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Viola Lamani

► **To cite this version:**

Viola Lamani. International trade, trade costs and quality of traded commodities. Economics and Finance. Université de Bordeaux, 2017. English. NNT : 2017BORD0746 . tel-01686395

**HAL Id: tel-01686395**

**<https://theses.hal.science/tel-01686395v1>**

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THÈSE PRÉSENTÉE  
POUR OBTENIR LE GRADE DE

**DOCTEUR DE  
L'UNIVERSITÉ DE BORDEAUX**

ÉCOLE DOCTORALE ENTREPRISE, ÉCONOMIE, SOCIÉTÉ (ED. 42)  
SPÉCIALITÉ SCIENCES ÉCONOMIQUES

Par **Viola LAMANI**

# **International Trade, Trade Costs and Quality of Traded Commodities**

*Commerce International, Coûts à l'Échange et Qualité des  
Produits Échangés*

Sous la direction de :

M. Antoine BOUËT et Mme Charlotte EMLINGER

Soutenue le 24 Novembre 2017

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# Acknowledgments

First and foremost, I would like to thank my PhD supervisors: Antoine Bouët and Charlotte Emlinger. Your careful examinations and invaluable comments have greatly contributed to this dissertation. Thanks to your unfaltering efforts, this work has yielded a co-authored paper that has been published. Professor Bouët, you have supported me since the beginning of this journey, and pushed me to always do my best. You first gave me a “taste for research” as my professor of economic modeling and have continued to inspire me during the past four years. Charlotte, you took me in as an intern at CEPII and worked with me with great patience every day during that month. Since then, you have continuously helped me with this dissertation and I am very excited about what the future holds for our paper. Your openness, kindness and good humor have been a comfort to me, even in my moments of doubt. Both of you have helped shape me into the researcher that I am today.

I would also like to thank the members of the jury: Kym Anderson, Anne-Célia Disdier, Lionel Fontagné and Karl Storchmann who have very kindly accepted to examine this work. I have already had the opportunity to present in front of them preliminary versions of the papers in this dissertation and have greatly benefited from their many helpful comments.

I am very grateful to the *Bureau National Interprofessionnel du Cognac* for helping us from the start with the constitution of the database on Cognac exports, as well as for providing constant attention and making interesting suggestions to this work. In particular, I thank Janine Bretagne, Christakis Christodoulou, Nadia Folio, Stéphane Feuillet, Sébastien Freulon, Lionel Lalague, and Catherine Lepage. I offer special thanks to Xavier Pichot from the ITC for providing us with the data on customs protections and Houssein Guimbard from CEPII for providing us with the data from MAcMap.

I have also had the amazing opportunity to discuss my research, at the very beginning, with Daniel Bernhofen who gave me great ideas and directions for my work and very kindly provided us with the data on containerization.

The third chapter of this dissertation would not have been written without the help and efforts of Julien Berthoumieu. Julien, you have demonstrated great patience toward me and I am inspired by your work diligence. It has also been a pleasure working with you for the online course. Our thought-provoking discussions (even those not related to R&D) have always been a source of excitement, even when they led to heated debates!

This dissertation has benefited greatly from helpful suggestions from participants in LAREFI, GREThA and CEPPI seminars; AAWE, ETSG, IATRC, MAD and SFER conferences. In particular I would like to thank: Tanguy Bernard, Sophie Brana, Jason Brent, Jean-Marie Cardebat, Angela Cheptea, Matthieu Clément, Karine Latouche, Thierry Mayer, Eric Rougier, Dominique Van der Mensbrugghe, and Anne-Gaël Vaubourg. I would also like to offer special thanks to Matthieu Crozet, Sébastien Jean, and Vincent Vicard for their careful examination of the paper related to the Cognac quality mix.

Many thanks go to Cristina Badarau and Michel Dupuy for trusting me with their *travaux dirigés* and helping me to have a very pleasant teaching experience.

My research started in LAREFI and then continued in GREThA, therefore I would like to thank their respective directors, Jean-Marie Cardebat and Marc-Alexandre Sénégas for their support.

One of the main reasons that I am able today to write these pages of acknowledgments, sitting at my office in Bordeaux, is because of my family. *Laurina, Mami, Babi, Mama Eko*: a thank you would be far from enough for your unconditional love and support. Nine years ago, you gave me the opportunity to study in France and have never ceased to watch over me. You have even shared my passion of Cognac and have a very good grasp of the Alchian and Allen effect! We have always discussed our teaching and research experiences and I will always look up to you. I share a particular bond with you Laurina, thank you for always comforting me when I become a ball of stress!

During these years, I have crossed paths with many amazing people. I would like to thank in general all the PhD students of LAREFI and GREThA. In particular: Louis, Ibrahima, Thomas you were the first to welcome me in our office in Larefi when I started my PhD. We have had countless discussions and have shared many laughs (even cries a few times). A heartfelt thanks also goes to Katia, Linda, Robin, Marine, François V, Irena, Laurent, Louai, Alexandra, Clément. Jeanne and Bao, my friends and current office colleagues: thank you for the discussions, but most of all for the laughs and fun - you made it so easy especially these past few weeks. To Lionel: thank you for carefully proof-reading my conclusion and I hope I have not “traumatized” you at the beginning of your PhD journey.

Thank you Geneviève for your corrections and for always being open to discussions.

To Onigiri: we will be going our separate ways but you have demonstrated unconditional support for my work. Thank you! To my dear Sunny: a ray of light - I can't begin to describe the help and joy you have brought me (thank you of course for the corrections). Thank you Dan, Nico Y, Pierre, Thibaud, Nico B, François, Samuel, Manu for many discussions, for sharing meals (and drinks) and many dances together! Also, thank you Pierre and Riana for your great help with the French summary! A big up to Lucile, Marjorie, Jérémy, Fadoua, Pauline: you rule!

Finally, to that special someone: it started as the "pilot" of a TV series that will hopefully have many seasons. I am excited for the future and I owe it to you for encouraging me!



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# Chapter 0

## General Introduction

The increasing integration of national economies into the international economy, also known as *globalization*, is a multidimensional process, extensively studied in the economic literature and a continuous source of debate.<sup>1</sup> The reduction of *policy-related* trade barriers (tariffs, quotas etc.) and/or *natural* trade barriers (transport costs for example) is a key component of such a process. It leads to an increase in the flows of goods and services across borders and may be considered as one of the driving factors and among the most visible aspects of globalization. Indeed, according to [Jacks, Meissner, and Novy's \(2010\)](#) estimations, about 44 percent of the rise of trade observed during the first wave of globalization (1870-1913) can be attributed to reductions in trade barriers. These barriers include tariffs, transport costs and all other factors that impede international trade flows. Their estimated decrease from 1870 to 1913 is between 10 and 16 percent.<sup>2</sup> Meanwhile from 1950 to 2000, the estimated decline of international trade barriers is about 16 percent which explains 31 percent of the trade growth during this period of time ([Jacks, Meissner, and Novy, 2011](#)).<sup>3</sup>

Despite the overall downward trend observed in the past five to six decades, barriers to trade that impede the exchange of goods across borders, commonly known in the economic literature as *trade costs*, still matter.<sup>4</sup> According to [Anderson and van Wincoop \(2004\)](#) the representative estimate of total trade costs for industrialized countries is equal to 170 percent in ad valorem equivalent. This figure can be decomposed into a 74-percent ad

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<sup>1</sup>For a complete and comprehensive outlook on (economic) globalization and its pros and cons, see for example [Bhagwati \(2004\)](#).

