | 147644 |      |
| 65                                       | -0.029     | 0.241      | 0.020        | 0.015      |        | 3    |
| Builders' carpentry and joinery          | (0.330)    | (0.379)    | (0.373)      | (0.344)    | 122076 |      |
| 87                                       | 0.017      | 0.036      | 0.047        | 0.026      |        | 89   |
| Soap cleaning & cosmetic preparations    | (0.020)    | (0.016)**  | (0.022)**    | (0.027)    | 228591 |      |
| 88                                       | -0.020     | 0.004      | 0.040        | 0.062      |        | 86   |
| Other chemical products n.e.c.           | (0.066)    | (0.004)    | (0.033)      | (0.049)    | 260440 |      |
| 151                                      | 0.487      | -0.442     | 0.472        | 0.444      |        | 15   |
| Sports goods                             | (0.155)*** | (0.156)*** | (0.161)***   | (0.154)*** | 182704 |      |
| 162                                      | -2.065     | 0.208      | 0.037        | -0.011     |        | 7    |
| Telecommunications, computer, and info.. | (0.394)*** | (0.058)*** | (0.069)      | (0.066)    | 27431  |      |

Notes: Here is the report of estimates for a sample of sectors from ITPD-E which have been hit in at least one period and in one exporting country. We have performed four regressions to get each four dates (In Force, All Raised, First Raised, and Initiation). For representativeness, we showed at least one sector in each broad sector, and sectors which were both containing a high number of STCs (such as Wine) and a low number of STCs (such as Mining of Iron Ores). Standard errors in parentheses \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. See text for further details.

## Figures

Figure 15 – Number of HS4 2017 product lines in raised STCs by year



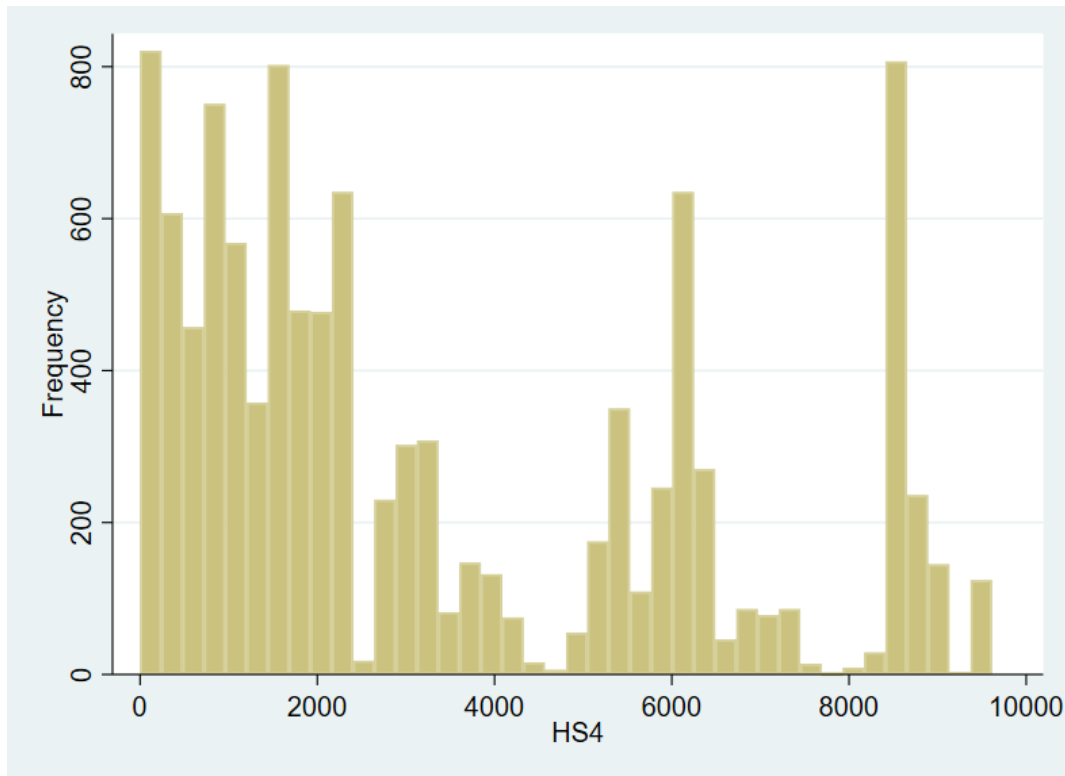
Notes: author's calculations using HS4 codes contained in both STC database and WIIW database. The number of HS4 lines through time is increasing.

## A.3 APPENDIX CHAPTER 4

### Tables

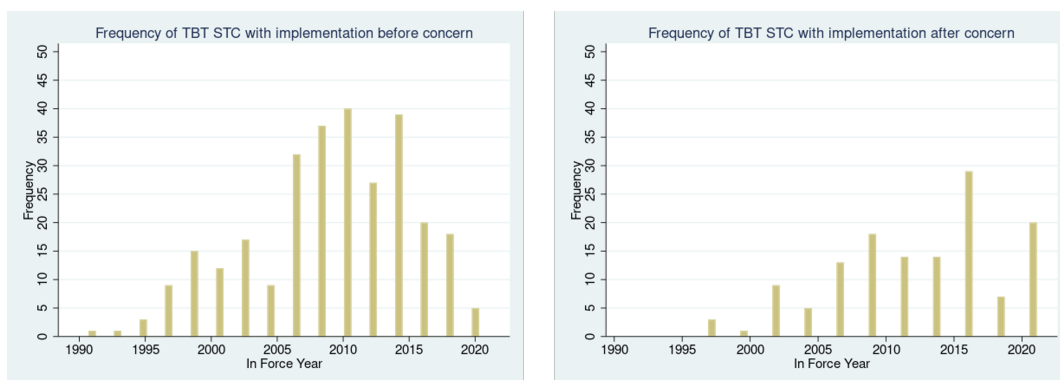
#### A.3.1 Additional results

Figure 16 – HS4 2017 product lines distribution (in TBT STCs)



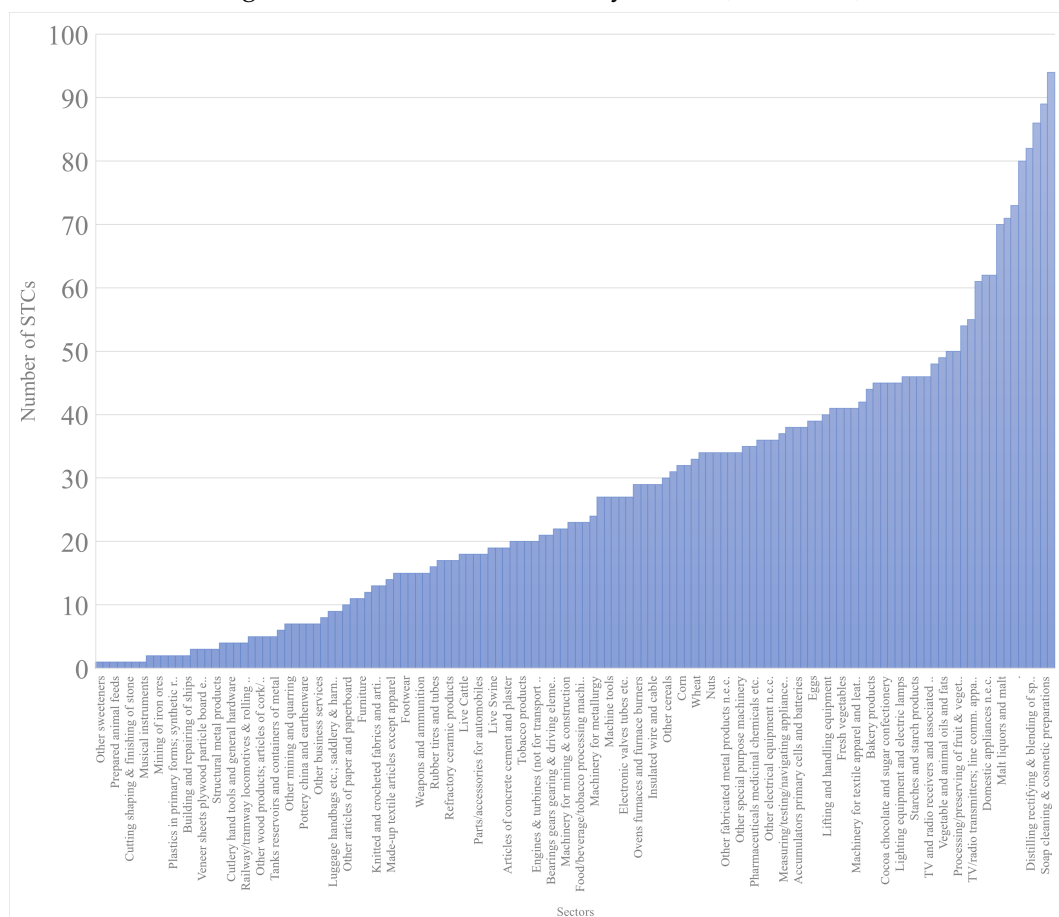
Notes: author's calculations using HS4 codes contained in both STC database and WIIW database. All hs4 lines are not visible but an aggregation is made among hs4 lines close to each other. Still it allows us to see that agriculture, food and manufacture products are the most concerned by TBT STCs.

Figure 17 – Frequencies of STCs according to the timing of implementation and concern



Notes: author's calculations using the updated STC database.

Figure 18 – Number of STCs by sector (1995-2021)



Notes: author's calculations over 131 sectors, 10 deciles of 13 sectors (14 for the 10th). The distribution shows an unequal distribution. The top 10% of most concerned sectors cover the same number of complaints as the bottom 60%.

Table 32 – Composition of G20 compared to WIOD

| Country        | G20 | WIOD |
|----------------|-----|------|
| Argentina      | x   |      |
| Australia      | x   | x    |
| Brazil         | x   | x    |
| Canada         | x   | x    |
| China          | x   | x    |
| France         | x   | x    |
| Germany        | x   | x    |
| India          | x   | x    |
| Indonesia      | x   | x    |
| Italy          | x   | x    |
| Japan          | x   | x    |
| Mexico         | x   | x    |
| Russia         | x   | x    |
| Saudi Arabia   | x   |      |
| South Africa   | x   |      |
| South Korea    | x   | x    |
| Turkey         | x   | x    |
| United Kingdom | x   | x    |
| United States  | x   | x    |
| European Union | x   | x    |
| Taiwan         |     | x    |
| Norway         |     | x    |
| Switzerland    |     | x    |

Table 33 – NACE - WIOD sectors

| Nace code | Name                                                                         | WIOD Number | Nace code | Name                                                                                                                       | WIOD Number |
|-----------|------------------------------------------------------------------------------|-------------|-----------|----------------------------------------------------------------------------------------------------------------------------|-------------|
| A01       | Crop and animal production, hunting and related service activities           | 1           | G46       | Wholesale trade, except of motor vehicles and motorcycles                                                                  | 29          |
| A02       | Forestry and logging                                                         | 2           | G47       | Retail trade, except of motor vehicles and motorcycles                                                                     | 30          |
| A03       | Fishing and aquaculture                                                      | 3           | H49       | Land transport and transport via pipelines                                                                                 | 31          |
| B         | Mining and quarrying                                                         | 4           | H50       | Water transport                                                                                                            | 32          |
| C10-      | Manufacture of food products,                                                | 5           | H51       | Air transport                                                                                                              | 33          |
| C12       | beverages and tobacco products                                               |             |           |                                                                                                                            |             |
| C13-      | Manufacture of textiles, wearing                                             | 6           | H52       | Warehousing and                                                                                                            | 34          |
| C15       | apparel and leather products                                                 |             |           | support activities for transportation                                                                                      |             |
| C16       | Manufacture of wood and of products of wood and cork, except furniture       | 7           | H53       | Postal and courier activities                                                                                              | 35          |
| C17       | Manufacture of paper and paper products                                      | 8           | I         | Accommodation and food service activities                                                                                  | 36          |
| C18       | Printing and reproduction of recorded media                                  | 9           | J58       | Publishing activities                                                                                                      | 37          |
| C19       | Manufacture of coke and refined petroleum products                           | 10          | J59-      | Motion picture, video and television programme production,                                                                 | 38          |
|           |                                                                              |             | J60       | sound recording and music publishing activities;                                                                           |             |
|           |                                                                              |             |           | programming and broadcasting activities                                                                                    |             |
| C20       | Manufacture of chemicals and chemical products                               | 11          | J61       | Telecommunications                                                                                                         | 39          |
| C21       | Manufacture of basic pharmaceutical products and pharmaceutical preparations | 12          | J62-      | Computer programming, consultancy and                                                                                      | 40          |
|           |                                                                              |             | J63       | related activities; information service activities                                                                         |             |
| C22       | Manufacture of rubber and plastic products                                   | 13          | K64       | Financial service activities, except insurance and pension funding                                                         | 41          |
| C23       | Manufacture of other non-metallic mineral products                           | 14          | K65       | Insurance, reinsurance and pension funding, except compulsory social security                                              | 42          |
| C24       | Manufacture of basic metals                                                  | 15          | K66       | Activities auxiliary to financial services and insurance activities                                                        | 43          |
| C25       | Manufacture of fabricated metal products, except machinery and equipment     | 16          | L68       | Real estate activities                                                                                                     | 44          |
| C26       | Manufacture of computer electronic and optical products                      | 17          | M69-      | Legal and accounting activities; activities of head offices;                                                               | 45          |
|           |                                                                              |             | M70       | management consultancy activities                                                                                          |             |
| C27       | Manufacture of electrical equipment                                          | 18          | M71       | Architectural and engineering activities; technical testing and analysis                                                   | 46          |
| C28       | Manufacture of machinery and equipment n.e.c.                                | 19          | M72       | Scientific research and development                                                                                        | 47          |
| C29       | Manufacture of motor vehicles, trailers and semi-trailers                    | 20          | M73       | Advertising and market research                                                                                            | 48          |
| C30       | Manufacture of other transport equipment                                     | 21          | M74-      | Other professional, scientific and technical activities;                                                                   | 49          |
|           |                                                                              |             | M75       | veterinary activities                                                                                                      |             |
| C31-      | Manufacture of furniture; other manufacturing                                | 22          | N         | Administrative and support service activities                                                                              | 50          |
| C32       |                                                                              |             |           |                                                                                                                            |             |
| C33       | Manufacture of furniture; other manufacturing                                | 23          | O84       | Public administration and defence; compulsory social security                                                              | 51          |
| D35       | Electricity, gas, steam and air conditioning supply                          | 24          | P85       | Education                                                                                                                  | 52          |
| E36       | Water collection, treatment and supply                                       | 25          | Q         | Human health and social work activities                                                                                    | 53          |
| E37-      | Water supply, sewerage, waste management                                     | 26          | R-S       | Other service activities                                                                                                   | 54          |
| E39       | and remediation                                                              |             |           |                                                                                                                            |             |
| F         | Construction                                                                 | 27          | T         | Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use | 55          |
| G45       | Wholesale and retail trade, repair of motor vehicles and motorcycles         | 28          | U         | Activities of extraterritorial organizations and bodies                                                                    | 56          |

Table 34 – Foreign Value-Added share in Total Exports (OLS)

|                                          | (1)                       | (2)                  | (3)                  | (4)                  | (5)                  |
|------------------------------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
|                                          | Forward GVC participation |                      |                      |                      |                      |
| STC First Raised date                    | 0.049<br>(0.010)***       |                      |                      |                      |                      |
| STC In Force date                        |                           | -0.012<br>(0.005)*** |                      |                      |                      |
| STC Reason Strenght                      |                           |                      | -0.001<br>(0.002)    |                      |                      |
| STC Duration                             |                           |                      |                      | -0.007<br>(0.002)*** |                      |
| STC Duration weighted by Reason Strenght |                           |                      |                      |                      | 0<br>(0.000)***      |
| Tariffs                                  | -0.117<br>(0.034)***      | -0.121<br>(0.033)*** | -0.111<br>(0.031)*** | -0.111<br>(0.031)*** | -0.111<br>(0.031)*** |
| Inward FDI                               | 0.091<br>(0.006)***       | 0.092<br>(0.006)***  | 0.087<br>(0.006)***  | 0.087<br>(0.006)***  | 0.087<br>(0.006)***  |
| NTMs                                     | 0<br>(0.000)***           | 0<br>(0.000)***      | 0<br>(0.000)***      | 0<br>(0.000)***      | 0<br>(0.000)***      |
| N                                        | 33630                     | 33630                | 33630                | 33630                | 33630                |
| R-squared                                | 0.953                     | 0.953                | 0.953                | 0.953                | 0.953                |

For all three tables 34, 35, and 36, there is a strong R-squared value. While MFN tariffs are increasing forward value chains significantly, they are also strongly decreasing backward value chains and global value chains participation.