<sup>2</sup>[Jacks, Meissner, and Novy \(2010\)](#) derive a measure for all of these barriers combined based on a micro-founded gravity model. They have data on the US, UK, France and fifteen of their most important trading partners.

<sup>3</sup>These global trends have been confirmed in a more recent empirical study by [Fouquin and Hugot \(2016\)](#) using a large database of more than 1.9 million bilateral trade observations covering the period from 1827 to 2014.

<sup>4</sup>[Anderson and van Wincoop \(2004\)](#) explain in detail why “trade costs matter” (p.691).



valorem equivalent related to international costs and a 55-percent ad valorem equivalent related to domestic (retail and wholesale distribution) costs.<sup>5</sup>

Issues related to trade costs continue to be of great interest in macroeconomics (Obstfeld and Rogoff, 2000) and in policy debates. More recently, following the economic crisis of 2008-2009 and the global slow growth registered in the past years, there has been an increase in the implementation of policy-related restrictive measures. Many governments have questioned the benefits of trade liberalization.<sup>6</sup> Evenett (2013) refers to this trend as “protectionism’s quiet return”. There may indeed be reasons for concern considering, for example that the Group of Twenty (G20)<sup>7</sup> economies implemented 145 new protectionist measures at the fastest pace since 2009 (21 new measures per month), from mid-October 2015 to mid-May 2016 (World Trade Organization, 2016).<sup>8</sup>

For all of these reasons, trade costs have been and still are the object of extensive and distinguished theoretical and empirical examinations starting from their definition, their measurement, their effects etc.<sup>9</sup> In the abundance of the economic literature on the subject, we contribute by studying the effects of trade costs on one of the key determinants of international trade patterns: *product quality*.

It is well-established in the economic literature that trade in quality-differentiated products<sup>10</sup> affects many important aspects of the economy like growth and development (Grossman and Helpman, 1991), firms’ export success (Verhoogen, 2008) and employment and wages (Verhoogen, 2008; Khandelwal, 2010). Theoretical research on the relationship between quality and trade is abundant following the seminal contributions of Krugman (1979) and Lancaster (1980), to mention only a few. However, with the exception of Linder (1961), empirical examinations of the relevance of product quality as a driver of international trade flows have proliferated quite recently. The main challenge of these em-

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<sup>5</sup>Anderson and van Wincoop’s (2004) estimates are based on direct measures (for example, from the Trade Analysis Information System - TRAINS database for 1999) and indirect measures inferred either from trade volumes and/or prices.

<sup>6</sup>Trade liberalization can be defined as the removal or reduction of policy-related barriers to trade in order to achieve “freer trade”.

<sup>7</sup>The Group of Twenty comprises: Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom, the United States of America and the European Union.

<sup>8</sup>According to the most recent report of the WTO on G20 trade measures (june 2017), 42 new trade-restrictive measures were introduced between mid-October 2016 and mid-May 2017.

<sup>9</sup>See for example Anderson and van Wincoop (2004) for a global review of the literature on trade costs.

<sup>10</sup>Products are differentiated by quality, or *vertically-differentiated* when: “[for any two distinct products], if they were sold at the same price, then all consumers would choose the same one (the ‘higher quality’ product)” (Shaked and Sutton, 1987, p. 134).

irical analyses is related to the measurement of product quality. In the first two chapters of this dissertation, we overcome this challenge by focusing on *Cognac*; a product whose quality measure is objective and invariant over time.

In chapter three we consider the quality of a firm’s product to be directly related and dependent on the *product Research and Development* (product R&D) expenditures. Our rationale for doing this is based on [Sutton \(2001\)](#) who argues “What determines the levels of attainable quality, and productivity? The list of proximate causes range from inventiveness in finding new methods of production, to the mixture of luck and judgment involved in successful product development” (p. 249). This product development and attainable quality is related to product R&D investment. More precisely, it involves the creation of new or significantly improved products. The objective of firms that engage in this investment activity is to vertically- (quality-) differentiate their products as a means to counter competition. R&D and innovation<sup>11</sup> in general are among the key drivers of competitiveness and growth ([Global Competitiveness Report for 2014-2015](#)).

**In the first and second chapters of the present work we adopt an empirical approach and concentrate on Cognac, first by studying the determinants of its trade with an emphasis on the effects of trade costs (distance and customs protection) and then, by analyzing the impact of trade costs on the quality mix (i.e. the quality structure) of Cognac exports. In the third chapter, we adopt a theoretical approach and study the impact of several policy restrictive measures (a tariff, an import quota and a quality standard) on product R&D investment.**

Before exposing in further detail the outline of this dissertation, we first discuss trade costs. Then we discuss the definition and measurement of a product’s quality. Finally, we review the literature on how trade costs affect the quality of traded products.

## 0.1 Trade Costs: A State of Evidence

Trade costs as previously defined are obstacles to international trade flows.<sup>12</sup> They are highly variable in time, across countries, sectors of economies and commodities. They also differ in nature. Different trade costs have different effects on the economy ([Anderson and van Wincoop, 2004](#)).

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<sup>11</sup>Innovation goes beyond R&D. There can be product innovation, process innovation, marketing innovation and organizational innovation (OECD).

<sup>12</sup>[Moïse and Le Bris’ \(2013\)](#) definition of trade costs is the following: “[...]the difference between the amount of trade flows that would take place in a hypothetical ‘frictionless’ world and what is actually observed” (p.6).

## 0.1. TRADE COSTS: A STATE OF EVIDENCE

Based on their nature, we distinguish between environment-related (or natural) trade costs and policy-related (or unnatural) trade costs.<sup>13</sup> The first category includes transportation, time, and other related costs. The second category includes measures that can be further categorized into *tariffs* and a larger group generally known as *non-tariff barriers* (like quotas, technical barriers to trade, sanitary and phyto-sanitary measures, to mention a few). According to [Anderson and van Wincoop's \(2004\)](#) estimates for industrialized countries, transport costs amount to 21 percent while policy-related costs are about 8 percent (in ad valorem equivalent).<sup>14</sup>

*Natural trade costs* more often, but not exclusively, refer to transport costs. According to [Hummels \(2007\)](#) “transportation costs pose a barrier to trade at least as large as, and frequently larger than, tariffs” (p. 136). He points out that while border barriers such as tariffs have been decreasing, the ratio of transport costs to the sum of tariffs and transport costs has been on the contrary, increasing.

Transport costs include freight and insurance charges incurred as a result of the shipment and delivery of goods at the destination port (or airport).<sup>15</sup> Transport costs vary largely in time, by country and commodity and their variability is comparable to that of tariffs and non-tariffs barriers ([Anderson and van Wincoop, 2004](#)). They are often assumed to have an “iceberg” form and are expressed in ad valorem terms, proportional to goods’ prices. [Hummels and Skiba's \(2004\)](#) empirical findings invalidate this assumption. Using bilateral trade data on six importers and worldwide exporters for 1994, they find that the price-elasticity of freight rates is 0.6 and conclude that shipping fees have a per-unit rather than per-value structure.<sup>16</sup>

Data on direct measures of transport costs are relatively hard to obtain especially for panels of countries<sup>17</sup>, therefore empirical investigations often rely on a proxy, usually *distance*. When examining the impact of trade costs on Cognac exports and their structure by quality we also rely on distance as a proxy for transport costs. The intuition is straightforward: higher distance between countries reflects higher transport costs. [Hummels \(1999\)](#) esti-

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<sup>13</sup>This distinction is based on [Anderson and van Wincoop \(2004\)](#) and [Bergstrand and Egger \(2013\)](#).

<sup>14</sup>Another classification of trade costs is based on whether traded goods and services incur these costs: “at-the-border”, “behind-the-border” or “beyond-the-border”. See section [A.1](#) in the global appendix for a schematic representation of trade costs based on this categorization.

<sup>15</sup>To be more precise, freight and insurance charges are *direct* costs as opposed to *indirect* transport costs related to transit, inventory and preparation for shipment of goods. The latter are hard to measure and must therefore be inferred ([Anderson and van Wincoop, 2004](#)).

<sup>16</sup>If transport costs had an iceberg form, the price-elasticity would have been equal to one.

<sup>17</sup>Measurement problems are discussed in detail in [Anderson and van Wincoop \(2004\)](#) and [Moïse and Le Bris \(2013\)](#).

mates that the elasticity of freight rates to distance is 0.27 based on bilateral data at the five-digit commodity level, for the US, New Zealand, Latin America and all of their importers.

Despite distance, transport cost also depend on shipment modes.<sup>18</sup> Whether goods move by air or ocean - the two major modes of goods transportation across borders - is an important determinant of the level of transport costs and their variation over time. Even though air shipping is growing rapidly, ocean shipping still dominates transportation modes with “99 percent of world trade by weight and a majority of world trade by value” (Hummels, 2007 p. 152). Of a particular interest to our research in chapter two is one of the major revolutions of the twentieth century in ocean shipping: *containerization*.<sup>19</sup> Indeed, Cognac has historically been linked to ocean shipping and containers have become a very important means of transport for this product.

The adoption of containerization and the advent of intermodal transport<sup>20</sup> made possible for goods to be shipped to distant destinations whether by ship, rail or truck, without the necessity of further handling when changing modes. Consequently, the overall quality of transport services improved, productivity of dock labor increased, and expenses (insurance costs for instance) decreased. The benefits associated with the introduction of containerization have been well documented<sup>21</sup>, but empirical research on its effects has been relatively scarce.<sup>22</sup> **To the extent of our knowledge, we are the first to analyze empirically the effects of containerization on the quality structure of trade flows (chapter two). More specifically, we evaluate the impact of the variation in trade costs as a result of containerization on the quality mix of Cognac exports.**

Despite our focus on transport costs, *adjacency* (i.e. sharing a common border) and being *landlocked* also fall under the category of natural trade costs. The share of world trade by value that takes place between countries that share a common border is about 23 percent

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<sup>18</sup>Limão and Venables (2001) and Hummels (2007) emphasize the importance of other factors like the quality of shipment service offered and the infrastructure level. We do not discuss them because it goes beyond the scope of the present analysis.

<sup>19</sup>The introduction of containerization might be considered as policy-related because it is “man-made”, borrowing the term from Bergstrand and Egger (2013). We do not believe this to be a relevant issue and do not discuss it further.

<sup>20</sup>Intermodal transport that was made possible following the adoption of containerization is defined as the “movement of goods (in one and the same loading unit or a vehicle) by successive modes of transport without handling of the goods themselves when changing modes” (Source: OECD).

<sup>21</sup>See for example Levinson (2006).

<sup>22</sup>A notable exception is the study by Bernhofen, El-Sahli, and Kneller (2016) who estimate the effects of containerization on world trade.

## 0.1. TRADE COSTS: A STATE OF EVIDENCE

according to [Hummels \(2007\)](#). As to being landlocked, [Limão and Venables \(2001\)](#) show that “landlocked countries on average had an import share in GDP of 11 percent compared with 28 percent for coastal economies” (p.451). Based on World Bank data, they point out that during the period from 1965 to 1990, the majority of the top exporters are island countries and none landlocked. In chapter one we estimate empirically the impact of being landlocked, as part of one of the determinants of Cognac export flows.<sup>23</sup>

Other natural trade costs that are not discussed further because they are not directly related to our research include: time, language and the overall quality of communications between countries ([Anderson and van Wincoop, 2004](#); [Hummels and Schaur, 2013](#)).

*Unnatural trade costs* include tariffs and non-tariff barriers. Tariffs are taxes implemented on an imported good. They can be *ad valorem*, defined in percentage terms relative to the value of goods, or *specific*, defined in monetary units per units of volume. According to data from World Bank’s World Integrated Trade Solutions (WITS) reported by [Bergstrand and Egger \(2011\)](#), the average ad valorem equivalent of tariffs amounts to less than 5percent for developed countries and between 10 and 25 percent for developing countries.<sup>24</sup>

Tariffs are among the most traditional policy instruments. They have been at the heart of international debates and negotiations under the Generalized Agreement on Tariffs and Trade (GATT), and then under the World Trade Organization (WTO). With the proliferation of regional economic integration agreements, tariffs have continued to decrease (on average) over time. [Hummels \(2007\)](#) notes that the average tariff rate imposed by the United States has dropped from 6.0 to 1.5 percent between 1950 and 2004.<sup>25</sup> Meanwhile during the period from 1960 and 1995, the worldwide average import tariffs fell from 8.6 to 3.2 percent ([Clemens and Williamson, 2002](#)).

In 2013 traditional forms of barriers to trade such as tariffs represented less than half of all implemented measures ([Evenett, 2013](#)). They are still relevant, if we take the automobile industry for example: in 2014 the European Union’s average ad valorem import tariff equals 10 percent according to data from the Market Access Map (MAcMap). Alcohol products such as Cognac are subject to relatively high taxation.<sup>26</sup> **In chapters one and**

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<sup>23</sup>As previously mentioned, we do not have data on transport costs. For this reason we use a proxy (distance) and we also add to our econometric estimation a variable controlling for being landlocked.

<sup>24</sup>Similar figures are reported by [Anderson and van Wincoop \(2004\)](#) based on data from the United Nations Conference on Trade and Development’s (UNCTAD’s) TRAINS.

<sup>25</sup>The weighted average tariff imposed by the US according to the latest data from the WITS database is 1.69 percent.

<sup>26</sup>In the case of Cognac, the simple average of ad valorem duties on all destination\*year pairs is 42.8 percent when 0 are included, but 76.2 percent when 0 are excluded. It is comparable to other alcohol

two we quantify the impact of tariffs on the determinants and the quality mix of this product. In chapter three we study the impact of the implementation of such an instrument on product R&D investment.