Table 35 – Domestic Value-Added share in Total Exports (OLS)

|                                          | (1)                        | (2)                  | (3)                  | (4)                  | (5)                  |
|------------------------------------------|----------------------------|----------------------|----------------------|----------------------|----------------------|
|                                          | Backward GVC participation |                      |                      |                      |                      |
| STC First Raised date                    | -0.028<br>(0.005)***       |                      |                      |                      |                      |
| STC In Force date                        |                            | 0.005<br>(0.003)*    |                      |                      |                      |
| STC Reason Strenght                      |                            |                      | 0.000<br>(0.001)     |                      |                      |
| STC Duration                             |                            |                      |                      | 0.003<br>(0.001)***  |                      |
| STC Duration weighted by Reason Strenght |                            |                      |                      |                      | 0<br>(0.000)***      |
| Tariffs                                  | 0.042<br>(0.013)***        | 0.04<br>(0.013)***   | 0.039<br>(0.013)***  | 0.039<br>(0.013)***  | 0.039<br>(0.013)***  |
| Inward FDI                               | -0.035<br>(0.002)***       | -0.035<br>(0.002)*** | -0.034<br>(0.002)*** | -0.034<br>(0.002)*** | -0.034<br>(0.002)*** |
| NTMs                                     | 0<br>(0.000)***            | 0<br>(0.000)***      | 0<br>(0.000)***      | 0<br>(0.000)***      | 0<br>(0.000)***      |
| N                                        | 34054                      | 34054                | 34054                | 34054                | 34054                |
| R-squarred                               | 0.929                      | 0.929                | 0.929                | 0.929                | 0.929                |

For all three tables 34, 35, and 36, there is a strong R-squared value. While MFN tariffs are increasing forward value chains significantly, they are also strongly decreasing backward value chains and global value chains participation.

Table 36 – GVC share in Total Exports (OLS)

|                                          | (1)                              | (2)                  | (3)                  | (4)                  | (5)                  |
|------------------------------------------|----------------------------------|----------------------|----------------------|----------------------|----------------------|
|                                          | GVC share in Total Exports (OLS) |                      |                      |                      |                      |
| STC First Raised date                    | 0.049<br>(0.010)***              |                      |                      |                      |                      |
| STC In Force date                        |                                  | -0.012<br>(0.005)*** |                      |                      |                      |
| STC Reason Strenght                      |                                  |                      | -0.001<br>(0.002)    |                      |                      |
| STC Duration                             |                                  |                      |                      | -0.007<br>(0.002)*** |                      |
| STC Duration weighted by Reason Strenght |                                  |                      |                      |                      | 0<br>(0.000)***      |
| Tariffs                                  | -0.117<br>(0.034)***             | -0.121<br>(0.033)*** | -0.111<br>(0.031)*** | -0.111<br>(0.031)*** | -0.111<br>(0.031)*** |
| Inward FDI                               | 0.091<br>(0.006)***              | 0.092<br>(0.006)***  | 0.087<br>(0.006)***  | 0.087<br>(0.006)***  | 0.087<br>(0.006)***  |
| NTMs                                     | 0<br>(0.000)***                  | 0<br>(0.000)***      | 0<br>(0.000)***      | 0<br>(0.000)***      | 0<br>(0.000)***      |
| N                                        | 33630                            | 33630                | 33630                | 33630                | 33630                |
| R-squarred                               | 0.953                            | 0.953                | 0.953                | 0.953                | 0.953                |

For all three tables 34, 35, and 36, there is a strong R-squarred value. While MFN tariffs are increasing forward value chains significantly, they are also strongly decreasing backward value chains and global value chains participation.

Table 37 – Variance Inflation Factors without GDP

| Variance Inflation Factors (VIFs) |      |
|-----------------------------------|------|
| Unclear Content                   | 1.00 |
| Wrong Content                     | 1.00 |
| Trade Barrier                     | 1.01 |
| Tariff                            | 1.01 |
| Inward FDI (GFCF)                 | 1.05 |
| NTMs                              | 1.05 |

*Notes:* a VIF below 4 is not considered as problematic in terms of multicollinearity when following a restrictive rules of thumb (O'Brien, 2007). Here all VIFs are below this threshold.

Table 38 – Variance Inflation Factors with GDP

| Variable          | VIF   |
|-------------------|-------|
| GDP               | 15.4  |
| Inward FDI (GFCF) | 15.38 |
| unclear content   | 1.75  |
| wrong content     | 1.62  |
| trade barrier     | 1.34  |
| tariff            | 1.01  |

*Notes:* a VIF below 4 is not considered as problematic in terms of multicollinearity when following a restrictive rules of thumb (O'Brien, 2007). Here GDP with Inward FDI (GFCF) are above. I decided to discard GDP which corrects the issue, as shown in table 37.

Table 39 – STC reason strength dummy values and frequencies

| STC reason strength dummy |           |         |
|---------------------------|-----------|---------|
| Value                     | Frequency | Percent |
| 1                         | 121       | 19.06   |
| 2                         | 93        | 14.65   |
| 3                         | 421       | 66.3    |

Table 40 – STC reason strength dummy values and frequencies

| STC reason strength dummy |           |         |
|---------------------------|-----------|---------|
| Reason                    | Frequency | Percent |
| trade barrier             | 421       | 71.36   |
| unclear content           | 75        | 12.71   |
| wrong content             | 94        | 15.93   |

Rows show the frequencies for reasons linked to trade barriers (at least one subreason is a trade barrier reasons), to wrong content (at least one subreason linked to wrong content and not any linked to trade barriers), and to unclear content (at least one subreason linked to unclear content and no other categories). The subreasons are given in table 19.

Table 41 – STC reason strength dummy values and frequencies

|                                   | Frequency |
|-----------------------------------|-----------|
| Unclear and Wrong content         | 67        |
| Trade barrier and Unclear content | 84        |
| Trade barrier and Wrong content   | 126       |

The different dummies are mutually exclusive and do not have any common STCs.

Figures

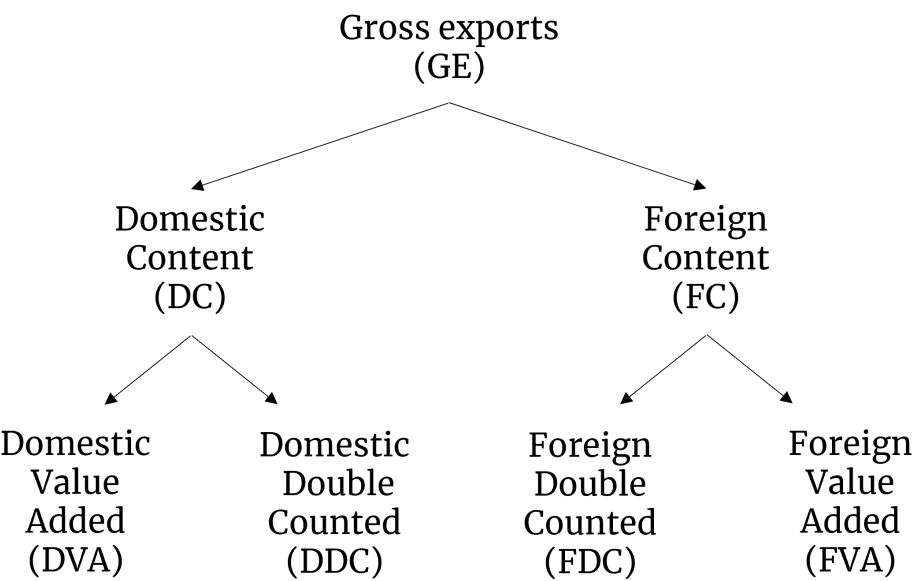
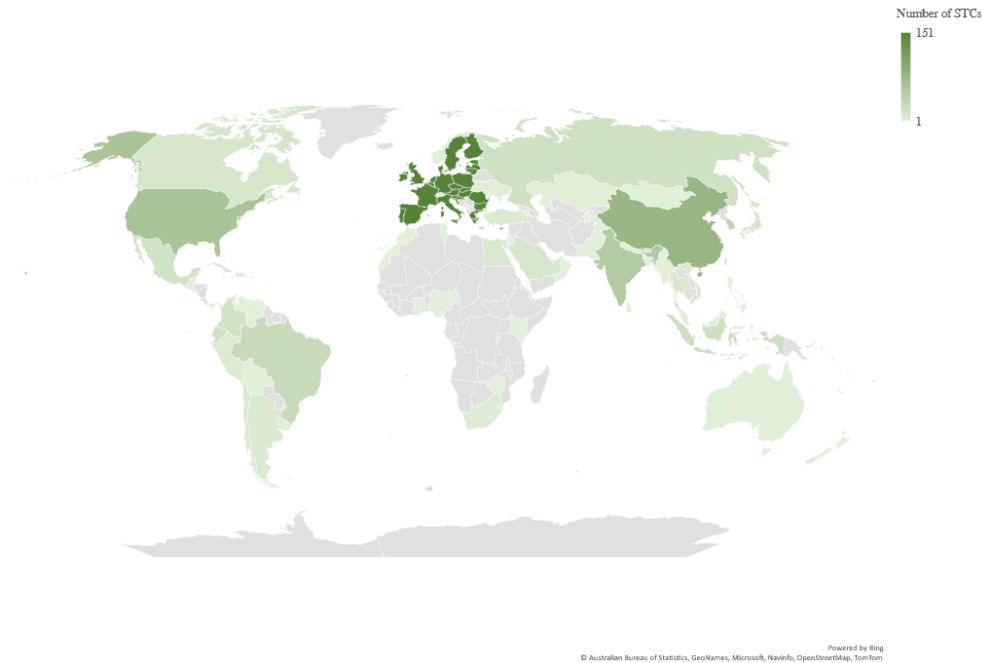


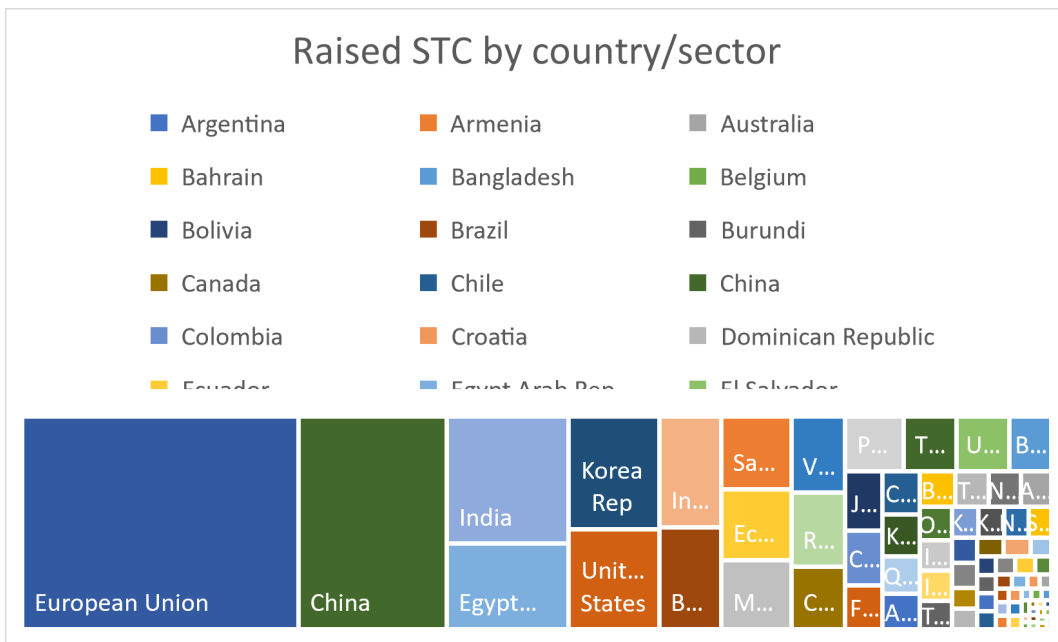
Figure 19 – Decomposition of gross exports by [Koopman et al. \(2014\)](#)