Non-tariff barriers are policy-related frictions, other than tariffs, that restrict trade flows. They are more difficult to quantify (Bergstrand and Egger, 2013). A non-exhaustive list of these measures includes: import quotas, technical barriers to trade, sanitary and phytosanitary measures, rules of origin etc. (Moïse and Le Bris, 2013). They are implemented in fewer sectors of economy compared to tariffs. For example, non-tariff barriers are widely used by developed countries in the food sector (Anderson and van Wincoop, 2004).<sup>27</sup> Disdier, Fontagné, and Mimouni (2008) show that in 2004 some countries like Australia and Mexico had a coverage ratio of technical barriers to trade and sanitary and phyto-sanitary measures (i.e. percentage of imports affected by these barriers) above 90 percent. Non-tariff barriers are also more restrictive on average. According to Kee, Nicita, and Olarreaga's (2009) estimates, non-tariff measures "add on average an additional 87 percent to the level of restrictiveness imposed by tariffs" (p. 191).<sup>28</sup>

**In the theoretical model developed in chapter three we examine the impact on the product R&D investment of a classical non-tariff measure: an import quota and a more modern instrument: a quality standard.** An import quota can be defined as a restriction on the quantity of an imported good. It might appear as an outdated policy measure, but in the automobile industry for example, data from the WTO suggest that the number of quantitative restrictions in force on automobile vehicles imports in 2015 is still high in many developed countries such as: Australia (18), Japan (12), New Zealand (8) and Switzerland (7).

A quality standard can be broadly defined as a set of specifications or requirements related to the quality of a product. It may include technical barriers to trade and/or sanitary and phytosanitary measures.<sup>29</sup> An example of the implementation of a quality standard is the ISO technical specification ISO/TS 16949 aimed at quality improvement and defect prevention in the automobile industry.

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beverages except for beer, which is taxed at significantly lower rates (see chapter one, section 1.3.2 for more details).

<sup>27</sup>According to Anderson and van Wincoop (2004), in 1999 the trade-weighted coverage ratio (i.e. the percentage of a country's imports subject to non-tariff barriers) of agriculture, forestry and fishery products for the United States is equal to 74 percent and 24 percent for the European Union.

<sup>28</sup>This figure is obtained from estimates for 78 countries of the *OTRI* index that "summarizes the impact of each country's trade policies on its aggregate imports" (Kee et al., 2009, p. 179)

<sup>29</sup>A standard is a broad concept that refers to defining and establishing uniform specifications and characteristics for products and/or services (OECD Glossary). In this dissertation we only investigate the impact of a standard aimed at enhancing a product's quality.

## 0.2 Quality: Definition and Measurement

Quality is one of the key means to counter competition in a globalized world. It is a relevant issue for firms in developed countries that are confronted with cost-advantaged firms from developing countries. Indeed, [Khandelwal \(2010\)](#) points out that “if countries are unable to exploit comparative-advantage factors to manufacture vertically superior goods, employment and output in these products are likely to shift to lower cost countries” (p. 1474).

A large amount of theoretical work followed by a relatively more recent - yet abundant - amount of empirical evidence has examined the importance of quality in international trade. In the economic literature, the concept of *quality* is not new. [Rosen \(1974\)](#) for example introduces in his framework the notion of *differentiated* products that possess a set (vector) of characteristics (attributes) that can objectively be measured. These characteristics/attributes determine the value of goods. [Leffler \(1982\)](#) gives a more clear-cut definition of quality as “the amounts of the unpriced attributes contained in each unit of the priced attribute” (p. 956). For instance, in the case of Cognac, the priced attribute is “the Cognac liquid”, while quality refers to the the age of the youngest eau-de-vie used in creating the blend. The higher the age, the higher the quality.

In more general terms, quality refers to a combination of tangible and intangible attributes/characteristics aimed at enhancing consumers’ willingness to pay for a given product ([Crinò and Ogliari, 2015](#)). It is important to note that these attributes can be *objective* or *perceived*.<sup>30</sup> Objective characteristics are inherent to goods; they can be measured and ranked. These attributes may refer to the performance, features and durability of goods ([Garvin, 1984](#)). Firms may incur increasing costs such as R&D expenditures aimed at product development or improvement in order to enhance the objective quality of their products and consumers’ willingness to pay for them ([Shaked and Sutton, 1987](#)). As previously mentioned, product R&D investment is the object of chapter three.

Perceived quality is directly related to the consumers’ perception of a product’s quality. It is therefore highly subjective and can be affected by brand name, reputation, advertising, aesthetics etc. Consumers may not choose products solely based on their “utility-bearing” characteristics, but also based on the social prestige and image these goods project upon their owner. This is the case of *status goods* defined by [Grossman and Shapiro \(1988\)](#) as “those goods for which the mere use or display of a particular branded product confers prestige on their owners, apart from any utility deriving from their function” (p. 82).

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<sup>30</sup>Quality is a complex notion. It has been studied extensively in several disciplines besides economics: management, marketing and philosophy. Section [A.2](#) of the global appendix tends to shed light, albeit very briefly, on some of the interdisciplinary aspects associated with this notion.

## 0.2. QUALITY: DEFINITION AND MEASUREMENT

Luxury goods fall under this category. The consumption of these goods may therefore be *conspicuous* and lead to a [Veblen \(1899\)](#) effect where products are purchased because they are expensive.<sup>31</sup> Cognac, for example is a luxury product and recognized as such by consumers. We discuss this point in detail in chapter one.

Evidently, it is not easy to define the quality of a product. It is also difficult to (correctly) measure it. This is the main challenge faced by researchers that undertake the endeavor of quantifying the effects of quality in international trade. Current measures of product quality in the literature can be classified in two categories: *indirect* and *direct*.

The methodology adopted by researchers who use indirect measures of product quality is either based on unit values or derived from an econometric estimation.

*Unit values* defined as the ratio between a product's value and its physical volume, have been until recently, one of the most used proxies for product quality ([Hummels and Skiba, 2004](#); [Schott, 2004](#); [Hummels and Klenow, 2005](#)). The intuition behind the use of this measure is straightforward: higher unit values indicate higher quality. While this method offers an advantage in terms of data availability at the product-country-year level, it has a major drawback: differences in unit values do not necessarily reflect differences in product quality. Indeed, higher unit values could be the result of higher production costs (manufacturing- or input-related). They could also be the result of higher margins related to market power. For these reasons, unit values are considered as an imprecise measure of product quality ([Khandelwal, 2010](#); [Hallak and Schott, 2011](#)).

Alternative indirect measures of product quality have been developed quite recently. One of the most cited was proposed by [Khandelwal \(2010\)](#). The author derives a product's quality based on a nested logit demand system. More precisely, using both unit value and quantity information, he estimates a model that captures the mean valuation that consumers attach to an imported product. Behind this method there is the following intuition: "conditional on price, imports with higher market shares are assigned higher quality" (p. 1451). The same approach is adopted by [Amiti and Khandelwal \(2013\)](#) who emphasize its advantages in terms of "accounting for differences in quality-adjusted manufacturing costs, such as wages, that could explain variation in prices" (p. 476), without additional hurdles associated to its implementation.

[Hallak and Schott \(2011\)](#) construct a price index based on trade data that they decompose into quality versus quality-adjusted-price components. Their strategy is based on the intuition that if two countries have the same prices but differ in their global trade

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<sup>31</sup>What motivates consumers' choice in terms of product quality is a vast subject. Discussing it any further goes beyond the scope of our work.



### 0.3. HOW DO TRADE COSTS AFFECT QUALITY?

balances, then their products must exhibit different quality levels: higher product quality is possessed by the country with the higher trade balance.

In recent years, most of the empirical studies have used either one of the above mentioned methods, with a notable exception by [Crozet, Head, and Mayer \(2012\)](#). They are the first to use a *direct* measure of quality when examining Champagne export flows. Their measure of quality is based on experts' (Juhlin's and Parker's) ratings. Other exceptions are [Fontagné and Hatte \(2013\)](#) and [Martin and Mayneris \(2015\)](#) who use a "mixed" approach that consists in identifying high-end products combining a direct approach based on the *Comité Colbert* list and an indirect one based on unit values.

In this dissertation we adopt a *direct* approach, therefore related to [Crozet, Head, and Mayer \(2012\)](#). Nevertheless, there is an important distinction between their procedure and ours when measuring quality. In our case, the measure of Cognac's quality is objective and invariant over time and recognized as such by the consumers.<sup>32</sup> It is not based on a subjective judgment, as it is the case for experts' ratings. All producing firms are obliged to comply with the requirements related to Cognac's quality designations under the close supervision of the *Bureau National Interprofessionnel du Cognac* (BNIC). **Based on this objective definition and direct measure of the product's quality, we evaluate empirically the effect of trade costs on Cognac's quality mix in chapter two.**

## 0.3 How Do Trade Costs Affect Quality?

The impact of trade costs, whether natural or policy-related, on the quality structure of international trade flows has been examined extensively by both theoretical and empirical studies. To the extent of our knowledge, [Alchian and Allen \(1964\)](#) are the first to contribute to this line of literature. While discussing the evidence of validity of the laws of demand in their *University Economics* textbook, the authors try to explain a seemingly intriguing pattern related to sales of grapes and oranges. They raise the following questions "[...]how does one explain the larger proportion of good quality relative to poor quality oranges or grapes sold in New York than in California? Why is a larger proportion of the good, rather than bad, shipped to New York? [...] Why are 'luxuries' disproportionately represented in international trade?" (p. 70-71 of the 1972 edition). Alchian and Allen answer these questions arguing that a per-unit charge (e.g. a per-unit shipping cost) applied to both the high and poor quality good, increases the relative price of the poor relative to high quality good. High quality grapes shipped to New York will therefore be

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<sup>32</sup>Cognac's quality designations (VS for Very Special, VSOP for Very Superior Old Pale and XO for Extra Old) to be used based on the age of the Cognac in the blend were codified by a decision of the Government Commissioner to the BNIC in 1983.

### 0.3. HOW DO TRADE COSTS AFFECT QUALITY?

relatively cheaper compared to low quality grapes than in the grape-producing state of California. As a result, consumers in New York will purchase relatively more high quality grapes than Californians. This came to be known as the *Alchian and Allen effect* which basically stipulates that per-unit transport costs increase the relative demand for higher quality goods.

Several extensions to the original Alchian and Allen theoretical framework were developed in the past decades. [Borcherding and Silberberg \(1978\)](#) and later on [Bauman \(2004\)](#) generalize the Alchian and Allen conjecture to a three- and n-good world respectively. [Falvey \(1979\)](#) examines the effects of other trade barriers (quantity and ad valorem restrictions) on the relative demand for high and low quality goods. [Razzolini, Shughart II and Tollison \(2003\)](#) question the validity of the Alchian and Allen effect under an increasing cost-industry and a monopolistic market structure. Meanwhile, [Saito \(2006\)](#) and [Liu \(2010\)](#) analyze the Alchian and Allen conjecture for various qualities.

Related theoretical research on the relationship between trade costs and the quality of exported/imported goods has shown that quantitative restrictions are likely to raise the quality of imported goods within quota categories, contrary to ad valorem tariffs which have no impact on relative prices and therefore no effect on quality ([Rodriguez, 1979](#); [Das and Donnenfeld, 1987, 1989](#); [Krishna, 1987, 1990](#)). These studies cannot be considered as a direct extension of Alchian and Allen's original conjecture, but the results produced are along the same lines.

Empirical verifications of the Alchian and Allen effect and more generally of the impact of trade costs on the quality of traded products have proliferated quite recently<sup>33</sup> due to difficulties related with finding a good measure of quality. We explained this issue in detail in the previous subsection. Indeed, most of the current empirical analyses use either proxies such as unit values ([Hummels and Skiba, 2004](#)) or parametric measures ([Curzi and Olper, 2012](#); [Curzi, Raimondi, Olper, 2015](#)) when examining the impact of trade costs on the quality structure of trade flows. A few exceptions mentioned earlier include: [Crozet, Head, and Mayer \(2012\)](#), [Fontagné and Hatte \(2013\)](#), [Martin and Mayneris \(2015\)](#). Conversely, we analyze empirically the impact of trade costs on the quality structure of Cognac export flows, based on a measure of quality that is objective and invariant over time. Thus, we are able to test if Alchian and Allen's conjecture holds in the case of Cognac, which is a luxury product.

Another important aspect directly related to product quality, as pointed out earlier on, is product development and innovation, usually in the form of product R&D investment.

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<sup>33</sup>A few exceptions include: [Aw and Roberts \(1986\)](#), and [Feenstra \(1988\)](#).

## 0.4. AN IN-DEPTH VIEW OF THE DISSERTATION

A large amount of theoretical research focuses on the impact of policy instruments on cost/reducing R&D investment (Bhagwati, 1968; Krishna, 1989; Reitzes, 1991). Meanwhile, most of the theoretical examinations on product R&D focus on identifying strategic product R&D policies (Park, 2001; Zhou, Spencer, and Vertinsky, 2002; Jinji, 2003; Jinji and Toshimitsu, 2006; Jinji and Toshimitsu, 2013; Ishii, 2014). **Our objective in the third chapter is to provide a theoretical framework that analyzes the impact of several policy instruments on product R&D, which is a key determinant of product quality.**

### 0.4 An In-Depth View of the Dissertation

In **the first chapter** of this dissertation we adopt an empirical approach in order to understand: “*What drives export flows of luxury products?*”. We examine this rather large issue focusing on Cognac using a unique database of Cognac shipments to more than 140 destinations between 1996 and 2013. We use this database to construct descriptive statistics concerning the evolution of Cognac exports during this period. More than 95 percent of this luxury product’s production is exported every year. Cognac exports have become a booming sector of the French economy; their value has reached more than 2 billion euros as of 2013. We also build a database of protectionist policies that impact worldwide Cognac exports.

We analyze the determinants of Cognac exports and focus on the effect of trade costs (distance and tariffs) based on Heckman’s (1979) procedure. We estimate successively the impact of geographical, demand and policy factors on the extensive margin of trade (i.e. the volume of trade) and the intensive margin of trade (i.e. the probability of trade). We also control for the possibility of an endogeneity bias on the probability of trade. We show that, as with other luxury products, the elasticity of Cognac exports to distance is negative, significant, and relatively small, while the elasticity to GDP is positive, significant, and relatively large. We also find that average customs duties do not have a significant impact on the intensive margin, but impact significantly and negatively the probability of trade. We obtain this last result after correcting for the endogeneity bias using tax revenues of importing countries in percentage of GDP as an instrument. Our main contribution to the existing literature is to provide evidence - which up until now, to the extent of our knowledge, has been relatively scarce - of the impact of trade costs on high-end/luxury products exports.

In **chapter two**, we raise the following questions: “*How do trade costs affect the quality mix of exported products? Does the Alchian and Allen conjecture hold from an empirical point of view?*” We answer these questions using our database of French Cognac exports.