Figure 20 – Number of STCs raised by countries



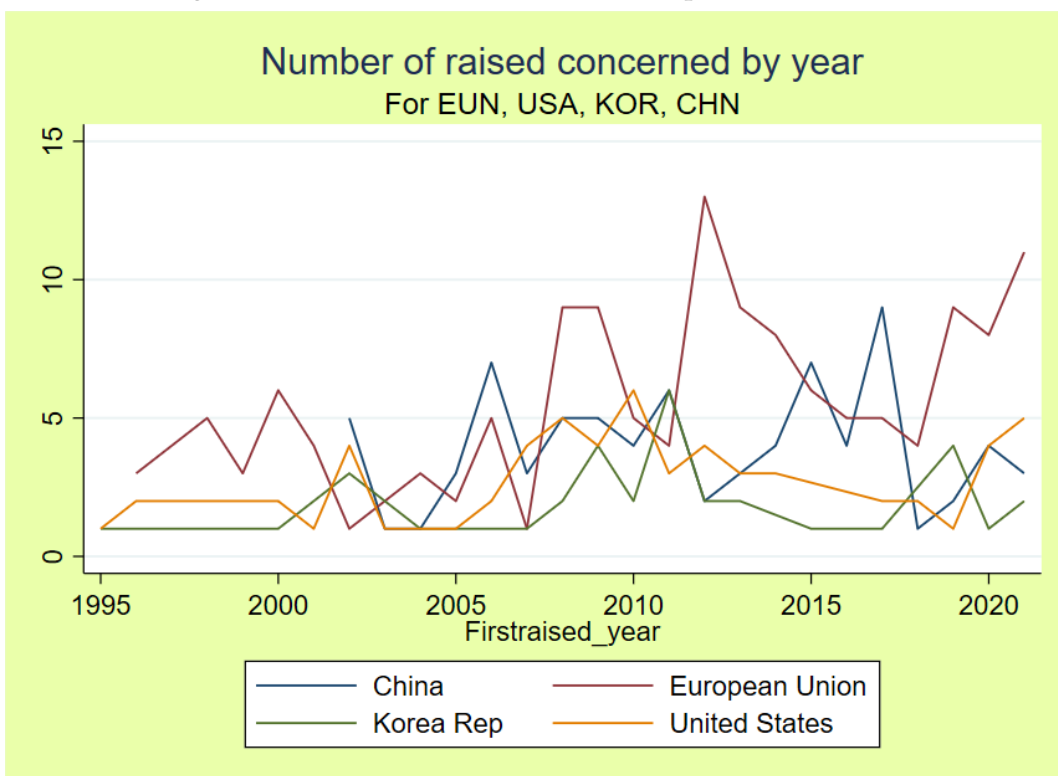
Based on the updated STC database

Figure 21 – Number of STCs raised by countries-sector pair



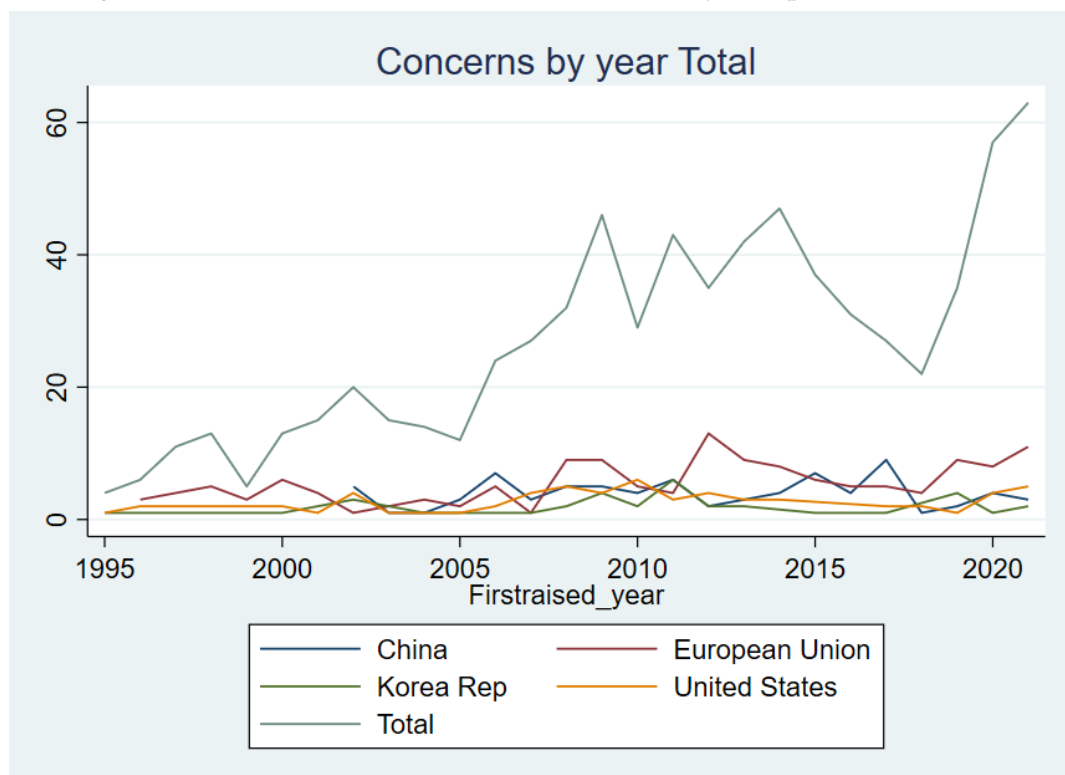
Based on the updated STC database

Figure 22 – Growth in concerns for 4 important countries



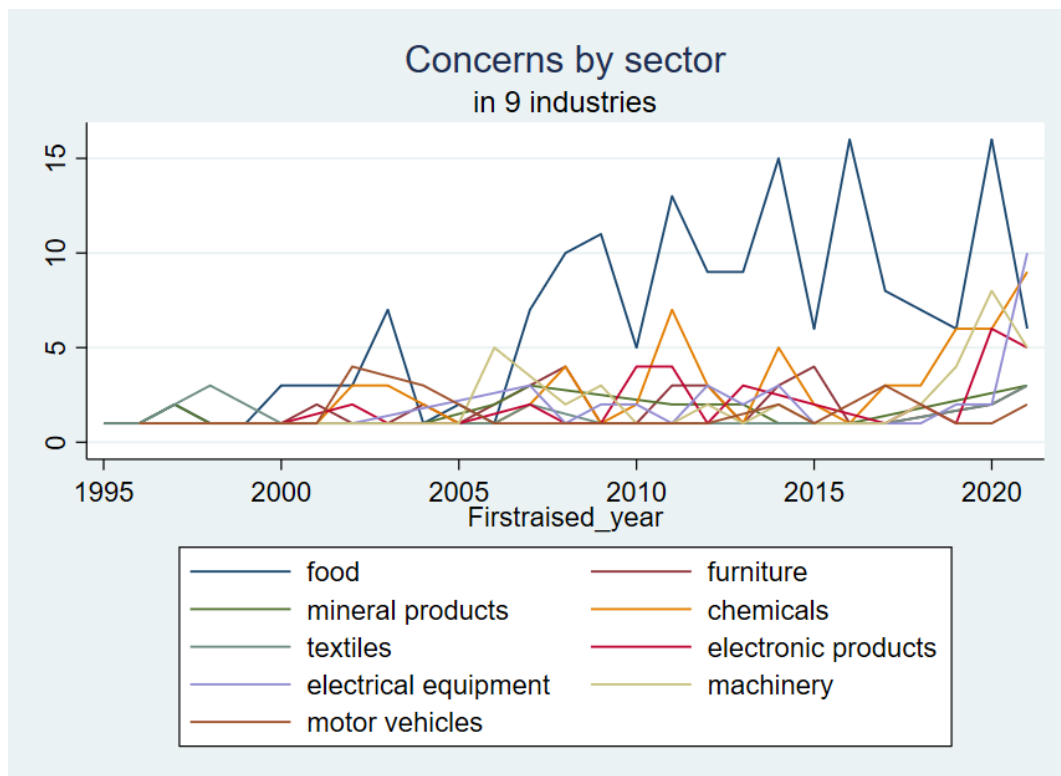
Based on the updated STC database

Figure 23 – Cumulative number of STCs raised by 4 important countries



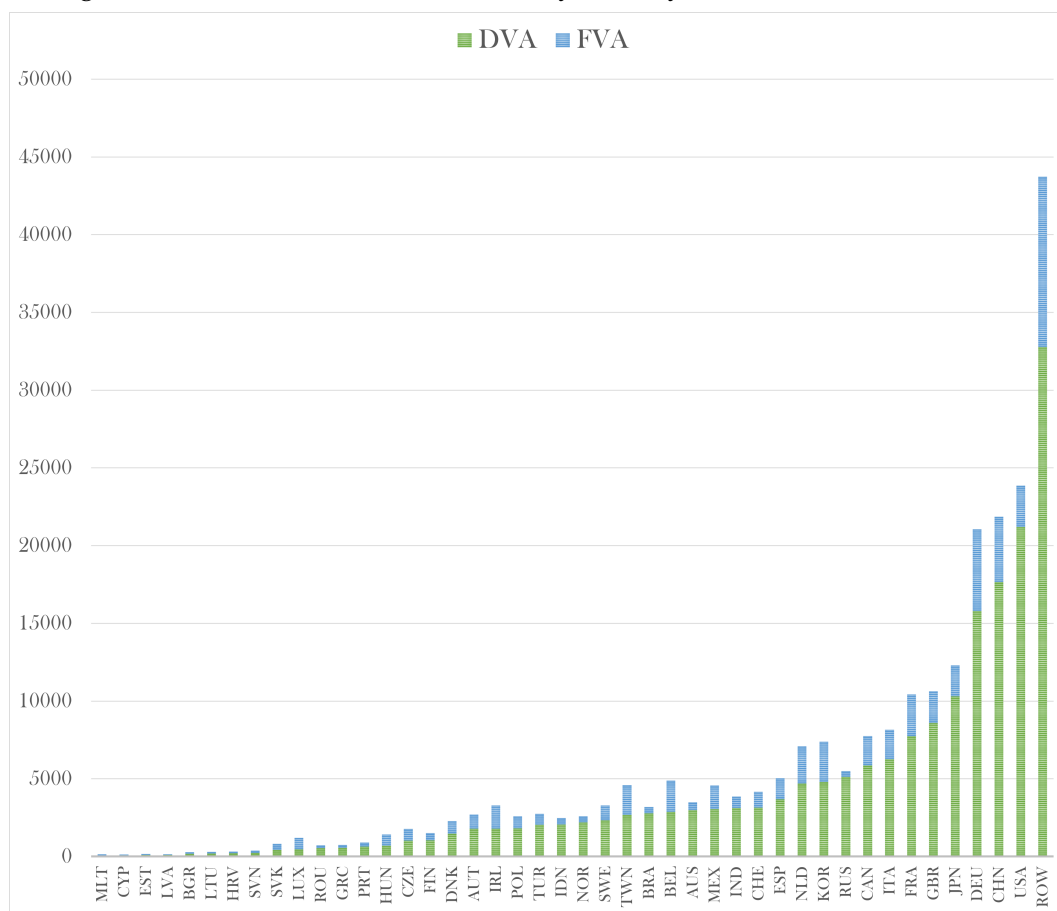
Based on the updated STC database

Figure 24 – Growth of STCs raised by 9 industries



Based on the updated STC database

Figure 25 – Volume of DVA and FVA by country (mean value in mln USD)



Notes: Author's calculations based on the WIOD dataset.

## MATHEMATICAL APPENDIX FOR CHAPTER 2

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The domestic utility specific to the consumers of one country is:

$$\max_{q_k, p_k} U_i = \left( \int_{k \in \Omega_i} \left( \theta_k^{\beta_i} q_k \right)^{\frac{\sigma-1}{\sigma}} dk \right)^{\frac{\sigma}{\sigma-1}}$$

$$\text{s.c. : } L_i = E_i = \int_{k \in \Omega_i} p_k q_k dk$$

$$\theta \in [\underline{\theta}; \bar{\theta}]$$

Deriving it by  $q_k$  and  $p_k$  using a Lagrangian, I find the following demand and expenditure equations:

$$q_{ii} = \frac{\theta_i^{\beta_i(\sigma-1)} \left[ \int_{k \in \Omega_i} \left( \theta_k^{\beta_i} q_k \right)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}} p_k^{-\sigma}}{\Lambda_j^{\sigma}}$$

$$p_k q_k = \frac{\theta_k^{\beta_i(\sigma-1)} \left[ \int_{k \in \Omega_i} \left( \theta_k^{\beta_i} q_k \right)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}} p_k^{1-\sigma}}{\Lambda_j^{\sigma}}$$

Plugging the expenditure in the budget constraint and isolating the marginal utility of income, I find:

$$\Lambda_j^{\sigma} = \frac{1}{L_i} \int_{k \in \Omega_i} \theta_k^{\beta_i(\sigma-1)} p_k^{1-\sigma} \left[ \int_{k \in \Omega_i} \left( \theta_k^{\beta_i} q_k \right)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}} dk$$

Plugging this expression back in the expenditure equation, I find:

$$p_k q_k = L_i \theta_k^{\beta_i(\sigma-1)} p_k^{1-\sigma} p_{ii}^{\sigma-1}$$

$\int_{k \in \Omega_i} \theta_k^{\beta_i(\sigma-1)} p_k^{1-\sigma} dk$  is the price index  $p_{ii}^{1-\sigma}$  which is derived from the well-known properties of the CES demand function. To be able to measure the impacts on the number of firms later, I complete this expression as follows:

$$p_{ii}^{1-\sigma} = \int_{k \in \Omega_i} \theta_{ki}^{\beta_i(\sigma-1)} p_{ki}^{1-\sigma} dk = \sum_k \int_{\varphi_{ij}}^{\infty} \theta_{ki}^{\beta_i(\sigma-1)} p_{ki}^{1-\sigma}(\varphi) M_{ki} \varphi_{kk}^{\gamma}(\varphi) d\varphi$$

Where  $M_{ki}$  is the mass of firms producing  $k$  and selling in  $i$ .  $g(\varphi) = \gamma \varphi_i i^{-\gamma-1}$  is the ex-post distribution of productivity if the firm exists and sell in  $i$ . As in Gaigné & Larue (2016), note the negative relationship between the price index and quality because  $\sigma > 1$ .

For simplicity of notation, I now get rid of the variety  $k$  index.

### B.1 DEMAND

I get the following domestic demand:

$$q_{ii} = L_i \theta_{ii}^{\beta_i(\sigma-1)} p_{ii}^{-\sigma} (p_{ii}^{1-\sigma})^{-1} = \theta_{ii}^{\beta_i(\sigma-1)} p_{ii}^{-\sigma} L_i p_{ii}^{\sigma-1}$$

By symmetry, foreign demand is the following:

$$q_{ij} = \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j p_{ij}^{\sigma-1}$$

And total demand is as follows if a firm sells in both markets (in  $i+j$ ):

$$q_{ij} = \sum_{j=i}^j \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j p_{ij}^{\sigma-1}$$

Notice that prices are different in each market, depending on the quality chosen for each of them.

### B.2 REVENUE

Given the demand, the domestic revenue is:

$$r_{ii} = p_{ii} q_{ii} = \theta_{ii}^{\beta_i(\sigma-1)} p_{ii}^{1-\sigma} L_i p_{ii}^{\sigma-1}$$

Thus, the exporting revenue is:

$$r_{ij} = \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma} L_j p_{ij}^{\sigma-1}$$

Total revenue for the firm selling in both markets is:

$$r_T = r_{ii} + r_{ij} = \sum_{j=i}^j \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma} L_j p_{ij}^{\sigma-1}$$

Costs:

$$C_i = \sum_{j=i}^j c_{ij} t_{ij} q_{ij} + \theta_{ij}^{\alpha_i} + F_{ij}$$

Where  $F_{ij} = f_i + I_j f_x$  Profit:

$$\pi_{ij} = \sum_{j=i}^j p_{ij} q_{ij} - c_{ij} t_{ij} q_{ij} - \theta_{ij}^{\alpha_i} - F_{ij}$$

### B.3 EXPORTING PROFIT MAXIMIZATION

Exporting profit:

$$\begin{aligned} \pi_{ij} &= p_{ij} q_{ij} - \frac{\theta_{ij}^\varepsilon}{\varphi_{ij}} t_{ij} q_{ij} - \theta_{ij}^{\alpha_i} - F_{ij} \\ &= \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma} L_j p_j^{\sigma-1} - \frac{\theta_{ij}^\varepsilon}{\varphi_{ij}} t_{ij} \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j p_j^{\sigma-1} - \theta_{ij}^{\alpha_i} - F_{ij} \end{aligned}$$

Max in terms of  $p_{ij}$

$$\max_{p_{ij}} \pi_{ij} \iff \pi'_{ij} = 0$$

$$\Leftrightarrow p_{ij} = \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{ij}^\varepsilon \quad (44)$$

Max in terms of  $\theta_{ij}$  Maximize with respect to quality

$$\max_{\theta_{ij}} \pi_{ij} \implies \pi'_{ij} = 0$$

$$\begin{aligned} \pi'_{ij} &= \beta_j (\sigma-1) \theta_{ij}^{\beta_j(\sigma-1)-1} p_{ij}^{1-\sigma} L_j p_j^{\sigma-1} - (\varepsilon + \beta_j (\sigma-1)) \\ &\quad \frac{1}{\varphi_{ij}} t_{ij} \theta_{ij}^{\varepsilon+\beta_j(\sigma-1)-1} p_{ij}^{-\sigma} L_j p_j^{\sigma-1} - \alpha_i \theta_{ij}^{\alpha_i-1} \end{aligned}$$

$$\theta_{ij} = \left[ \frac{\beta_j - \varepsilon}{\alpha_i} \left[ \frac{\sigma-1}{\sigma} \right]^\sigma \varphi_{ij}^{\sigma-1} t_{ij}^{1-\sigma} L_j p_j^{\sigma-1} \right]^{\frac{1}{\alpha_i - \beta_j}} \quad (45)$$

Where  $\Lambda_j = (\beta_j - \varepsilon)(\sigma - 1)$ . If  $\beta_j - \varepsilon \leq 0$ , the profit is decreasing with quality. Firms will always produce the minimum quality; if  $\beta_j - \varepsilon > 0$ , a firm increases its operating profit (the left part of the inequality) by increasing its quality. However, it is not necessarily the case if I take the cost of upgrading quality into account. Particularly above the optimum quality,  $\frac{\partial \pi_{ij}}{\partial \theta_{ij}} < 0$ . The optimal price is found:

$$\begin{aligned} \Longleftrightarrow p_{ij}^* &= \left[ \frac{\beta_j - \varepsilon}{\alpha_i} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \left[ \frac{\sigma - 1}{\sigma} \right]^{\frac{\beta_j(\sigma-1) + \varepsilon - \alpha_i}{\alpha_i - \Lambda_j}} \\ &\quad \times \varphi_{ij}^{\frac{\beta_j(\sigma-1) - \alpha_i}{\alpha_i - \Lambda_j}} \left[ t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \end{aligned} \quad (46)$$

The price adjusted to quality is:

$$\tilde{p}_{ij}^* = A_j \eta_{ij}^{\frac{-1}{\sigma-1}} \left( L_j P_j^{\sigma-1} t_{ij}^{1-\sigma} \right)^{\frac{\varepsilon - \beta_j}{\alpha_i - \Lambda_j}} \quad (47)$$

$$\text{With } \eta_{ij}(\varphi_{ij}) = \varphi_{ij}^{\frac{\alpha_i(\sigma-1)}{\alpha_i - \Lambda_j}}; A_j \equiv \left[ \frac{\sigma-1}{\sigma} \right]^{\frac{-\alpha_i - \beta_j + \varepsilon}{\alpha_i - \Lambda_j}} \left[ \frac{\beta_j - \varepsilon}{\alpha_i} \right]^{\frac{\varepsilon - \beta_j}{\alpha_i - \Lambda_j}}$$

The exporting revenue is:

$$r_{ij} = H_j \eta_{ij} \left( t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \quad (48)$$

$$\text{Where: } H_j = \left[ \frac{\sigma-1}{\sigma} \right]^{\frac{(\sigma-1)\alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}} \left[ \frac{\beta_j - \varepsilon}{\alpha_i} \right]^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}}$$

Finally, the optimal profit:

$$\pi_{ij}^* = \eta_{ij} J_j N_j \left( t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \quad (49)$$

$$\text{With: } J_j \equiv \left[ \frac{\sigma-1}{\sigma} \right]^{\frac{\sigma\alpha_i}{\alpha_i - \Lambda_j}} \left[ \frac{\beta_j - \varepsilon}{\alpha_i} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}}; N_j \equiv \frac{\alpha_i t_{ij}^{\sigma} (\sigma t_{ij}^{-1} - \sigma + 1) - \Lambda_j}{\Lambda_j}$$

Small simplifications of foc from my results:

$$r_{ij} = \left[ \frac{\beta_j - \varepsilon}{\alpha_i} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \left[ \frac{\sigma-1}{\sigma} \right]^{\frac{\sigma\alpha_i}{\alpha_i - \Lambda_j}} \eta_{ij} \left( t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \left[ \frac{\sigma}{\sigma-1} \right] \left[ \frac{\alpha_i}{\beta_j - \varepsilon} \right]$$

$$\eta_{ij}(\varphi_{ij}) = \varphi_{ij}^{\frac{\alpha_i(\sigma-1)}{\alpha_i - \Lambda_j}}$$

$$\theta_{ij}^* = \left[ \frac{1}{\sigma} \frac{\Lambda_j}{\alpha_i} \left( \frac{\sigma-1}{\sigma} \right)^{\sigma-1} \varphi_{ij}^{\sigma-1} t_{ij}^{1-\sigma} L_j P_j^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}}$$

$$\Rightarrow r_{ij} = \theta_{ij}^{\alpha_i} \left[ \frac{\sigma}{\sigma-1} \right] \left[ \frac{\alpha_i}{\beta_j - \varepsilon} \right]$$

$$\Longleftrightarrow p_{ij} q_{ij} = \theta_{ij}^{\alpha_i} \frac{\sigma \alpha_{ij}}{\Lambda_j} = \frac{\omega_{ij} \sigma \alpha_{ij}}{\Lambda_j} \quad (50)$$

$$\pi_{ij}^* = \theta_{ij}^{\alpha_i} \frac{\sigma \alpha_i}{\Lambda_j} \frac{\Lambda_j}{\sigma \alpha_i} \left( \frac{\alpha_i - \Lambda_j}{\Lambda_j} \right) - F_{ij} = \theta_{ij}^{\alpha_i} \frac{\alpha_i - \Lambda_j}{\Lambda_j} - F_{ij} \quad (51)$$

as a result, a firm decides to export if and only if  $\frac{\theta_{ij}^{\alpha_i} (\alpha_i - \Lambda_j)}{\Lambda_j} \geq F_{ij}$ .

In addition,

$$p_{ij} q_{ij} = \theta_{ij}^{\alpha_i} \frac{\sigma \alpha_{ij}}{\Lambda_j}$$

and

$$\begin{aligned} & \frac{\theta_{ij}^{\alpha_i}}{\Lambda_j} \\ &= \frac{F_{ij} \Lambda_j}{(\alpha_i - \Lambda_j)} \rightarrow p_{ij} q_{ij} \\ &= \theta_{ij}^{\alpha_i} \frac{\sigma \alpha_{ij} F_{ij}}{\Lambda_j} \end{aligned}$$

Also:

$$p_{ij} q_{ij} \frac{\alpha_i - \Lambda_j}{\sigma \alpha_i} = \frac{\omega_{ij} (\alpha_i - \Lambda_j)}{\Lambda_j} = \frac{\theta_{ij}^{\alpha_i} (\alpha_i - \Lambda_j)}{\Lambda_j}$$

$$\Longleftrightarrow p_{ij} q_{ij} \frac{\alpha_i - \Lambda_j}{\sigma \alpha_i} = \frac{\theta_{ij}^{\alpha_i} (\alpha_i - \Lambda_j)}{\Lambda_j}$$

$$\Longleftrightarrow p_{ij} q_{ij} \frac{\Lambda_j}{\sigma \alpha_i} = \theta_{ij}^{\alpha_i} \quad (52)$$

$$\Longleftrightarrow p_{ij} q_{ij} \frac{\Lambda_j}{\sigma \alpha_i} - \theta_{ij}^{\alpha_i} = 0$$

### B.3.1 Sales

Sales are the price times the quantities knowing  $p_{ij} = \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{ij}^\varepsilon$  and  $p_{ij} q_{ij} = L_j \theta_{ij}^{\beta_j(\sigma-1)} p_j^{1-\sigma} p_j^{\sigma-1}$  Thus:

$$p_{ij} q_{ij} = L_j \theta_{ij}^{\beta_j(\sigma-1)} \left( \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{ij}^\varepsilon \right)^{1-\sigma} p_j^{\sigma-1} = \theta_{ij}^{\Lambda_j} \varphi_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} t_{ij} \right)^{1-\sigma} p_j^{\sigma-1} L_j \quad (53)$$

## B.3.2 Hybrid price index:

Knowing the limit profit leads to  $p_{ij} q_{ij} \frac{\alpha_i - \Lambda_j}{\sigma \alpha_i} = F_{ij}$

and the sales:  $p_{ij} q_{ij} = \theta_{ij}^{\Lambda_j} \varphi_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} t_{ij} \right)^{1-\sigma} p_j^{\sigma-1} L_j$  leads to the following price index:

$$p_{ij} q_{ij} = \theta_{ij}^{\Lambda_j} \varphi_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} t_{ij} \right)^{1-\sigma} p_j^{\sigma-1} L_j = \frac{\sigma \alpha_i F_{ij}}{\alpha_i - \Lambda_j}$$

$$\Leftrightarrow p_j^{\sigma-1} = \frac{\alpha_i}{\alpha_i - \Lambda_j} \frac{\sigma F_{ij}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \theta_{ij}^{-\Lambda_j} \varphi_{ij}^{1-\sigma}$$

then, knowing that

$$\theta_{ij} = \left( \frac{F_{ij} \Lambda_j}{\alpha_i - \Lambda_j} \right)^{\frac{1}{\alpha_i}}$$

$$\Leftrightarrow F_{ij} = \theta_{ij}^{\alpha_i} \left( \frac{\alpha_i - \Lambda_j}{\Lambda_j} \right)$$

when profit is zero, I obtain:

$$\Leftrightarrow p_j^{\sigma-1} = \frac{\alpha_i}{\alpha_i - \Lambda_j} \frac{\sigma \theta_{ij}^{\alpha_i} \left( \frac{\alpha_i - \Lambda_j}{\Lambda_j} \right)}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \theta_{ij}^{-\Lambda_j} \varphi_{ij}^{1-\sigma}$$

$$\Leftrightarrow p_j^{\sigma-1} = \frac{\alpha_i}{\Lambda_j} \frac{\sigma \theta_{ij}^{\alpha_i}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \theta_{ij}^{-\Lambda_j} \varphi_{ij}^{1-\sigma}$$

$$\Leftrightarrow p_j^{\sigma-1} = \frac{\sigma \alpha_i}{\Lambda_j L_j} \frac{\theta_{ij}^{\alpha_i - \Lambda_j}}{1} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \varphi_{ij}^{1-\sigma}$$

or

$$\Leftrightarrow p_j^{\sigma-1} = \frac{\alpha_i}{\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \left( \frac{F \Lambda_j}{\alpha_i - \Lambda_j} \right)^{\frac{\alpha_i - \Lambda_j}{\alpha_i}} \varphi_{ij}^{1-\sigma}$$

$$\Leftrightarrow p_j^{\sigma-1} = \theta_{sj}^{-\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \frac{\alpha_i F_{ij}}{\alpha_i - \Lambda_j} \varphi_{ij}^{1-\sigma}$$

$$\Leftrightarrow p_j^{\sigma-1} = \theta_{sj}^{-\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \left( \theta_{ij}^{\alpha_i} + F_{ij} \right) \varphi_{ij}^{1-\sigma}$$

Knowing that

$$\theta_{ij}^{\alpha_i} = \frac{F_{ij} \Lambda_j}{\alpha_i - \Lambda_j} \rightarrow \theta_{ij}^{\alpha_i} + F_{ij}$$

$$= \frac{F_{ij} \Lambda_j}{\alpha_i - \Lambda_j} + F_{ij} = \frac{F_{ij} (\Lambda_j + \alpha_i - \Lambda_j)}{\alpha_i - \Lambda_j}$$

$$= \frac{\alpha_i F_{ij}}{\alpha_i - \Lambda_j}$$

## B.4 EXPORTING CUTOFF

Since  $\alpha_i - \Lambda_j > 0$  because of  $\alpha_i' > 0$ ,  $\underline{\theta}_{ij} = \left( \frac{F_{ij}\Lambda_j}{(\alpha_i - \Lambda_j)} \right)^{\frac{1}{\alpha_i}}$  is the only condition to get to the production cutoff and represent the lowest quality to export. Similarly, the zero-profit condition for the domestic firm is found by setting  $t = 1$  and using  $\beta_i$ . Here below, I find the welfare based on the price index and this zero-profit condition. What is the minimum productivity threshold? (when not taking the optimal quality)

$$\begin{aligned}
 \theta_{ij}^{\Lambda_j} L_j P_j^{\sigma-1} t_{ij}^{1-\sigma} \varphi_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} \right)^{1-\sigma} &= \theta_{ij}^{\Lambda_j} t_{ij}^{1-\sigma} \varphi_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} \right)^{-\sigma} L_j P_j^{\sigma-1} + \theta_{ij}^{\alpha_i} + F_{ij} \\
 \iff \theta_{ij}^{\Lambda_j} t_{ij}^{1-\sigma} \varphi_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} \right)^{-\sigma} L_j P_j^{\sigma-1} \left( \frac{1}{\sigma-1} \right) &= \theta_{ij}^{\alpha_i} + F_{ij} \\
 \iff \varphi_{ij}^{\sigma-1} = \theta_{ij}^{-\Lambda_j} \left( \frac{\sigma}{\sigma-1} \right)^{\sigma-1} \frac{\sigma \left( \theta_{ij}^{\alpha_i} + F_{ij} \right)}{t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}} & \quad (54)
 \end{aligned}$$

## B.5 LABOR MARKET CLEARING AND MASS OF FIRMS UNDER A ZERO-QS

$$\underline{\theta}_{ij} = \left( \frac{F_{ij}\Lambda_j}{\alpha_i - \Lambda_j} \right)^{\frac{1}{\alpha_i}}$$

and

$$\begin{aligned}
 p_{ij} q_{ij} &= \theta_{ij}^{\alpha_i} \frac{\sigma \alpha_i}{\Lambda_j} \\
 \iff \theta_{ij}^{\alpha_i} &= \frac{p_{ij} q_{ij} \Lambda_j}{\sigma \alpha_i} \implies \theta_{ij}^* \\
 &= \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{\sigma-1}{\alpha_i - \Lambda_j}} \left( \frac{F_{ij}\Lambda_j}{\alpha_i - \Lambda_j} \right)^{\frac{1}{\alpha_i}} \\
 \iff \theta_{ij}^{\alpha_i} &= \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i - \Lambda_j}} \frac{F_{ij}\Lambda_j}{\alpha_i - \Lambda_j} \\
 &= \frac{p_{ij} q_{ij} \Lambda_j}{\sigma \alpha_i} \\
 \iff \frac{p_{ij} q_{ij}}{\sigma \alpha_i} &= \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i - \Lambda_j}} \frac{F_{ij}}{\alpha_i - \Lambda_j}
 \end{aligned}$$

$$L_i = l_i + M_e f_e + \sum_j M_i \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} F_{ij} \quad (55)$$

The probability of entry  $f_e$  is: Reminder:  $g(\varphi_{ij}) = \gamma \varphi_{ij}^{-\gamma-1}$  and  $G(\varphi_{ij}) = 1 - \varphi_{ij}^{-\gamma}$

$$\bar{\pi}_i = \varphi_{ii}^\gamma \int_{\varphi_{ij}}^{\infty} \left[ \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} - F_{ij} \right] g(\varphi_{ij}) d\varphi_{ij}$$

and

$$\varphi_{ii}^\gamma f_e = \bar{\pi}_i$$

and

$$\begin{aligned} f_e &= \bar{\pi}_i [1 - G(\varphi_{ii})] \\ &= \varphi_{ii}^\gamma \int_{\varphi_{ij}}^{\infty} \left[ \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} - F_{ij} \right] g(\varphi_{ij}) d\varphi_{ij} \\ &= \varphi_{ii}^\gamma \int_{\varphi_{ij}}^{\infty} \left[ \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} - F_{ij} \right] g(\varphi_{ij}) d\varphi_{ij} \\ &= \varphi_{ii}^\gamma \int_{\varphi_{ij}}^{\infty} \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} g(\varphi_{ij}) - f_g(\varphi_{ij}) - f_x g(\varphi_{ij}) d\varphi_{ij} \\ &= \varphi_{ii}^\gamma \int_{\varphi_{ij}}^{\infty} \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} \gamma \varphi_{ij}^{-\gamma-1} - F_{ij} \gamma \varphi_{ij}^{-\gamma-1} d\varphi_{ij} \\ &= \varphi_{ii}^\gamma \left( \int_{\varphi_{ij}}^{\infty} \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} \gamma \varphi_{ij}^{-\gamma-1} d\varphi_{ij} + F_{ij} \varphi_{ij}^{-\gamma} \right) \\ &= \varphi_{ii}^\gamma \left( \int_{\varphi_{ij}}^{\infty} \left( \frac{1}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} \gamma \varphi_{ij}^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j} - \gamma - 1} d\varphi_{ij} + F_{ij} \varphi_{ij}^{-\gamma} \right) \\ &= \varphi_{ii}^\gamma \left( \left( \frac{1}{\varphi_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} F_{ij} \left( \frac{\alpha_i - \Lambda_j}{(\sigma-1)\alpha_i - \gamma(\alpha_i - \Lambda_j)} \right) \gamma \varphi_{ij}^{\frac{(\sigma-1)\alpha_i - \gamma(\alpha_i - \Lambda_j)}{\alpha_i - \Lambda_j}} + F_{ij} \varphi_{ij}^{-\gamma} \right) \\ &= \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} \left( F_{ij} \left( \frac{\alpha_i - \Lambda_j}{\gamma(\alpha_i - \Lambda_j) - (\sigma-1)\alpha_i} \right) \gamma + F_{ij} \right) \\ &\iff \bar{\pi}_i = \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} \left( F_{ij} \left( \frac{\gamma(\alpha_i - \Lambda_j) + (\sigma-1)\alpha_i - \gamma(\alpha_i - \Lambda_j)}{\gamma(\alpha_i - \Lambda_j) - (\sigma-1)\alpha_i} \right) \right) \\ &\iff \bar{\pi}_i = \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} F_{ij} \frac{(\sigma-1)\alpha_i}{\gamma(\alpha_i - \Lambda_j) - (\sigma-1)\alpha_i} \\ &\implies f_e = \bar{\pi}_i [1 - G(\varphi_{ii})] \end{aligned}$$

$$\begin{aligned}
&= \bar{\pi}_i \varphi_{ii}^{-\gamma} \\
&= \varphi_{ij}^{-\gamma} F_{ij} \frac{(\sigma-1) \alpha_i}{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i} \\
&\iff F_{ij} = f_e \varphi_{ij}^{-\gamma} \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i}
\end{aligned}$$

ASSUMPTION:  $\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i > 0$

$$\begin{aligned}
M_e &= M_i \varphi_{ii}^\gamma \\
l_i &= M_{ij} \int_{\varphi_{ij}}^{\infty} \left[ \frac{\theta_{ij}^\varepsilon q_{ij} t_{ij}}{\varphi_{ij}} + \theta_{ij}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\
l_i &= \int_{\varphi_{ij}}^{\infty} M_{ij} \left[ \frac{\sigma-1}{\sigma} p_{ij} q_{ij} + \theta_{ij}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\
&= \int_{\varphi_{ij}}^{\infty} M_{ij} \left[ \frac{\sigma-1}{\sigma} p_{ij} q_{ij} + \frac{p_{ij} q_{ij} \Lambda_j}{\sigma \alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\
&= \int_{\varphi_{ij}}^{\infty} M_{ij} \left[ (\sigma-1) \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1) \alpha_i}{\alpha_i - \Lambda_j}} \frac{\alpha_i F_{ij}}{\alpha_i - \Lambda_j} + \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1) \alpha_i}{\alpha_i - \Lambda_j}} \frac{\Lambda_j F_{ij}}{\alpha_i - \Lambda_j} \right] g(\varphi_{ij}) d\varphi_{ij} \\
&= \int_{\varphi_{ij}}^{\infty} M_{ij} \left[ \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\frac{(\sigma-1) \alpha_i}{\alpha_i - \Lambda_j}} \frac{F_{ij}}{\alpha_i - \Lambda_j} \left( \sigma-1 + \frac{\Lambda_j}{\alpha_i} \right) \right] \gamma \varphi_{ij}^{-\gamma-1} d\varphi_{ij} \\
&= M_{ij} \left[ \left( \frac{1}{\varphi_{ij}} \right)^{\frac{(\sigma-1) \alpha_i}{\alpha_i - \Lambda_j}} F_{ij} \left( \sigma-1 + \frac{\Lambda_j}{\alpha_i} \right) \right] \frac{\gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i - \gamma (\alpha_i - \Lambda_j)} \varphi_{ij}^{\frac{(\sigma-1) \alpha_i - \gamma (\alpha_i - \Lambda_j)}{\alpha_i - \Lambda_j}} \\
&= M_{ij} \varphi_{ij}^{-\gamma} \left( \sigma-1 + \frac{\Lambda_j}{\alpha_i} \right) F_{ij} \frac{\gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i - \gamma (\alpha_i - \Lambda_j)}
\end{aligned}$$

Knowing that

$$\begin{aligned}
f_e &= \varphi_{ij}^{-\gamma} F_{ij} \frac{(\sigma-1) \alpha_i}{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i} \\
&\iff \varphi_{ij}^{-\gamma} F_{ij} = f_e \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \\
&= M_{ij} \left( \sigma-1 + \frac{\Lambda_j}{\alpha_i} \right) f_e \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \frac{\gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i - \gamma (\alpha_i - \Lambda_j)} \\
&= M_{ij} \left( \sigma-1 + \frac{\Lambda_j}{\alpha_i} \right) f_e \frac{\gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i} \\
&= M_{ij} \frac{(\sigma-1) \alpha_i + \Lambda_j}{\alpha_i} f_e \frac{\gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i} \\
&= M_i \frac{(\sigma-1) \alpha_i + \Lambda_j}{(\sigma-1) \alpha_i} f_e \frac{\gamma (\alpha_i - \Lambda_j)}{\alpha_i} \\
&= M_{ij} \left( 1 + \frac{\Lambda_j}{(\sigma-1) \alpha_i} \right) f_e \frac{\gamma (\alpha_i - \Lambda_j)}{\alpha_i}
\end{aligned}$$

Knowing that  $M_{ij} = M_i \varphi_{ii}^\gamma$

$$l_i = M_i \varphi_{ii}^\gamma \left( 1 + \frac{\Lambda_j}{(\sigma-1) \alpha_i} \right) f_e \frac{\gamma (\alpha_i - \Lambda_j)}{\alpha_i}$$

Also (and finally),

$$\begin{aligned} & \sum_j M_i \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} F_{ij} \\ &= \sum_j M_i \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} f_e \varphi_{ij}^\gamma \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \\ &= \sum_j M_i \varphi_{ii}^\gamma f_e \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \\ &\implies L_i = l_i + M_e f_e + \sum_j M_i \varphi_{ii}^\gamma \varphi_{ij}^{-\gamma} F_{ij} \\ &= M_i \varphi_{ii}^\gamma \left( 1 + \frac{\Lambda_j}{(\sigma-1) \alpha_i} \right) f_e \frac{\gamma (\alpha_i - \Lambda_j)}{\alpha_i} + M_i \varphi_{ii}^\gamma f_e + M_i \varphi_{ii}^\gamma f_e \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \\ &= M_i \varphi_{ii}^\gamma f_e \left[ \left( 1 + \frac{\Lambda_j}{(\sigma-1) \alpha_i} \right) \frac{\gamma (\alpha_i - \Lambda_j)}{\alpha_i} + 1 + \frac{\gamma (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \right] \\ &= M_i \varphi_{ii}^\gamma f_e \gamma \left[ \left( 1 + \frac{\Lambda_j}{(\sigma-1) \alpha_i} \right) \frac{(\alpha_i - \Lambda_j)}{\alpha_i} + \frac{(\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} + \frac{(\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \right] \\ &= M_i \varphi_{ii}^\gamma f_e \gamma \left[ \left( \frac{(\sigma-1) \alpha_i + \Lambda_j}{(\sigma-1) \alpha_i} \right) \frac{(\alpha_i - \Lambda_j)}{\alpha_i} + \frac{(\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} + \frac{(\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i}{(\sigma-1) \alpha_i} \right] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma}{(\sigma-1) \alpha_i} \left[ ((\sigma-1) \alpha_i + \Lambda_j) \frac{(\alpha_i - \Lambda_j)}{\alpha_i} + (\sigma-1) \alpha_i + (\alpha_i - \Lambda_j) - (\sigma-1) \alpha_i \right] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma}{(\sigma-1) \alpha_i} \left[ ((\sigma-1) \alpha_i + \Lambda_j) \frac{(\alpha_i - \Lambda_j)}{\alpha_i} + (\alpha_i - \Lambda_j) \right] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i} \left[ ((\sigma-1) \alpha_i + \Lambda_j) \frac{1}{\alpha_i} + \frac{\alpha_i}{\alpha_i} \right] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i \alpha_i} [(\sigma-1) \alpha_i + \Lambda_j + \alpha_i] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i \alpha_i} [\sigma \alpha_i + \Lambda_j] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i \alpha_i} \sigma \alpha_i \left[ 1 + \frac{\Lambda_j}{\sigma \alpha_i} \right] \\ &= \frac{M_i \varphi_{ii}^\gamma f_e \gamma (\alpha_i - \Lambda_j)}{(\sigma-1) \alpha_i} \sigma \left[ 1 + \frac{\Lambda_j}{\sigma \alpha_i} \right] \end{aligned}$$