More specifically we estimate the impact of trade costs on the share and relative price of high quality Cognac. The definition and measure of Cognac quality is based on the minimum time in oak of the youngest eau-de-vie used in creating the blend, and it is objective and invariant in time. It is therefore particularly relevant to study Cognac in order to analyze the impact of different trade costs on the quality mix.

Our estimation proceeds in two parts. First, we investigate to what extent distance and customs duties impact the Cognac quality mix from 1996 to 2013. Second, we assess the impact of a variation in trade costs, through the adoption of containerization, on the quality mix of Cognac exports between 1969 and 2013. To the extent of our knowledge, this is the first study to quantify the impact of containerization on the quality structure of trade flows. Our results confirm the Alchian and Allen effect: per-unit trade costs increase the share of high-quality Cognac and have the opposite impact on its relative price. We contribute to the existing literature in several aspects: i) we validate empirically the Alchian and Allen effect based on a direct and physical rather than perceived definition and measure of product quality; ii) we assess empirically the impact of customs protection on trade flows by quality by distinguishing between per-unit and ad valorem tariffs; and iii) we evaluate empirically the impact of the time variation of trade costs through containerization during a long time-span covering forty-seven years of Cognac export flows by quality.

In **the third chapter** of this dissertation, we develop a theoretical framework in order to examine: “*What is the impact of the implementation of trade policy instruments on product R&D investment?*” This issue is channeled through a model of a North-South duopoly where a Northern firm competes in prices with a Southern firm on both markets. The Northern firm invests in product R&D owing to a competitive disadvantage compared to the Southern firm which benefits from a lower labor cost. The outcome of the R&D activity is uncertain. If successful, vertical differentiation occurs in both markets. Our framework relates to an empirical example, for instance the mobile phone industry where firms continuously invest on product R&D, especially at the beginning of their products’ lifecycle. In the past decade handset manufacturing firms from Northern countries (Apple for example) that export their finished goods to foreign markets, have been facing growing competition even in their local markets from firms in emerging countries (Huawei, OPPO and vivo, for example). Another example comes from the automobile industry, where competition in Northern countries from firms like India’s Tata and Maruti Suzuki is increasing rapidly.

In our model we assume that the Northern country’s government is the only one to be policy-active and can implement the following trade policy instruments: an import tariff,

#### 0.4. AN IN-DEPTH VIEW OF THE DISSERTATION

an import quota and a quality standard. The results show that the Northern firm's R&D expenditures increase with each policy instrument except for the import quota. This chapter also provides a welfare analysis based on numerical simulations in order to verify whether or not the Northern government is encouraged to implement these policy instruments. Our results suggest that the Northern country's government would favor the implementation of an import tariff. By this means, the domestic expected profit, consumer surplus and public revenues could increase. We contribute to the existing literature by developing a cost-asymmetric theoretical framework and studying the impact of *several* policy instruments on product R&D investment. Another contribution is introducing uncertainty with respect to the outcome of the product R&D investment.

# Chapter 1

## What Determines Exports of Luxury Products? The Case of Cognac<sup>1</sup>

### 1.1 Introduction

In recent decades, Cognac exports have become a booming sector of the French economy. Cognac brandy<sup>2</sup> is produced in a limited region but was sold in over 140 countries in 2013; more than 95 percent of France’s total Cognac production is exported every year. In 2013, 441 thousand hectoliters of pure alcohol (HL PA) were shipped worldwide. The value of Cognac shipments in real terms has quadrupled in the past forty-seven years reaching over 2 billion euros (current) as of 2013.

International trade has been a historical priority for the Cognac region for ten centuries. Wine production started in the region in the Middle Ages, and the river Charente (nicknamed “the Walking Path” by the Romans) offered a unique way to transport products to the Atlantic Ocean and to northern Europe, particularly the Netherlands. The birth of Cognac brandy is also associated with international trade. Because the low-alcohol wine coming from the Cognac region did not keep well during its transportation to northern Europe, the Dutch decided to distill the product and then mix it with water for consumption at its destination; thus, the brandy known as Cognac was born. Today more

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<sup>1</sup>This chapter is an extended version of the paper written with Antoine Bouët (GREThA, University of Bordeaux and IFPRI) and Charlotte Emlinger (CEPII), and published in *Journal of Wine Economics* (Bouët, Emlinger, and Lamani, 2017).

<sup>2</sup>French and English-speaking countries do not use the same definitions of these products. We adopt here the following definition, close to the one of English-speaking countries. Brandy is a distilled beverage made from wine (Cognac, Armagnac). *Eau-de-vie* is a distilled beverage made from fruit other than grape (Calvados, Poire, ...). Spirit or liquor is an alcoholic beverage obtained from distillation and includes brandies, *eaux-de-vie*, but also vodka (made from cereals grains or potatoes), gin (from juniper berries), whiskey (grains like barley, corn, rye and wheat), rum (sugarcane) ...

## 1.2. REVIEW OF LITERATURE

than 440,000 HL PA, equivalent to more than 157 million bottles, are exported worldwide.<sup>3</sup>

What are the reasons behind Cognac's success story? The objective of this chapter is to identify the determinants of Cognac exports using a unique database covering Cognac shipments in volume to more than 140 destinations from 1996 to 2013<sup>4</sup> and a database on customs protection on brandy. We use these two resources to estimate the impact of geographical, demand, and policy factors on the Cognac trade.

Our contribution is twofold. First, we use this unique database to estimate the determinants of Cognac exports based on Heckman's (1979) procedure, which allows us to analyze the impact of different determinants on the probability of trade to a destination and on the intensity of that trade. Second, by emphasizing the impact of customs protection on the Cognac trade, we provide evidence - which up until now, to the extent of our knowledge, has been relatively scarce - of the impact of trade costs on luxury and/or alcohol products.

We find that all covariates have the expected impact on Cognac exports, except for the impact of the average customs duties on the probability of trade (extensive margin). Correcting for an endogeneity bias using an instrumental variable (IV) estimation method, we find that protectionist measures have a significant negative impact on the extensive margin. The robustness of these results is tested by adopting a different measure of the importer's average customs duties and by using alternative estimation methods.

This Chapter is structured as follows. We review the related literature in section 1.2. Section 1.3 presents the database of Cognac exports along with a database on worldwide customs protections on Cognac. We also present some stylized statistics on the evolution of Cognac exports. In section 1.4 we describe our econometric strategy, present our results and conduct robustness checks. Section 1.5 presents our conclusions.

## 1.2 Review of Literature

Our work is directly related to the literature on the determinants of sales and exports of luxury and alcohol products.

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<sup>3</sup>The first Cognac House, *Augier*, was created in 1643. There are today 353 Cognac Houses, the most important are: Hennessy (42.1 percent of all bottles sold worldwide in 2014), Martell (14.8 percent), Rémy Martin (14.0 percent) and Courvoisier (10.9 percent). These four houses concentrate most of the total production of the brandy (around 81.8 percent in volume terms in 2014). All these figures are from Sud-Ouest - April 11, 2015.

<sup>4</sup>Data on worldwide Cognac exports are available for the period from 1967 to 2013. But in this chapter, we focus on the period from 1996 to 2013 because our econometric estimation needs data on customs duties, only available during these latter years.