Thus,

$$M_i = \frac{L_i}{\varphi_{ii}^\gamma f_e \gamma} \frac{\sigma-1}{\sigma} \frac{\alpha_i}{\alpha_i - \Lambda_j} \left( \frac{\alpha_i \sigma}{\Lambda_j} + 1 \right) \quad (56)$$

## B.6 QUALITY STANDARDS

B.6.1 *Constrained and unconstrained firms*

Constrained firms have optimal qualities below or equal to the standard but are still making nonnegative profit; unconstrained firms have optimal qualities above the standard and choose their optimal quality. Their case is similar as when the standard is 0. In a world with both types of firms, I need to find a specific price index which accounts for this standard. I can also find the mass of firms accounting for both types of firms. To solve the mass of firms, I need to make the hypothesis that there are no fixed costs. In [Gaigne et al. \(2021\)](#), the fixed cost only depends on quality. They assume that  $f = 0$  or is a product of the other fixed cost. [Lugovskyy and Skiba \(2015\)](#) also ignores the fixed transportation cost. The impact of a QS on quality and prices using substitution The exporting profit for a firm is:

$$\max_{p_{ij}, \theta_{ij}} \pi_i = \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma} L_j P_j^{\sigma-1} - \frac{\theta_{ij}^\varepsilon}{\varphi_{ij}} t_{ij} \theta_{ij}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j P_j^{\sigma-1} - \theta_{ij}^{\alpha_i} - F_{ij}$$

Under constraint:  $\theta_{sj} \leq \theta_{ij}$  At the limit, one firm is indifferent between the standard and its optimal quality.

B.6.2 *Binding constraint*

However, some firms are not able to optimize their profit according to quality, those for which the constraint is binding. Thus, when the constraint is binding, the profit maximization is:

$$\begin{aligned} \max_{p_{ij}} \pi_j &= \theta_{sj}^{\beta_j(\sigma-1)} p_{ij}^{1-\sigma} L_j P_j^{\sigma-1} - \frac{\theta_{sj}^\varepsilon}{\varphi_{ij}} t_{ij} \theta_{sj}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j P_j^{\sigma-1} - \theta_{sj}^{\alpha_i} - F_{ij} \\ \frac{\partial \pi}{\partial p_{ij}} &= 0 \end{aligned}$$

$$p_{ij} = \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{sj}^\varepsilon \quad (57)$$

Thus, the optimal profit for the representative constrained firm is:

$$\pi_j^c = \left( \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{sj}^\varepsilon - \frac{\theta_{sj}^\varepsilon}{\varphi_{ij}} t_{ij} \right) \theta_{sj}^{\beta_j(\sigma-1)} \left( \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{sj}^\varepsilon \right)^{-\sigma} L_j P_j^{\sigma-1} - \theta_{sj}^{\alpha_i} - F_{ij}$$

My preliminary constrained profit:

$$\pi_{ij}^c = \frac{\varphi_{ij}^{\sigma-1}}{\sigma} \left( \frac{t_{ij}\sigma}{\sigma-1} \right)^{1-\sigma} \theta_{sj}^{\Lambda_j} L_j P_j^{\sigma-1} - \omega_{ij} - F_{ij}$$

Using this hybrid price index (as in GL):

$$P_j^{\sigma-1} = \theta_{sj}^{-\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{1-\sigma}$$

$$\pi_{ij}^c = \frac{\varphi_{ij}^{\sigma-1}}{\sigma} \left( \frac{t_{ij}\sigma}{\sigma-1} \right)^{1-\sigma} \theta_{sj}^{\Lambda_j} L_j \theta_{sj}^{-\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{1-\sigma} - \theta_{sj}^{\alpha_i} - F_{ij}$$

My final constrained profit:

$$\pi_{ij}^c = \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \frac{\alpha_{ij}}{\Lambda_j} \theta_{sj}^{\alpha_i} - \theta_{sj}^{\alpha_i} - F_{ij} \quad (58)$$

### B.6.3 Non-binding constraint

For unconstrained firms, a standard should be below or equal to the optimal quality (when profit is max).

$$\left[ \frac{\beta_j - \varepsilon}{\alpha_i} \left[ \frac{\sigma-1}{\sigma} \right]^\sigma \varphi_{ij}^{\sigma-1} L_j P_j^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}} \geq \theta_{sj}$$

The unconstrained firms make an optimal quality similar as in the case with a standard of zero but with respect to the new price index.

$$\theta_{ij}^* = \left[ \frac{1}{\sigma} \frac{\Lambda_j}{\alpha_i} \left( \frac{\sigma-1}{\sigma} \right)^{\sigma-1} \varphi_{ij}^{\sigma-1} t^{1-\sigma} L_j P_j^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}}$$

and

$$\begin{aligned} & P_j^{\sigma-1} \\ &= \sigma \bar{\varphi}_{ij}^{1-\sigma} t_{ij}^{\sigma-1} \left( \frac{\sigma}{\sigma-1} \right)^{\sigma-1} \theta_{sj}^{-\Lambda_j} \frac{1}{L_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \\ \Rightarrow \theta_{ij}^* &= \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}} \end{aligned}$$

The optimal profit for the representative unconstrained firm is the following (taking back the optimal profit for the firm with a standard of zero):

$$\pi_{ij}^* = \frac{\theta_{ij}^{*\alpha_i} (\alpha_i - \Lambda_j)}{\Lambda_j} - F_{ij}$$

$$\rightarrow \pi_{ij}^* = \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \quad (59)$$

Note that another form of the profit, equivalent can be found: using

$$\begin{aligned} p_j^{\sigma-1} &= \frac{\sigma \alpha_i}{\Lambda_j} \frac{\theta_{sj}^{\alpha_i - \Lambda_j} \bar{\varphi}_{ij}^{1-\sigma}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \\ \pi^u &= \frac{\varphi_{ij}^{\sigma-1}}{\sigma} \left( \frac{t_{ij} \sigma}{\sigma-1} \right)^{1-\sigma} \theta_{sj}^{\Lambda_j} p_j^{\sigma-1} L_j - \omega_{ij} - F_{ij} \\ &= \frac{\varphi_{ij}^{\sigma-1}}{\sigma} \left( \frac{t_{ij} \sigma}{\sigma-1} \right)^{1-\sigma} \theta_{sj}^{\Lambda_j} \frac{\sigma \alpha_i}{\Lambda_j} \frac{\theta_{sj}^{\alpha_i - \Lambda_j} \bar{\varphi}_{ij}^{1-\sigma}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} L_j - \omega_{ij} - F_{ij} \\ &= \frac{\varphi_{ij}^{\sigma-1}}{\sigma} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{1-\sigma} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \\ &\quad \times \frac{\sigma \alpha_i}{\Lambda_j} \frac{\theta_{sj}^{\alpha_i - \Lambda_j} \bar{\varphi}_{ij}^{1-\sigma}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} L_j - \omega_{ij} - F_{ij} \\ &= \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \frac{\alpha_i}{\Lambda_j} \alpha_i - \Lambda_j \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\Lambda_j}{\alpha_i}} \\ &\quad - \Lambda_j - \theta_{sj}^{\alpha_i} - F_{ij} \\ &= \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i - \Lambda_j}} \frac{\alpha_i}{\Lambda_j} \alpha_i - \Lambda_j \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} - \theta_{sj}^{\alpha_i} - F_{ij} \\ &= \theta_{sj}^{\alpha_i} \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i - \Lambda_j}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{\alpha_i - 2\Lambda_j}{\alpha_i - \Lambda_j}} \theta_{sj}^{-\frac{\alpha_i \Lambda_j}{\alpha_i - \Lambda_j}} \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} - 1 \right) - F_{ij} \quad (60) \end{aligned}$$

Reminder: the revenue found above is

$$\Rightarrow r_{ij} = \theta_{ij}^{\alpha_i} \left[ \frac{\sigma}{\sigma-1} \right] \left[ \frac{\alpha_i}{\beta_j - \varepsilon} \right]$$

And the revenue is:

$$\begin{aligned} \Leftrightarrow p_{ij} q_{ij} &= \theta_{ij}^{\alpha_i} \frac{\sigma \alpha_i}{\Lambda_j} \\ &= \frac{\omega_{ij} \sigma \alpha_i}{\Lambda_j} \end{aligned}$$

and

$$\theta_{ij}^* = \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}}$$

$$p_{ij}^u q_{ij}^u = \Lambda_j^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \left[ \frac{1}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \sigma \alpha_i \quad (61)$$

Below, I find the price, quantities, sales and then the number of constrained firms needed to measure welfare.

#### B.6.4 Sales

##### B.6.4.1 Constrained firms

An increase in the QS has a positive effect on revenues. Substituting for the price index which applies to all firms:

$$p_j^{\sigma-1} = \theta_{sj}^{-\Lambda_j} \frac{\sigma}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{1-\sigma}$$

and knowing

$$p_{ij} = \frac{1}{\varphi_{ij}} \frac{t_{ij} \sigma}{\sigma-1} \theta_{sj}^\varepsilon$$

and

$$q_{ij} = \theta_{sj}^{\beta_j(\sigma-1)} p_{ij}^{-\sigma} L_j p_j^{\sigma-1}$$

Gives:

$$p_{ij}^c q_{ij}^c = \frac{1}{\varphi_{ij}} \frac{t_{ij} \sigma}{\sigma-1} \theta_{sj}^{\varepsilon + \beta_j(\sigma-1)} \left( \frac{1}{\varphi_{ij}} \frac{t_{ij} \sigma}{\sigma-1} \theta_{sj}^\varepsilon \right)^{-\sigma} L_j p_j^{\sigma-1}$$

$$p_{ij}^c q_{ij}^c = \frac{\sigma \alpha_i}{\Lambda_j} \theta_{sj}^{\alpha_i} \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \quad (62)$$

Which I divide with equilibrium price (I get the same result as [Gagné and Larue \(2016\)](#)) to find the sales:

$$q_{ij}^c = \frac{\left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \sigma \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)}{\frac{\sigma t}{\sigma-1} \frac{1}{\varphi_{ij}} \theta_{sj}^\varepsilon}$$

$$q_{ij}^c = \frac{\alpha_i (\sigma-1)}{\Lambda_j} \frac{\varphi_{ij}^\sigma}{t \bar{\varphi}_{ij}^{\sigma-1}} \theta_{sj}^{\alpha_i - \varepsilon} \quad (63)$$

B.6.4.2 *Unconstrained firms:*

The optimal revenue is (profit max):

$$p_{ij} q_{ij} = \frac{\sigma \alpha_i}{\Lambda_j} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \quad (64)$$

The optimal price is:

$$p_{ij}^* = \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_{ij}^{\varepsilon^*}$$

and

$$\theta_{ij}^* = \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}}$$

and

$$\hat{\varphi}_{ij} = \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{1}{1-\sigma}} \bar{\varphi}_{ij}$$

$$p_{ij} = \frac{\sigma t}{(\sigma-1)} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \frac{1}{\varphi_{ij}} \varphi_{ij}^{\frac{[\sigma-1]\varepsilon}{\alpha_i - \Lambda_j}}$$

We know that

$$\frac{1}{\varphi_{ij}} \varphi_{ij}^{\frac{[\sigma-1]\varepsilon}{\alpha_i - \Lambda_j}} = \varphi_{ij}^{\frac{[\sigma-1]\varepsilon - \alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}}$$

thus,

$$p_{ij}^u = \frac{\sigma t_{ij}}{(\sigma-1)} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1]\varepsilon - \alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}} \quad (65)$$

Thus, the quantity is:

$$q_{ij}^u = \frac{\frac{\sigma \alpha_i}{\Lambda_j} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}}}{\frac{\sigma t}{(\sigma-1)} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1]\varepsilon - \alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}}}$$

$$q_{ij}^u = \frac{\alpha_i (\sigma-1)}{\Lambda_j t_{ij}} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i - \varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i - \varepsilon) + \alpha_i - \Lambda_j}{\alpha_i - \Lambda_j}} \quad (66)$$

B.6.5 *The impact of a QS on profit and productivity*

The productivity for a firm at the limit between being constrained and unconstrained is the following: Thus,

$$\pi_{ij}^c = \pi_{ij}^u$$

$$\begin{aligned}
& \Longleftrightarrow \theta_{sj}^{\alpha_i} \left[ \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \frac{\alpha_i}{\Lambda_j} - 1 \right] - F_{ij} \\
& = \theta_{sj}^{\alpha_i} \left( \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{\alpha_i-2\Lambda_j}{\alpha_i-\Lambda_j}} \theta_{sj}^{-\frac{\alpha_i\Lambda_j}{(\alpha_i-\Lambda_j)}} \left[ (\theta_{sj}^{\alpha_i} + F_{ij}) \right]^{\frac{\Lambda_j}{\alpha_i-\Lambda_j}} - 1 \right) - F_{ij} \\
& \Longleftrightarrow \theta_{sj}^{\alpha_i} \left[ \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \frac{\alpha_i}{\Lambda_j} - 1 \right] \\
& = \theta_{sj}^{\alpha_i} \left( \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i-\Lambda_j}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{\alpha_i-2\Lambda_j}{\alpha_i-\Lambda_j}} \theta_{sj}^{-\frac{\alpha_i\Lambda_j}{(\alpha_i-\Lambda_j)}} \left[ (\theta_{sj}^{\alpha_i} + F_{ij}) \right]^{\frac{\Lambda_j}{\alpha_i-\Lambda_j}} - 1 \right) \\
& \Longleftrightarrow \hat{\varphi}_{ij} = \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{\sigma-1}} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\frac{1}{\sigma-1}} \bar{\varphi}_{ij} \tag{67}
\end{aligned}$$

The limit firm exports iff

$$\begin{aligned}
& \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{\sigma-1}} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\frac{1}{\sigma-1}} > 1 \\
& \Longleftrightarrow \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} > \frac{\Lambda_j}{\alpha_i} \\
& \Longleftrightarrow \frac{\alpha_i}{\Lambda_j} > \frac{\theta_{sj}^{\alpha_i} + F_{ij}}{\theta_{sj}^{\alpha_i}} = 1 + \frac{F_{ij}}{\theta_{sj}^{\alpha_i}}
\end{aligned}$$

#### B.6.6 Price of the indifferent firm concerning the standard

Using

$$\begin{aligned}
p_j &= \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \theta_j^\varepsilon \\
\varphi_{ij} &= \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \left[ (\theta_{sj}^{\alpha_i} + F_{ij}) \right]^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \\
\theta_j^* &= \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{1}{\alpha_i-\Lambda_j}}
\end{aligned}$$

It can now be defined as:

$$\begin{aligned}
p_j &= \frac{1}{\varphi_{ij}} \frac{\sigma}{\sigma-1} t_{ij} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i-\Lambda_j}} \\
&= \frac{t_{ij} \sigma}{\sigma-1} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-1}{(\sigma-1)}} \theta_{sj}^{\frac{-\alpha_i}{\sigma-1}} \left[ (\theta_{sj}^{\alpha_i} + F_{ij}) \right]^{\frac{1}{\sigma-1}} \varphi_{ls}^{-1} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i-\Lambda_j}}
\end{aligned}$$

$$\begin{aligned}
&= \frac{t_{ij}\sigma}{\sigma-1} \bar{\varphi}_{ij}^{-1} \left[ \frac{\Lambda_j}{\alpha_i}^{-\alpha_i} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{1}{\sigma-1}} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{\varepsilon(\sigma-1)}{\alpha_i - \Lambda_j}} \\
&= \frac{t_{ij}\sigma}{\sigma-1} \theta_{sj}^{\frac{-\alpha_i}{\sigma-1} \frac{-\Lambda_j \varepsilon}{\alpha_i - \Lambda_j}} \left[ \frac{\Lambda_j}{\alpha_i} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{\alpha_i - \Lambda_j + \varepsilon(\sigma-1)}{(\alpha_i - \Lambda_j)(\sigma-1)}} \bar{\varphi}_{ij}^{\frac{-\alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}} \left[ \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right]^{\frac{\varepsilon(\sigma-1)}{\alpha_i - \Lambda_j}} \\
&= \frac{t_{ij}\sigma}{\sigma-1} \theta_{sj}^{\frac{-\alpha_i}{\sigma-1} \frac{-\Lambda_j \varepsilon}{\alpha_i - \Lambda_j}} \left[ \frac{\Lambda_j}{\alpha_i} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{\alpha_i - \Lambda_j + \varepsilon(\sigma-1)}{(\alpha_i - \Lambda_j)(\sigma-1)}} \bar{\varphi}_{ij}^{\frac{-\alpha_i + \Lambda_j - \varepsilon(\sigma-1)}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{\varepsilon(\sigma-1)}{\alpha_i - \Lambda_j}} \\
&= \frac{t_{ij}\sigma}{\sigma-1} \frac{-\alpha_i(\alpha_i - \Lambda_j) - \Lambda_j \varepsilon(\sigma-1)}{(\sigma-1)(\alpha_i - \Lambda_j)} \left[ \frac{\Lambda_j}{\alpha_i} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{\alpha_i - \Lambda_j + \varepsilon(\sigma-1)}{(\alpha_i - \Lambda_j)(\sigma-1)}} \bar{\varphi}_{ij}^{\frac{-\alpha_i + \Lambda_j - \varepsilon(\sigma-1)}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{\varepsilon(\sigma-1)}{\alpha_i - \Lambda_j}} \\
&= \frac{t_{ij}\sigma}{\sigma-1} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-1}{(\sigma-1)}} \theta_{sj}^{\frac{-\alpha_i}{\sigma-1}} \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{1}{\sigma-1}} \bar{\varphi}_{ij}^{-1} \\
&\quad \times \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\alpha_i}{\Lambda_j} \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{-1} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} \\
&\quad \hat{\varphi}_{ij} = \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij}
\end{aligned}$$

## B.7 ON ENTRY AND EXIT

The expected profits are summarized by the probability to adopt the public standard or to be above it, I call this form of profit the mixed expected profit. A specification will be made to distinguish home and foreign destinations at the end of the calculation. Knowing that

$$\begin{aligned}
\pi_{ij}^u &= \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{ij}^{-\Lambda_j} \left( \theta_{ij}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \\
\pi^c &= \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} - 1 \right)
\end{aligned}$$

Also:

$$\begin{aligned}
\hat{\varphi}_{ij} &= \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \\
\iff \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{-1}{\sigma-1}} &= \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \theta_{sj}^{\frac{-\alpha_i}{\sigma-1}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-1}{(\sigma-1)}} \\
\iff \theta_{sj}^{\alpha_i} + F_{ij} &= \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{1-\sigma} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \frac{\alpha_i}{\Lambda_j}
\end{aligned}$$

Always true.