Indeed, Cognac is a luxury product. Cognac VS (for Very Special, meaning that it is at least two years old) was sold at prices ranging from 25 euros to 45 euros per bottle in 2015, Cognac VSOP (for Very Superior Old Pale, meaning that it is at least four years old) was sold at prices ranging from 32 euros to 57 euros per bottle in 2015; and Cognac XO (for Extra Old, meaning that it is at least six years old), the highest quality of Cognac, was sold at prices ranging from 45 euros to 94 euros per bottle in 2015.

Important Cognac Houses, (e.g., Martell and Rémy Martin) belong to the famous *Comité Colbert*, an association of seventy-five French luxury brands founded in 1954 by Jean-Jacques Guerlain for the sole purpose of promoting the concept of luxury. Finally, it is worth noting that spirits are generally classified as a luxury good by studies estimating the income elasticity of demand. Fogarty (2010, p. 450-451) conducts a meta-analysis of the demand for alcohol literature, finding that “spirits income elasticity estimates range from -0.29 to 2.52 with a mean of 1.15 and a median of 1.24.” He concludes that “beer is a necessity, spirits are on balance a luxury”.<sup>5</sup>

The literature focusing on the relationship between quality and trade is quite large. Interestingly, Crozet, Head, and Mayer (2012) present it along three axes:

1. *Studies that investigate the attributes of countries that trade higher quality goods.* For example, Matsuyama (2000) develops a Ricardian model of trade (one factor, perfect competition, no return to scale, international differences in technology) with nonhomothetic preferences. Rich countries export products of the higher spectrum of goods with higher income elasticities. Choi, Hummels, and Xiang (2009) investigate how differences in income distribution within and across countries affect patterns of consumption and international trade in goods differentiated by quality. They base their theoretical model on Flam and Helpman (1987) to obtain a mapping wherein prices of imported goods rise with household income. These two references are useful contributions to explain international trade in goods differentiated by quality but their main focuses are to relate the unit value of imported goods to income distributions; here we evaluate the determinants of the volume of trade in high-quality goods. Hummels and Klenow (2005) find that quality increases with exporters’ per-capita. Hallak (2006) designs an empirical framework to study the role of quality in trade patterns and concludes that rich countries tend to import relatively more from countries that produce high-quality goods. Fajgelbaum, Grossman, and Helpman (2011) develop a framework for studying international trade in

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<sup>5</sup>For Nelson (2013) income elasticity of demand for spirits is closer to 1. However, within the group of spirits, income elasticity may vary between vodka, rum and Cognac in particular. We cannot provide herein a similar estimation of the income elasticity because Nelson’s estimations are based on household surveys, while ours are built on a gravity-like framework.



## 1.2. REVIEW OF LITERATURE

varieties and qualities with nonhomothetic preferences and study the pattern of trade between countries that differ in size and income distributions. Their main conclusion is that trade derives from a home market effect.

2. *Studies, based on product-level trade data, that test the implications of models of firm-level heterogeneity in quality.* For example, [Johnson \(2012\)](#) estimates a heterogeneous firm trade model based on disaggregated data on export values and prices. He concludes that high-productivity firms produce and export high-quality goods and charge high prices.
3. *Studies that confront firm-level theories with firm-level data.* [Manova and Zhang \(2012\)](#) use a new database on Chinese firms participating in international trade between 2003 and 2005, concluding that more successful exporters use higher-quality inputs to produce higher-quality goods and that the range of export prices offered by a firm varies significantly with the number of destinations.

[Crozet et al. \(2012\)](#) should certainly be classified in the third axis. They match firm-level export data with a quality ranking conducted by an expert in order to estimate the key parameters of [Melitz's \(2003\)](#) model, interpreted in terms of quality. They base their estimation on data on Champagne, which makes this study close to ours, even if we do not study quality sorting in this chapter.

Other empirical literature, specifically on international trade in high-quality products is much smaller. Based on a world database of trade flows, [Fontagné and Hatte \(2013\)](#) assess quality by high unit values and identify 416 high-quality products by a study of the distribution of unit values between 1994 and 2009. Exports of high-quality products - particularly of high-quality French goods - are less sensitive to distance than other products, but they are more sensitive to the per-capita gross domestic product (GDP) of the destination country. [Martin and Mayneris \(2015\)](#) find a null effect of distance and a positive effect of the importer's per-capita GDP on the export of high-quality products by French firms. They confirm the relatively low elasticity (in absolute value) of these exports to distance and the relatively large elasticity to per-capita GDP. This low distance-elasticity implies more geographic diversification.

Very few studies analyze the impact of trade costs on trade of luxury and/or alcohol products. [Dal Bianco et al. \(2016\)](#) conduct an estimation of a gravity equation for wine and find that coefficients of tariffs are negative in all specifications. In their preferred estimation (PPML) the elasticity of trade to tariffs is -0.472. For [Raimondi and Olper \(2011\)](#), trade in spirits is negatively and significantly responsive to tariffs, but less (in absolute value) than trade in wine or soft drinks. The elasticity of trade to tariffs ranges

from -1.0 to -2.1 across methodologies concerning spirits, from -1.4 to -8.4 concerning wine, and from -3.0 to -5.1 concerning soft drinks.

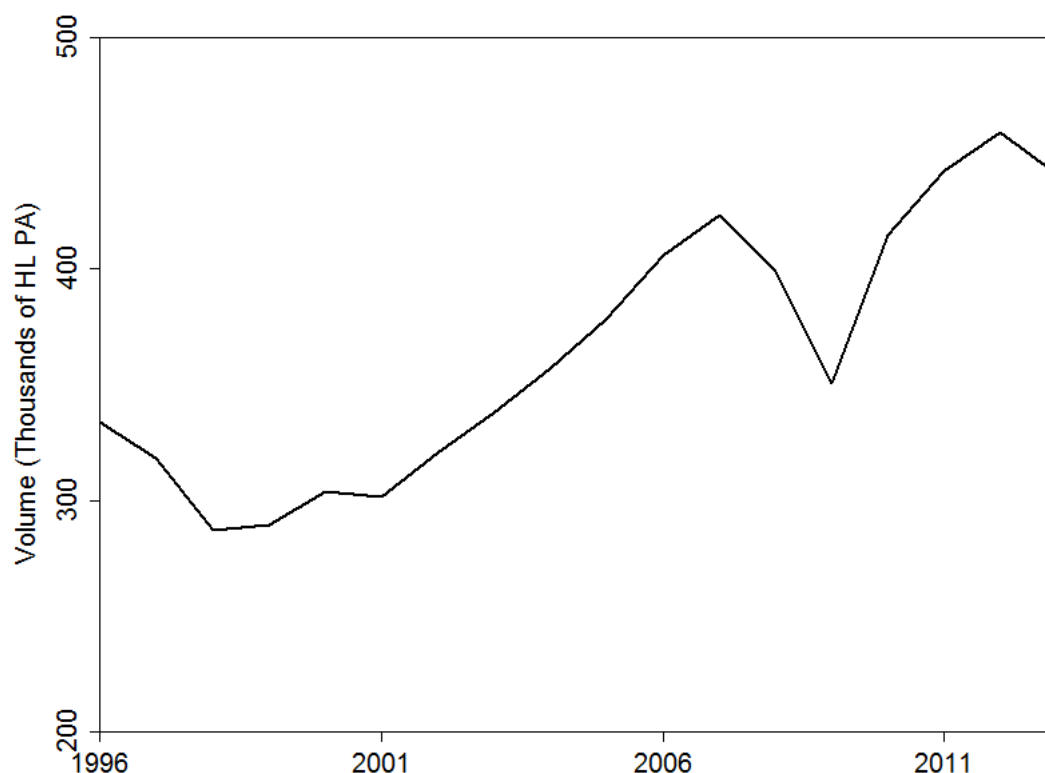
## 1.3 Data and Descriptive Statistics

Two specific databases have been constructed for this research: the first on worldwide Cognac exports over an eighteen-year period and the second on customs protections on Cognac from 1996 to 2013.<sup>6</sup>

### 1.3.1 Cognac Sales and Export

Raw data regarding Cognac exports by year and destination have been provided by the *Bureau National Interprofessionnel du Cognac* (the BNIC). We use information on Cognac shipments to more than 140 destinations from 1996 to 2013.