For the limit firm:

$$\begin{aligned} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) &= \frac{\alpha_i}{\Lambda_j} \theta_{sj}^{\alpha_i} \\ \Leftrightarrow \frac{\alpha_i}{\Lambda_j} &= \frac{\theta_{sj}^{\alpha_i} + F_{ij}}{\theta_{sj}^{\alpha_i}} \end{aligned}$$

THE EXPECTED PROFIT IS SUBDIVIDED IN CATEGORIES OF FIRMS

$$\int_{\bar{\varphi}_{ij}}^{\infty} \pi(\varphi_{ij}) g(\varphi_{ij}) d\varphi_{ij}$$

$$[1 - G(\varphi_{ij})] \bar{\pi}_i = \sum_{j=i}^j \left[ \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \pi_j^c(\theta_{sj}) g(\varphi_{ij}) d\varphi_{ij} + \int_{\hat{\varphi}_{ij}}^{\infty} \pi_j^u(\theta_{ij}) g(\varphi_{ij}) d\varphi_{ij} \right]$$

$$\begin{aligned} &= \sum_{j=i}^j \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} - 1 \right) g(\varphi_{ij}) d\varphi_{ij} + \\ &\int_{\hat{\varphi}_{ij}}^{\infty} \left( \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \right) g(\varphi_{ij}) d\varphi_{ij} \end{aligned}$$

$$\begin{aligned} &= \sum_{j=i}^j \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} - 1 \right) g(\varphi_{ij}) d\varphi_{ij} + \\ &\int_{\hat{\varphi}_{ij}}^{\infty} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} g(\varphi_{ij}) d\varphi_{ij} \\ &\quad - \int_{\hat{\varphi}_{ij}}^{\infty} F_{ij} g(\varphi_{ij}) d\varphi_{ij} \end{aligned}$$

SEPARATION OF THE CALCULATION      Reminder:  $g(\varphi_{ij}) = \gamma \varphi_{ij}^{-\gamma-1}$  and  $G(\varphi_{ij}) = 1 - \varphi_{ij}^{-\gamma}$ , thus

$$\begin{aligned} &\int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} g(\varphi_{ij}) d\varphi_{ij} \\ &= \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \gamma \varphi_{ij}^{-\gamma-1} d\varphi_{ij} \\ &= \frac{\gamma}{-\gamma} \varphi_{ij}^{-\gamma} = -\varphi_{ij}^{-\gamma} \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} - 1 \right) g(\varphi_{ij}) d\varphi_{ij} \\ &= \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} - 1 \right) \gamma \varphi_{ij}^{-\gamma-1} d\varphi_{ij} \end{aligned}$$

$$\begin{aligned}
&= \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \left( \frac{\gamma}{\sigma-\gamma-1} \right) \varphi_{ij}^{\sigma-\gamma-2} - \gamma \varphi_{ij}^{-\gamma-1} \right) \right]_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \\
&= \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \left( \frac{\gamma}{\sigma-\gamma-1} \right) \hat{\varphi}_{ij}^{\sigma-\gamma-1} + \hat{\varphi}_{ij}^{-\gamma} \right) \\
&\quad - \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \left( \frac{\gamma}{\sigma-\gamma-1} \right) \bar{\varphi}_{ij}^{\sigma-\gamma-1} + \bar{\varphi}_{ij}^{-\gamma} \right)
\end{aligned}$$

And:

$$\begin{aligned}
&\int_{\hat{\varphi}_{ij}}^{\infty} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} g(\varphi_{ij}) d\varphi_{ij} \\
&= \left[ \frac{\alpha_i - \Lambda_j}{\alpha_i} \theta_{sj}^{-\frac{\alpha_i \Lambda_j}{(\alpha_i - \Lambda_j)}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\frac{(\sigma-1)\alpha_i}{\alpha_i - \Lambda_j}} \right. \\
&\quad \left. \Lambda_j^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \frac{\gamma(\alpha_i - \Lambda_j)}{(\sigma-\gamma-1)\alpha_i + \gamma\Lambda_j} \varphi_{ij}^{\frac{(\sigma-\gamma-1)\alpha_i + \gamma\Lambda_j}{\alpha_i - \Lambda_j}} \right]_{\hat{\varphi}_{ij}}^{\infty} \\
&= \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \\
&\quad \left( \frac{\gamma(\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1)\alpha_i - \gamma\Lambda_j} \right)^{\frac{(\sigma-\gamma-1)\alpha_i + \gamma\Lambda_j}{\alpha_i - \Lambda_j}} \hat{\varphi}_{ij}
\end{aligned}$$

In order to find a solution, I need  $\infty^{\frac{(\sigma-\gamma-1)\alpha_i + \gamma\Lambda_j}{\alpha_i - \Lambda_j}} = 0$ , I need to assume that  $\sigma - \gamma - 1 < \frac{-\gamma\Lambda_j}{\alpha_i}$  which also implies that  $\sigma - 1 < \gamma$  and since  $\alpha_i - \Lambda_j$  is positive (known).  $\sigma - 1 < \gamma$  is the usual assumption about the Pareto distribution ([Arkolakis et al., 2012](#)). Also:

$$-F_{ij} \left( \int_{\hat{\varphi}_{ij}}^{\infty} \left( \gamma \varphi_{ij}^{-\gamma-1} \right) d\varphi_{ij} \right) = -F_{ij} \left( \left[ -\varphi_{ij}^{-\gamma} \right]_{\hat{\varphi}_{ij}}^{\infty} \right) = -F_{ij} \hat{\varphi}_{ij}^{-\gamma}$$

Thus:

$$\begin{aligned}
& [1 - G(\varphi_{ij})] \bar{\pi}_i = \\
& \sum_{j=i}^j (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \left( \frac{\gamma}{\sigma-\gamma-1} \right) \hat{\varphi}_{ij}^{\sigma-\gamma-1} + \hat{\varphi}_{ij}^{-\gamma} \right) \\
& - (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \left( \frac{\gamma}{\sigma-\gamma-1} \right) \bar{\varphi}_{ij}^{\sigma-\gamma-1} + \bar{\varphi}_{ij}^{-\gamma} \right) \\
& + \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \\
& \quad \times \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \hat{\varphi}_{ij}^{\frac{(\sigma-\gamma-1)\alpha_i + \gamma \Lambda_j}{\alpha_i - \Lambda_j}} - F_{ij} \hat{\varphi}_{ij}^{-\gamma}
\end{aligned}$$

Preliminary general expression :

$$\begin{aligned}
& [1 - G(\varphi_{ij})] \bar{\pi}_i = \\
& \sum_{j=i}^j (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \left( \frac{\gamma}{\gamma - (\sigma - 1)} \right) \left( \bar{\varphi}_{ij}^{-\gamma} - \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \hat{\varphi}_{ij}^{-\gamma} \right) - (\bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma}) \right) \\
& + \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \\
& \quad \times \hat{\varphi}_{ij}^{-\gamma} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \hat{\varphi}_{ij}^{-\gamma} \quad (68)
\end{aligned}$$

This general expected profit can be rewritten knowing

$$\left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} = (\theta_{sj}^{\alpha_i} + F_{ij})^{-1} \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j}$$

to distinguish between fixed costs  $F_{ij}$  and the rest.

$$\begin{aligned}
& [1 - G(\varphi_{ij})] \bar{\pi}_i \\
& = \sum_{j=i}^j (\theta_{sj}^{\alpha_i} + F_{ij}) \left( \left( \frac{\gamma}{\gamma - (\sigma - 1)} \right) \left( \bar{\varphi}_{ij}^{-\gamma} - (\theta_{sj}^{\alpha_i} + F_{ij})^{-1} \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j} \hat{\varphi}_{ij}^{-\gamma} \right) \right. \\
& \quad \left. - (\bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma}) \right) \\
& + \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \hat{\varphi}_{ij}^{-\gamma} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \\
& \quad \times \left[ \Lambda_j \theta_{sj}^{-\Lambda_j} (\theta_{sj}^{\alpha_i} + F_{ij}) (\theta_{sj}^{\alpha_i} + F_{ij})^{-1} \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - F_{ij} \hat{\varphi}_{ij}^{-\gamma}
\end{aligned}$$

$$\begin{aligned}
&= \sum_{j=i}^j \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \left( \frac{\gamma}{\gamma - (\sigma - 1)} \right) \left( \bar{\varphi}_{ij}^{-\gamma} - \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{-1} \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j} \hat{\varphi}_{ij}^{-\gamma} \right) \right. \\
&\quad \left. - \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right. \\
&\quad \left. + \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \hat{\varphi}_{ij}^{-\gamma} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \theta_{sj}^{\alpha_i} - F_{ij} \hat{\varphi}_{ij}^{-\gamma} \right) \\
&= \sum_{j=i}^j \left( \left( \frac{\gamma}{\gamma - (\sigma - 1)} \right) \left( \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) - \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j} \hat{\varphi}_{ij}^{-\gamma} \right) - \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) + \\
&\quad \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \hat{\varphi}_{ij}^{-\gamma} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \theta_{sj}^{\alpha_i} - F_{ij} \hat{\varphi}_{ij}^{-\gamma} \\
&= \sum_{j=i}^j \left( \left( \frac{\gamma}{\gamma - (\sigma - 1)} \right) \left( \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) - \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j} \hat{\varphi}_{ij}^{-\gamma} \right) - \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) + \\
&\quad \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \hat{\varphi}_{ij}^{-\gamma} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \theta_{sj}^{\alpha_i} - F_{ij} \hat{\varphi}_{ij}^{-\gamma} \\
&= \sum_{j=i}^j \left( \frac{\sigma - 1}{\gamma - (\sigma - 1)} \right) \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) - \frac{\gamma}{\gamma - (\sigma - 1)} \theta_{sj}^{\alpha_i} \frac{\alpha_i}{\Lambda_j} \hat{\varphi}_{ij}^{-\gamma} + \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \hat{\varphi}_{ij}^{-\gamma} \right) + \\
&\quad \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \right) \hat{\varphi}_{ij}^{-\gamma} \frac{\alpha_i - \Lambda_j}{\alpha_i \Lambda_j} \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \theta_{sj}^{\alpha_i} - F_{ij} \hat{\varphi}_{ij}^{-\gamma} \\
&= \sum_{j=i}^j \frac{\sigma - 1}{\gamma - (\sigma - 1)} \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \\
&\quad + \theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma} \left( \frac{\gamma (\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1) \alpha_i - \gamma \Lambda_j} \frac{\alpha_i - \Lambda_j}{\Lambda_j} \alpha_i^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} + 1 - \frac{\alpha_i}{\Lambda_j} \frac{\gamma}{\gamma - (\sigma - 1)} \right) \\
&= \sum_1^2 \frac{\sigma - 1}{\gamma - (\sigma - 1)} \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \\
&\quad \frac{\theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma}}{\alpha_i \Lambda_j} \left( \frac{\gamma (\alpha_i - \Lambda_j)^2}{\gamma (\alpha_i - \Lambda_j) - \alpha_i (\sigma - 1)} \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} - \frac{\alpha_i \gamma}{\gamma - (\sigma - 1)} + \Lambda_j \right)
\end{aligned}$$

Accordingly

$$[1 - G(\varphi)] \bar{\pi}_i = f_e$$

implies that

$$f_e = \frac{\sigma - 1}{\gamma - (\sigma - 1)} \sum_1^2 \Psi_{ij}$$

with

$$\begin{aligned}
\Psi_{ij} &\equiv \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \\
&\quad + \frac{\theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma}}{\alpha_i \Lambda_j} \frac{\gamma - (\sigma - 1)}{\sigma - 1} \left( \frac{\gamma \left( \alpha_i - \Lambda_j \right)^2 \alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}}}{\gamma \left( \alpha_i - \Lambda_j \right) - \alpha_i \left( \sigma - 1 \right)} - \frac{\alpha_i \gamma}{\gamma - (\sigma - 1)} + \Lambda_j \right) \\
&= \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \\
&\quad \frac{\theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma}}{\alpha_i \Lambda_j} \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\
&\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right)
\end{aligned}$$

Thus, the free entry condition can be rewritten as follows

$$\begin{aligned}
f_e &= \frac{\sigma - 1}{\gamma - (\sigma - 1)} \sum_1^2 \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \\
&\quad \frac{\theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma}}{\alpha_i \Lambda_j} \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\
&\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right)
\end{aligned}$$

#### B.8 IMPACT OF QUALITY STANDARDS ON THE CUTOFFS:

By using the implicit function theorem, we have that

$$\frac{\partial \hat{\varphi}_{ij}}{\partial \theta_{sj}} = - \frac{\partial \Psi_{ij}}{\partial \theta_{sj}} / \frac{\partial \Psi_{ij}}{\partial \hat{\varphi}_{ij}}$$

Which is complete because  $\Psi_{ij}$  considers both  $\hat{\phi}_{ij}$  (the cutoff between unconstrained and constrained firms) and  $\bar{\varphi}_{ij}$  (the cutoff for positive profit).

$$\begin{aligned} \frac{\partial \Psi_{ij}}{\partial \hat{\phi}_{ij}} &= \left( \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \frac{\theta_{sj}^{\alpha_i} \hat{\phi}_{ij}^{-\gamma} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \right. \\ &\quad \left. \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \right)' \\ &= -\gamma \frac{\theta_{sj}^{\alpha_i} \hat{\phi}_{ij}^{-\gamma-1} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) < 0 \end{aligned}$$

Because  $\alpha_i - \Lambda_j > 0$ ,  $\sigma - 1 < \gamma \implies -\frac{\alpha_i \gamma}{\gamma - (\sigma - 1)} < 0$  and  $\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j > 0$ .

Also,

$$\begin{aligned} \frac{\partial \Psi_{ij}}{\partial \theta_{sj}} &= \frac{\partial \Psi_{ij}}{\partial \theta_{sj}} + \frac{\partial \Psi_{ij}}{\partial \hat{\phi}_{ij}} \frac{\partial \hat{\phi}_{ij}}{\partial \theta_{sj}} \\ &= \bar{\varphi}_{ij}^{-\gamma} (\alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij}) + \frac{\alpha_i \theta_{sj}^{\alpha_i-1} \hat{\phi}_{ij}^{-\gamma} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\ &\quad + \frac{\partial \Psi_{ij}}{\partial \hat{\phi}_{ij}} \frac{\partial \hat{\phi}_{ij}}{\partial \theta_{sj}} \\ &= \bar{\varphi}_{ij}^{-\gamma} (\alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij}) + \frac{\alpha_i \theta_{sj}^{\alpha_i-1} \hat{\phi}_{ij}^{-\gamma} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\ &\quad - \gamma \frac{\theta_{sj}^{\alpha_i} \hat{\phi}_{ij}^{-\gamma-1} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \frac{\partial \hat{\phi}_{ij}}{\partial \theta_{sj}} \end{aligned}$$

$$\begin{aligned}
&= \bar{\varphi}_{ij}^{-\gamma} (\alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\
&\times \left( \frac{\alpha_i}{\theta_{sj}} - \frac{\gamma}{\hat{\varphi}} \frac{\partial \hat{\varphi}_{ij}}{\partial \theta_{sj}} \right) \\
&= \bar{\varphi}_{ij}^{-\gamma} (\alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i-1} \hat{\varphi}_{ij}^{-\gamma} (\alpha_i - \Lambda_j) \gamma}{\alpha_i \Lambda_j (\sigma - 1)} \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\
&\times \left( \frac{\alpha_i}{\gamma} - \frac{\theta_{sj}}{\hat{\varphi}} \frac{\partial \hat{\varphi}_{ij}}{\partial \theta_{sj}} \right)
\end{aligned}$$

Then, using

$$\hat{\varphi}_{ij} = \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij}$$

we have that:

$$\begin{aligned}
&\frac{\theta_{sj}}{\hat{\varphi}} \frac{\partial \hat{\varphi}_{ij}}{\partial \theta_{sj}} \\
&= \frac{\theta_{sj}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{\alpha_i}{\sigma-1} \theta_{sj} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}-1} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \\
&\quad + \frac{\theta_{sj}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \frac{-1}{\sigma-1} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}-1} \alpha_i \theta_{sj}^{\alpha_i-1} \bar{\varphi}_{ij} \\
&= \frac{1}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{\alpha_i}{\sigma-1} \theta_{sj} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \\
&\quad + \frac{1}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \frac{-1}{\sigma-1} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}-1} \alpha_i \theta_{sj}^{\alpha_i-1} \bar{\varphi}_{ij} \\
&= \frac{\bar{\varphi}_{ij}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{1}{\sigma-1} \theta_{sj} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}} \alpha_i \left( 1 - (\theta_{sj}^{\alpha_i} + F_{ij})^{-1} \theta_{sj}^{\alpha_i} \right) \\
&= \frac{\bar{\varphi}_{ij}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{\alpha_i}{\sigma-1} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right) > 0
\end{aligned}$$

Thus,

$$\begin{aligned}
\frac{\partial \Psi_{ij}}{\partial \theta_{sj}} &= \bar{\varphi}_{ij}^{-\gamma} (\alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i-1} \hat{\varphi}_{ij}^{-\gamma}}{\alpha_i \Lambda_j} \gamma \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\
&\times \left( \frac{\alpha_i}{\gamma} - \frac{\bar{\varphi}_{ij}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{\alpha_i}{\sigma - 1} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right) \right) \\
&= \bar{\varphi}_{ij}^{-\gamma} (\alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i-1} \hat{\varphi}_{ij}^{-\gamma}}{\Lambda_j} \gamma \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\
&\times \left( \frac{1}{\gamma} - \frac{\bar{\varphi}_{ij}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{1}{\sigma - 1} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right) \right)
\end{aligned}$$

Plugging

$$\hat{\varphi}_{ij} = \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij}$$

into  $\Psi_{ij}$  leads to

$$\begin{aligned}
\Psi_{ij} &= \bar{\varphi}_{ij}^{-\gamma} (\theta_{sj}^{\alpha_i} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i}}{\alpha_i \Lambda_j} \left( \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \right)^{-\gamma} \\
&\times \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\
&= \bar{\varphi}_{ij}^{-\gamma} (\theta_{sj}^{\alpha_i} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i}}{\alpha_i \Lambda_j} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{-\gamma \alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{\gamma}{\sigma-1}} \bar{\varphi}_{ij}^{-\gamma} \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\
&= \bar{\varphi}_{ij}^{-\gamma} \left( (\theta_{sj}^{\alpha_i} + F_{ij}) + \frac{\theta_{sj}^{\alpha_i}}{\alpha_i \Lambda_j} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{-\gamma \alpha_i}{\sigma-1}} (\theta_{sj}^{\alpha_i} + F_{ij})^{\frac{\gamma}{\sigma-1}} \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \right) \\
&\times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right)
\end{aligned}$$

So that

$$\begin{aligned} \frac{\partial \Psi_{ij}}{\partial \bar{\varphi}_{ij}} &= -\gamma \bar{\varphi}_{ij}^{-\gamma-1} \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \frac{\theta_{sj}^{\alpha_i}}{\alpha_i \Lambda_j} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{-\gamma \alpha_i}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma}{\sigma-1}} \right. \\ &\quad \times \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \end{aligned}$$

And

$$\begin{aligned} \frac{\partial \Psi_{ij}}{\partial \theta_{sj}} &= \bar{\varphi}_{ij}^{-\gamma} \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \frac{\theta_{sj}^{\alpha_i}}{\alpha_i \Lambda_j} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{-\gamma \alpha_i}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma}{\sigma-1}} \right. \\ &\quad \times \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \end{aligned}$$

$$\frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}} = -\frac{\frac{\partial \Psi_{ij}}{\partial \theta_{sj}}}{\frac{\partial \Psi_{ij}}{\partial \bar{\varphi}_{ij}}} = \frac{\bar{\varphi}_{ij}}{\gamma} \frac{\Upsilon_{ij}}{\Theta_{ij}}$$

Where,

$$\begin{aligned} \Upsilon_{ij} &= \frac{\bar{\varphi}_{ij}}{\gamma} \left( \left( \alpha_i \theta_{sj}^{\alpha_i-1} + F_{ij} \right) + \frac{\theta_{sj}^{\alpha_i-1} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{-\gamma \alpha_i}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma}{\sigma-1}}}{\Lambda_j} \right. \\ &\quad \times \gamma \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \\ &\quad \left( \frac{1}{\gamma} - \frac{\bar{\varphi}_{ij}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{1}{\sigma-1} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right) \right) \end{aligned}$$

is always positive. And

$$\begin{aligned} \Theta_{ij} &= \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) + \frac{\theta_{sj}^{\alpha_i}}{\alpha_i \Lambda_j} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{-\gamma \alpha_i}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma}{\sigma-1}} \frac{(\alpha_i - \Lambda_j) \gamma}{\sigma - 1} \\ &\quad \times \left( \frac{\alpha_i^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} (\alpha_i - \Lambda_j) (\gamma - (\sigma - 1)) + (\Lambda_j - \alpha_i) \gamma + (\sigma - 1) (\sigma \alpha_i - 1)}{\alpha_i (\gamma - (\sigma - 1)) - \gamma \Lambda_j} \right) \end{aligned}$$

In conclusion, I find that

$$\frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}} > 0 \text{ iff } \Upsilon_{ij} > 0 \text{ iff } \frac{1}{\gamma} - \frac{\bar{\varphi}_{ij}}{\hat{\varphi}} \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \frac{1}{\sigma-1} \left( \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right)^{\sigma-1} \left( 1 - \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right) > 0.$$

This means that the higher  $\frac{1}{\gamma}$ , the more likely is welfare going to be positive. In other words,  $\gamma$  needs to be low (more unequal distribution) for welfare to be positive when standards increase. Also, the highest is  $\hat{\varphi}$  compared to  $\bar{\varphi}_{ij}$ , the better for welfare. In other words, a greater number of constrained firms compared to unconstrained ones improve welfare. Finally, through  $\Lambda_j$ ,  $\beta_j$  improves welfare. Indeed, a country with consumers aiming at higher quality is less negatively impacted by higher standards in terms of welfare.

## B.9 MASS OF FIRMS

$$L_i = l_i^A + l_i^B + M_i \varphi_{ii}^\gamma f_e + M_i \varphi_{ii}^\gamma \sum_{j=i}^i \varphi_{ij}^{-\gamma} (\omega_{ij} + F_{ij}) \quad (69)$$

where  $M_i \varphi_{ii}^\gamma$  is the mass of firms in  $i$ ,  $l_i^A$  is the mass of workers allocated to the production of the constrained firms and  $l_i^B$  is the unconstrained firm's mass of workers. I assume that  $M_i = M_i^A + M_i^B$ . Among that, it is also important to distinguish firms selling domestically versus those exporting only. As in [Demidova and Rodriguez-Clare \(2013\)](#), I can say that constrained firms might be able to export if foreign standard is lower than the domestic one. I separate the calculation into those five terms. Reminder: knowing

$$\left( \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \frac{\alpha_i}{\Lambda_j} - 1 \right) \theta_{sj}^{\alpha_i} = F_{ij}$$

We have the following revenues:

$$p_{ij}^c q_{ij}^c = \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \sigma \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)$$

And sales:

$$q_{ij}^c = \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{(\sigma-1)}{t} \frac{\varphi_{ij}^\sigma}{\bar{\varphi}_{ij}^{\sigma-1}} \theta_{sj}^{-\varepsilon}$$

Thus, I find:

$$\begin{aligned} l_i^A &= \sum_j^i \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} M_j^A \left[ \frac{\theta_{sj}^\varepsilon t_j q_{ij}^c(\varphi_{ij})}{\varphi_{ij}} + \theta_{sj}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\ &= \sum_j^i \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} M_j^A \left[ \frac{\theta_{sj}^\varepsilon t_j \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{(\sigma-1)}{t} \frac{\varphi_{ij}^\sigma}{\bar{\varphi}_{ij}^{\sigma-1}} \theta_{sj}^{-\varepsilon}}{\varphi_{ij}} + \theta_{sj}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \end{aligned}$$

$$\begin{aligned}
&= \sum_j^i \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} M_j^A \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) (\sigma - 1) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} + \theta_{sj}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\
&\quad \sum_j^i \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} M_j^A \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) (\sigma - 1) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} + \theta_{sj}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\
&= \sum_j^i \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} M_j^A \left[ (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} + \theta_{sj}^{\alpha_i} \right] \gamma \varphi_{ij}^{-\gamma-1} d\varphi_{ij} \\
&= \sum_j^i \int_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} M_j^A \left[ (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \gamma \varphi_{ij}^{-\gamma-1} + \theta_{sj}^{\alpha_i} \gamma \varphi_{ij}^{-\gamma-1} \right] d\varphi_{ij} \\
&= \sum_j^i M_j^A \left[ (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma}{\sigma - \gamma - 1} \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \varphi_{ij}^{\sigma-\gamma-1} + \theta_{sj}^{\alpha_i} \frac{\gamma}{-\gamma} \varphi_{ij}^{-\gamma} \right]_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \\
&= \sum_j^i M_j^A \left[ (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma}{\sigma - \gamma - 1} \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \varphi_{ij}^{\sigma-\gamma-1} - \theta_{sj}^{\alpha_i} \varphi_{ij}^{-\gamma} \right]_{\bar{\varphi}_{ij}}^{\hat{\varphi}_{ij}} \\
&= M_j^A \sum_j^i (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma}{\sigma - \gamma - 1} \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \hat{\varphi}_{ij}^{\sigma-\gamma-1} \\
&\quad - \sum_j^i \theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma} - (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma}{\sigma - \gamma - 1} \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \bar{\varphi}_{ij}^{\sigma-\gamma-1} + \theta_{sj}^{\alpha_i} \bar{\varphi}_{ij}^{-\gamma} \\
&= M_j^A \sum_j^i \left( (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma}{\sigma - \gamma - 1} \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \hat{\varphi}_{ij}^{\sigma-\gamma-1} \right. \\
&\quad \left. - \sum_j^i \theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma} - (\sigma - 1) \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma}{\sigma - \gamma - 1} \bar{\varphi}_{ij}^{\sigma-\gamma-1} + \theta_{sj}^{\alpha_i} \bar{\varphi}_{ij}^{-\gamma} \right) \\
&\Rightarrow l_i^A \\
&= M_j^A \sum_j^i \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \bar{\varphi}_{ij}^{1-\sigma} \left( \hat{\varphi}_{ij}^{\sigma-\gamma-1} - \bar{\varphi}_{ij}^{\sigma-\gamma-1} \right) + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) \\
&\quad \alpha_i = \frac{F_{ij} \Lambda_j}{(\alpha_i - \Lambda_j)}
\end{aligned}$$

and

$$\theta_{sj}^{\alpha_i} + F_{ij} = \frac{\alpha_i}{\Lambda_j} \theta_{sj}^{\alpha_i}$$

$$l_i^A = M_i^A \sum_{j=i}^j \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \bar{\varphi}_{ij}^{1-\sigma} \left( \hat{\varphi}_{ij}^{\sigma-\gamma-1} - \bar{\varphi}_{ij}^{\sigma-\gamma-1} \right) + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right)$$

(70)

And knowing, for the non-constrained firms that

$$q^u = \frac{\alpha_i (\sigma - 1)}{\Lambda_j t_{ij}} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i - \varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i - \varepsilon) + \alpha_i - \Lambda_j}{\alpha_i - \Lambda_j}}$$

and

$$\theta_{ij}^* = \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{1}{\alpha_i - \Lambda_j}}$$

$l_i^B$  is:

$$l_i^B = \sum_j \int_{\varphi_{ij}}^{\infty} M_j^B \left[ \frac{\theta_{ij}^{\varepsilon} t_j q_{ij}(\varphi_{ij})}{\varphi_{ij}} + \theta_{ij}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij}$$

where

$$\begin{aligned} & \frac{\theta_{ij}^{\varepsilon} t_j q_{ij}(\varphi_{ij})}{\varphi_{ij}} + \theta_{ij}^{\alpha_i} \\ &= \frac{\theta_{ij}^{\varepsilon} t_j \frac{\alpha_i (\sigma - 1)}{\Lambda_j t_{ij}} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i - \varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i - \varepsilon) + \alpha_i - \Lambda_j}{\alpha_i - \Lambda_j}}}{\varphi_{ij}} + \theta_{ij}^{\alpha_i} \\ &= \theta_{ij}^{\varepsilon} t_j \frac{\alpha_i (\sigma - 1)}{\Lambda_j t_{ij}} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i - \varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i - \varepsilon) + \alpha_i - \Lambda_j - \alpha_i + \Lambda_j}{\alpha_i - \Lambda_j}} + \theta_{ij}^{\alpha_i} \\ &= \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\varepsilon}{\alpha_i - \Lambda_j}} t_j \frac{\alpha_i (\sigma - 1)}{\Lambda_j t_{ij}} \\ & \quad \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i - \varepsilon}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i - \varepsilon)}{\alpha_i - \Lambda_j}} \\ & \quad + \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \\ &= \frac{\alpha_i (\sigma - 1)}{\Lambda_j} \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i)}{\alpha_i - \Lambda_j}} + \\ & \quad \left[ \frac{\Lambda_j}{\alpha_i} \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \varphi_{ij}^{\frac{[\sigma-1](\alpha_i)}{\alpha_i - \Lambda_j}} \\ &= \left[ \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\varphi_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right) \end{aligned}$$

$$\begin{aligned}
&= \left[ \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\varphi_{ij}}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right) \\
&= \left[ \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \\
&\quad \times \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\alpha_i(\sigma-1) + (-\gamma-1)(\alpha_i - \Lambda_j)}{\alpha_i - \Lambda_j}} \gamma \varphi_{ij}
\end{aligned}$$

where the primitive function of this is the following:

$$\begin{aligned}
&\left[ \theta_{sj}^{-\Lambda_j} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{1}{\bar{\varphi}_{ij}} \right)^{\sigma-1} \right]^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \\
&\quad \times \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\gamma(\alpha_i - \Lambda_j)}{\alpha_i(\sigma-1) - \gamma(\alpha_i - \Lambda_j)}} \varphi_{ij} \\
&= X
\end{aligned}$$

Thus

$$\begin{aligned}
l_i^B &= \sum_j^i \int_{\hat{\varphi}_{ij}}^{\infty} M_j^B \left[ \frac{\theta_{ij}^{\varepsilon} t_j q_{ij}(\varphi_{ij})}{\varphi_{ij}} + \theta_{ij}^{\alpha_i} \right] g(\varphi_{ij}) d\varphi_{ij} \\
&= \sum_j^i M_{ij}^B [X]_{\varphi_{ij}}^{\infty} \\
l_i^B &= \sum_{j=i}^j M_{ij}^B \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right) \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \frac{\gamma(\alpha_i - \Lambda_j)}{\gamma(\alpha_i - \Lambda_j) - \alpha_i(\sigma-1)} \\
&\quad \times \theta_{sj}^{-\frac{\Lambda_j \alpha_i}{\alpha_i - \Lambda_j}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \hat{\varphi}_{ij}^{-\gamma} \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{\alpha_i(\sigma-1)}{\alpha_i - \Lambda_j}} \quad (71)
\end{aligned}$$

#### LABOR MARKET CLEARING WITH HYBRID CONFIGURATION

$$L_i = l_i^A + l_i^B + M_i \varphi_{ii}^{\gamma} f_e + M_i \varphi_{ii}^{\gamma} \sum_j^i \bar{\varphi}_{ij}^{-\gamma} (\omega_{ij} + F_{ij})$$

With  $\varphi_{ii}^{\gamma} = \bar{\varphi}_{ii}^{\gamma}$ ; also where  $M_j^B + M_i^B = \bar{\varphi}_{ii}^{\gamma} M_i = M_j^A + M_i^A$  by assumption, as in [Gagné and Larue \(2016\)](#).

$$\hat{\varphi}_{ij} = \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij}$$

(notice that for the limit firm,  $\left( \theta_{sj}^{\alpha_i} + F_{ij} \right) = \frac{\alpha_i}{\Lambda_j} \theta_{sj}^{\alpha_i}$ , thus  $\hat{\varphi}_{ij} = \bar{\varphi}_{ij}$ )

$$l_i^A = M_j^A \sum_j^i \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \bar{\varphi}_{ij}^{1-\sigma} \left( \hat{\varphi}_{ij}^{\sigma-\gamma-1} - \bar{\varphi}_{ij}^{\sigma-\gamma-1} \right) + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right)$$

$$\begin{aligned}
&= M_j^A \sum_j^i \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \bar{\varphi}_{ij}^{1-\sigma} \left( \left( \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{1}{(\sigma-1)}} \theta_{sj}^{\frac{\alpha_i}{\sigma-1}} \right. \right. \right. \\
&\quad \left. \left. \left[ \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \right]^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \right)^{\sigma-\gamma-1} - \bar{\varphi}_{ij}^{\sigma-\gamma-1} + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) \\
&= M_j^A \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \sum_j^i \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{1-\sigma} \left( \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{\sigma-\gamma-1}{\sigma-1}} \right. \right. \\
&\quad \left. \left. \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{-(\sigma-\gamma-1)}{\sigma-1}} \bar{\varphi}_{ij}^{\sigma-\gamma-1} - \bar{\varphi}_{ij}^{\sigma-\gamma-1} \right) + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) \\
&= M_j^A \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \sum_j^i \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{-\gamma} \left( \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{\sigma-\gamma-1}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma-(\sigma-1)}{\sigma-1}} - 1 \right) \right. \\
&\quad \left. + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right)
\end{aligned}$$

Notice that for the limit firm,  $\left( \theta_{sj}^{\alpha_i} + F_{ij} \right) = \frac{\alpha_i}{\Lambda_j} \theta_{sj}^{\alpha_i}$ , and  $\hat{\varphi}_{ij} = \bar{\varphi}_{ij}$

$$\begin{aligned}
&= M_j^A \sum_j^i \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \bar{\varphi}_{ij}^{-\gamma} \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\sigma-\gamma-1}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{-1} \right. \right. \\
&\quad \left. \left. \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\gamma} - 1 \right) + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) = 0
\end{aligned}$$

$$\begin{aligned}
l_i^B &= \sum_j^i M_{ij}^B \left[ \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right) \left( \frac{\Lambda_j}{\alpha_i} \right)^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} \frac{\gamma(\alpha_i - \Lambda_j)}{\gamma(\alpha_i - \Lambda_j) - \alpha_i(\sigma - 1)} \theta_{sj}^{-\frac{\Lambda_j \alpha_i}{\alpha_i - \Lambda_j}} \right. \\
&\quad \left. \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\alpha_i}{\alpha_i - \Lambda_j}} \hat{\varphi}_{ij}^{-\gamma} \left( \frac{\hat{\varphi}_{ij}}{\bar{\varphi}_{ij}} \right)^{\frac{\alpha_i(\sigma-1)}{\alpha_i - \Lambda_j}} \right]
\end{aligned}$$

$$= \sum_j^i M_{ij}^B \left[ \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right) \frac{\alpha_i}{\Lambda_j} \frac{\gamma(\alpha_i - \Lambda_j)}{\gamma(\alpha_i - \Lambda_j) - \alpha_i(\sigma - 1)} \theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma} \right]$$

$$\begin{aligned}
f_e &= \sum_{j=i}^j \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \left( \frac{\sigma-1}{\gamma-(\sigma-1)} + \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{-\gamma}{(\sigma-1)}} \theta_{sj}^{\frac{(\sigma-\gamma-1)\alpha_i}{\sigma-1}} \right. \\
&\quad \left. \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma-(\sigma-1)}{\sigma-1}} \right. \\
&\quad \left. \left( \frac{\gamma(\alpha_i - \Lambda_j)}{(\gamma - \sigma + 1)\alpha_i - \gamma\Lambda_j} \frac{\alpha_i - \Lambda_j}{\Lambda_j} \alpha_i^{\frac{\Lambda_j}{\alpha_i - \Lambda_j}} + \frac{\gamma(\Lambda_j - \alpha_i) - \Lambda_j(\sigma - 1)}{(\gamma - (\sigma - 1))\Lambda_j} \right) \right)
\end{aligned}$$

TO CONCLUDE, THE LABOR MARKET CLEARING CONDITION IS:

$$\begin{aligned}
 L_i = & \bar{\varphi}_{ii}^\gamma M_i \frac{\gamma(\sigma-1)}{\sigma-\gamma-1} \sum_j \left( \left( \theta_{sj}^{\alpha_i} + F_{ij} \right) \bar{\varphi}_{ij}^{-\gamma} \left( \left( \frac{\alpha_i}{\Lambda_j} \right)^{\frac{\sigma-\gamma-1}{\sigma-1}} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)^{\frac{\gamma-(\sigma-1)}{\sigma-1}} - 1 \right) \right. \\
 & \left. + \theta_{sj}^{\alpha_i} \left( \bar{\varphi}_{ij}^{-\gamma} - \hat{\varphi}_{ij}^{-\gamma} \right) \right) \\
 & + \sum_j \bar{\varphi}_{ii}^\gamma M_i \left[ \left( \sigma - 1 + \frac{\Lambda_j}{\alpha_i} \right) \frac{\alpha_i}{\Lambda_j} \frac{\gamma(\alpha_i - \Lambda_j)}{\gamma(\alpha_i - \Lambda_j) - \alpha_i(\sigma - 1)} \theta_{sj}^{\alpha_i} \hat{\varphi}_{ij}^{-\gamma} \right] \\
 & + M_i \bar{\varphi}_{ii}^\gamma f_e + M_i \bar{\varphi}_{ii}^\gamma \sum_j \bar{\varphi}_{ij}^{-\gamma} \left( \theta_{sj}^{\alpha_i} + F_{ij} \right)
 \end{aligned}$$

## B.10 WELFARE

### B.10.1 Without standards:

In [Melitz \(2003\)](#), the productivity is the average productivity  $\widetilde{\varphi}_{ij}$  which is a function of the productivity cutoff. In [Melitz and Redding \(2014\)](#), it is directly the productivity cutoff which measures welfare. Using [Melitz and Redding \(2014\)](#): Using the price index found in section [B.3.2](#).

$$\begin{aligned}
 P_j^{\sigma-1} &= \frac{\sigma \alpha_i}{\Lambda_j} \frac{\underline{\theta}_{ij}^{\alpha_i - \Lambda_j} \varphi_{ij}^{1-\sigma}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma - 1} \right)^{\sigma-1} \\
 W = P_j^{-1} &= \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\underline{\theta}_{ij}^{\frac{\alpha_i - \Lambda_j}{1-\sigma}} \varphi_{ij}^{\sigma-1}}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}}
 \end{aligned}$$

and

$$\frac{\left( \underline{\theta}_{ij}^{\alpha_i} + F_{ij} \right)}{\underline{\theta}_{ij}^{\alpha_i}} = \frac{\alpha_i}{\Lambda_j}$$

with  $\underline{\theta}_{ij}$  being the quality of the lowest productivity firm.

$$\Rightarrow W = \left( \frac{\sigma \left( \underline{\theta}_{ij}^{\alpha_i} + F_{ij} \right)}{L_j} \right)^{\frac{1}{1-\sigma}} \frac{\underline{\theta}_{ij}^{\frac{\Lambda_j}{\sigma-1}} \varphi_{ij}^{\sigma-1}}{\sigma t_{ij}} \quad (72)$$

## B.10.2 With standards

$$P_i^{-1} = \frac{\sigma-1}{t_{ij}\sigma} \left[ \frac{\sigma\theta_{si}^{-\Lambda_i}}{L_i} (\theta_{si}^{\alpha_i} + F_{ij}) \right]^{\frac{1}{1-\sigma}} \bar{\varphi}_{ij}$$

$$W_i = P_i^{-1} = \theta_{si}^{\frac{\Lambda_j}{\sigma-1}} \left( \frac{t_{ij}\sigma}{\sigma-1} \right)^{-1} \left[ \frac{\sigma}{L_i} (\theta_{si}^{\alpha_i} + F_{ij}) \right]^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ij} \quad (73)$$

I find the equivalent expression as without standard, switching the lowest quality level to export with the standard.

$$P_j^{\sigma-1} = \frac{\sigma\alpha_i}{\Lambda_j} \frac{\theta_{si}^{\alpha_i-\Lambda_j} \bar{\varphi}_{ij}^{1-\sigma}}{L_j} \left( \frac{\sigma t_{ij}}{\sigma-1} \right)^{\sigma-1}$$

$$W = P_j^{-1} = \left( \frac{\sigma\alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{si}^{\frac{\Lambda_j-\alpha_i}{\sigma-1}} \bar{\varphi}_{ij}}{L_j^{\frac{1}{1-\sigma}}} \frac{\sigma-1}{\sigma t_{ij}} \quad (74)$$

Just to check it fits:

$$\begin{aligned} & \frac{\sigma-1}{t_{ij}\sigma} \left[ \frac{\sigma\theta_{si}^{-\Lambda_i}}{L_i} (\theta_{si}^{\alpha_i} + F_{ij}) \right]^{\frac{1}{1-\sigma}} \bar{\varphi}_{ij} \\ &= \left( \frac{\sigma\alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{si}^{\frac{\Lambda_j-\alpha_i}{\sigma-1}} \bar{\varphi}_{ij}}{L_j^{\frac{1}{1-\sigma}}} \frac{\sigma-1}{\sigma t_{ij}} \\ &\iff \left[ \frac{\sigma\theta_{si}^{-\Lambda_i}}{L_i} (\theta_{si}^{\alpha_i} + F_{ij}) \right]^{\frac{1}{1-\sigma}} \\ &= \left( \frac{\sigma\alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{si}^{\frac{\Lambda_j-\alpha_i}{\sigma-1}}}{L_j^{\frac{1}{1-\sigma}}} \\ &\iff \frac{\sigma\theta_{si}^{-\Lambda_i}}{L_i} (\theta_{si}^{\alpha_i} + F_{ij}) \\ &= \left( \frac{\sigma\alpha_i}{\Lambda_j} \right)^{\frac{1-\sigma}{1-\sigma}} \frac{\theta_{si}^{\frac{(\Lambda_j-\alpha_i)(1-\sigma)}{\sigma-1}}}{L_j^{\frac{1-\sigma}{1-\sigma}}} \\ &\iff \sigma\theta_{si}^{-\Lambda_i} (\theta_{si}^{\alpha_i} + F_{ij}) \\ &= \frac{\sigma\alpha_i}{\Lambda_j} \theta_{si}^{\alpha_i-\Lambda_j} \iff \theta_{si}^{\alpha_i} + F_{ij} \end{aligned}$$

$$\begin{aligned}
&= \frac{\alpha_i}{\Lambda_j} \theta_{si}^{\alpha_i} \\
&\iff F_{ij} = \frac{\alpha_i}{\Lambda_j} \theta_{sj}^{\alpha_i} - \theta_{si}^{\alpha_i} \\
&= \theta_{si}^{\alpha_i} \left( \frac{\alpha_i - \Lambda_j}{\Lambda_j} \right) \\
&\iff \frac{\Lambda_j F_{ij}}{\alpha_i - \Lambda_j} = \theta_{si}^{\alpha_i} \quad \square
\end{aligned}$$

Then using the equation the proportion of the productivity cutoff to serve the domestic over the productivity cutoff to serve foreign markets:

$$\begin{aligned}
\bar{\varphi}_{ij}^{\sigma-1} &= \bar{\varphi}_{ii}^{\sigma-1} \left( \frac{\theta_{si}}{\theta_{sj}} \right)^{\Lambda_j} t_{ij}^{\sigma-1} \frac{(\theta_{sj}^{\alpha_i} + F_{ij})}{(\theta_{si}^{\alpha_i} + F_{ii})} \\
\bar{\varphi}_{ij} &= \bar{\varphi}_{ii} \left( \frac{\theta_{si}}{\theta_{sj}} \right)^{\frac{\Lambda_j}{\sigma-1}} t_{ij} \left( \frac{\theta_{sj}^{\alpha_i} + F_{ij}}{\theta_{si}^{\alpha_i} + F_{ii}} \right)^{\frac{1}{\sigma-1}}
\end{aligned}$$

Welfare becomes

$$\begin{aligned}
W_i = P_i^{-1} &= \frac{\sigma-1}{t_{ij}\sigma} \left[ \frac{\sigma \theta_{si}^{-\Lambda_j}}{L_i} (\theta_{si}^{\alpha_i} + F_{ij}) \right]^{\frac{1}{1-\sigma}} \bar{\varphi}_{ij} \\
&= \theta_{si}^{\frac{\Lambda_j}{\sigma-1}} \left( \frac{\sigma}{\sigma-1} \right)^{-1} \left[ \frac{\sigma}{L_i} (\theta_{si}^{\alpha_i} + F_{ii}) \right]^{\frac{-1}{\sigma-1}} \bar{\varphi}_{ii}
\end{aligned}$$

Impact of QS on welfare:

$$\begin{aligned}
\frac{\theta_{sj}}{W_j} \frac{\partial W_j}{\partial \theta_{sj}} &= \frac{\theta_{sj}}{W_j} \frac{\partial \left[ \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{sj}^{\frac{\Lambda_j - \alpha_i}{\sigma-1}} \bar{\varphi}_{ij}^{\frac{\sigma-1}{\sigma}}}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}} \right]}{\partial \theta_{sj}} \\
&= \frac{\theta_{sj}}{\left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{sj}^{\frac{\Lambda_j - \alpha_i}{\sigma-1}} \bar{\varphi}_{ij}^{\frac{\sigma-1}{\sigma}}}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}}} * \left[ \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{sj}^{\frac{\Lambda_j - \alpha_i}{\sigma-1}} \bar{\varphi}_{ij}^{\frac{\sigma-1}{\sigma}}}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}} \sigma - 1 \right]' \\
&= \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{\sigma-1}} \frac{\theta_{sj}^{\frac{\alpha_i - \Lambda_j + \sigma - 1}{\sigma-1}} \sigma t_{ij} L_j^{\frac{1}{1-\sigma}}}{\bar{\varphi}_{ij} (\sigma - 1)} \\
&\times \left[ \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\Lambda_j - \alpha_i}{\sigma - 1} \frac{\theta_{sj}^{\frac{\Lambda_j - \alpha_i - \sigma + 1}{\sigma-1}} \bar{\varphi}_{ij}^{\frac{\sigma-1}{\sigma}}}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}} + \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{sj}^{\frac{\Lambda_j - \alpha_i}{\sigma-1}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}} \sigma - 1}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}} \right] \\
&= \frac{\Lambda_j - \alpha_i}{\sigma - 1} + \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{\sigma-1}} \frac{\theta_{sj}^{\frac{\alpha_i - \Lambda_j + \sigma - 1}{\sigma-1}} \sigma t_{ij} L_j^{\frac{1}{1-\sigma}}}{\bar{\varphi}_{ij} (\sigma - 1)} \left[ \left( \frac{\sigma \alpha_i}{\Lambda_j} \right)^{\frac{1}{1-\sigma}} \frac{\theta_{sj}^{\frac{\Lambda_j - \alpha_i}{\sigma-1}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}} \sigma - 1}{L_j^{\frac{1}{1-\sigma}} \sigma t_{ij}} \right]
\end{aligned}$$

$$= \underbrace{\frac{\Lambda_j - \alpha_i}{\sigma - 1}}_{<0} + \underbrace{\frac{\theta_{sj}}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}}_{\text{ambiguous}}$$

In conclusion, the sign depends on  $\frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}$ .

$$\underbrace{\frac{\Lambda_j - \alpha_i}{\sigma - 1}}_{<0} + \underbrace{\frac{\theta_{sj}}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}}_{\text{ambiguous}}$$

Indeed:

$$\begin{aligned} & \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}} \\ &= \frac{\sigma}{\sigma - 1} \frac{1}{\sigma - 1} \left( \frac{\sigma (\theta_{sj}^{\alpha_i} + F_{ij})}{t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}} \right)^{\frac{1}{\sigma-1}} \theta_{sj}^{\frac{-\Lambda_j - \sigma + 1}{\sigma-1}} \left( -\Lambda_j + \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \alpha_i \right) \end{aligned}$$

Thus,

$$\begin{aligned} & \underbrace{\frac{\Lambda_j - \alpha_i}{\sigma - 1}}_{<0} + \underbrace{\frac{\theta_{sj}}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \theta_{sj}}}_{\text{ambiguous}} \\ &= \frac{\Lambda_j - \alpha_i}{\sigma - 1} + \frac{1}{\bar{\varphi}_{ij}} \frac{\sigma}{\sigma - 1} \frac{1}{\sigma - 1} \left( \frac{\sigma (\theta_{sj}^{\alpha_i} + F_{ij})}{t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}} \right)^{\frac{1}{\sigma-1}} \theta_{sj}^{\frac{-\Lambda_j}{\sigma-1}} \left( -\Lambda_j + \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \alpha_i \right) \\ &= \frac{\Lambda_j - \alpha_i}{\sigma - 1} + \frac{\left( \frac{\sigma (\theta_{sj}^{\alpha_i} + F_{ij})}{t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}} \right)^{\frac{1}{\sigma-1}} \theta_{sj}^{\frac{-\Lambda_j}{\sigma-1}} \left( -\Lambda_j + \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \alpha_i \right)}{\theta_{sj}^{\frac{-\Lambda_j}{\sigma-1}} \frac{\sigma}{\sigma - 1} \left( \frac{\sigma (\theta_{sj}^{\alpha_i} + F_{ij})}{t_{ij}^{1-\sigma} L_j P_j^{\sigma-1}} \right)^{\frac{1}{\sigma-1}}} \frac{\sigma}{\sigma - 1} \frac{1}{\sigma - 1} \\ &= \frac{\Lambda_j - \alpha_i}{\sigma - 1} + \frac{1}{\sigma - 1} \left( -\Lambda_j + \frac{\theta_{sj}^{\alpha_i}}{\theta_{sj}^{\alpha_i} + F_{ij}} \alpha_i \right) \\ &= \frac{\alpha_i}{\sigma - 1} \left( \frac{-F_{ij}}{\theta_{sj}^{\alpha_i} + F_{ij}} \right) < 0 \end{aligned}$$



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## DECLARATION

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*Louvain-la-Neuve/Mons, June 2023*

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Malo Beguin