**Figure 1.1 – Evolution of Total Cognac Shipments from 1996 to 2013**



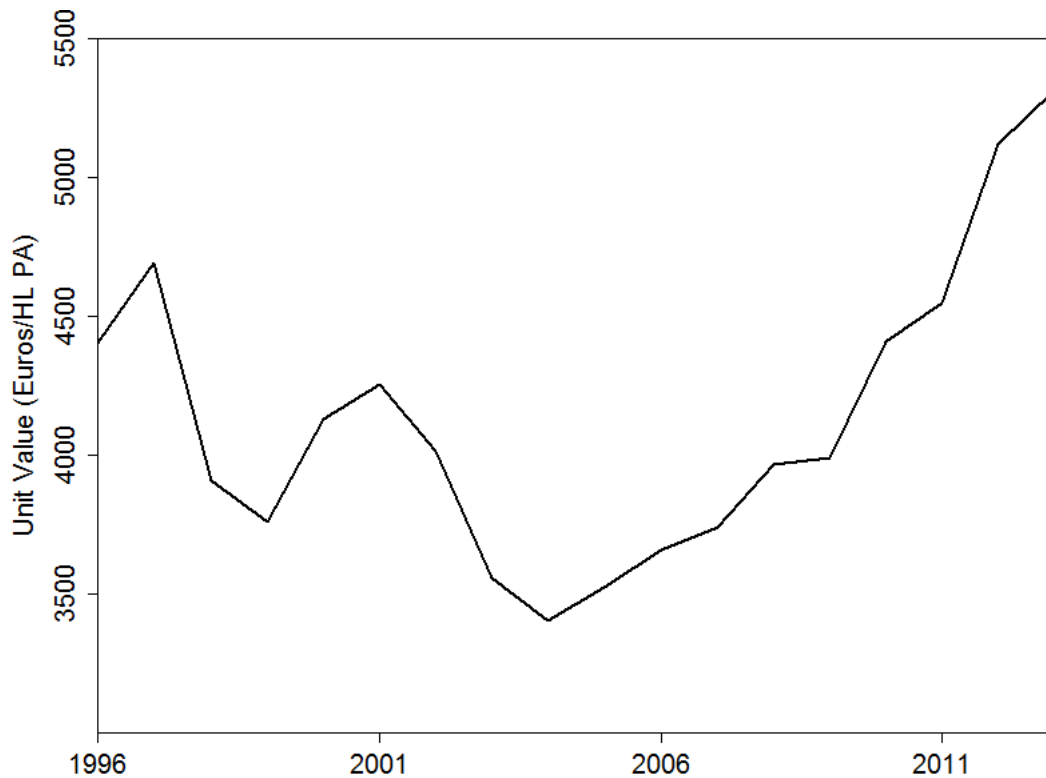
Source: authors; raw data from BNIC.

<sup>6</sup>Our database on Cognac shipments covers a larger period: 1967-2013. Sections A.3 and A.4 of the global appendix provide respectively, details on the compilation of this 47 year-long database and some stylized facts on the evolution of Cognac shipments from 1967 to 2013. In this chapter we focus on the period from 1996 to 2013 because customs protection data are not available before 1996.

### 1.3. DATA AND DESCRIPTIVE STATISTICS

Figure 1.1 presents the evolution of total shipments, in volume, of Cognac from 1996 to 2013. Over these eighteen years, the volume of foreign shipments increased by 32 percent. As shown by Figure 1.1, Cognac exports increase steadily during the first half of the 2000s until the financial crisis in 2007-2008. Global sales recover by 2010.

**Figure 1.2 – Evolution of the Export Unit Value of Cognac from 1996 to 2013**

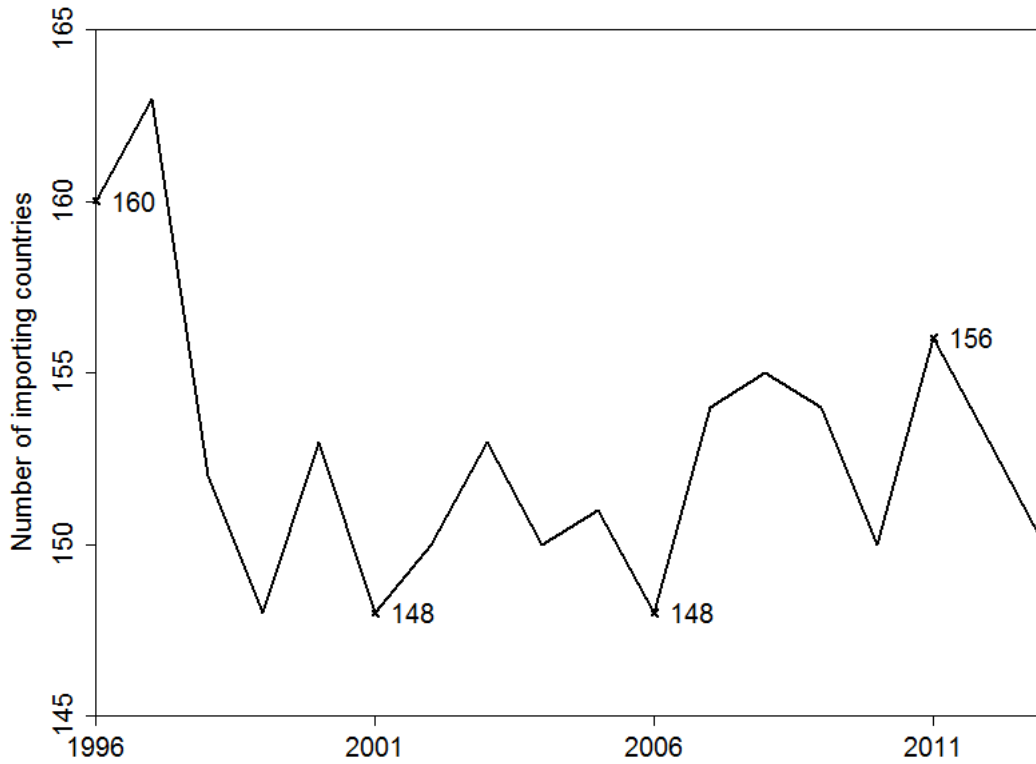


Source: authors; raw data from BNIC.

In 1996, the export unit value of Cognac is 4,402 euros/HL PA. Despite the ups and downs, it increases by 21 percent between 1996 and 2013, reaching more than 5,313 euros/HL PA in 2013 (Figure 1.2). The average export unit value of Cognac during this period is more than 4,133 euros/HL PA.

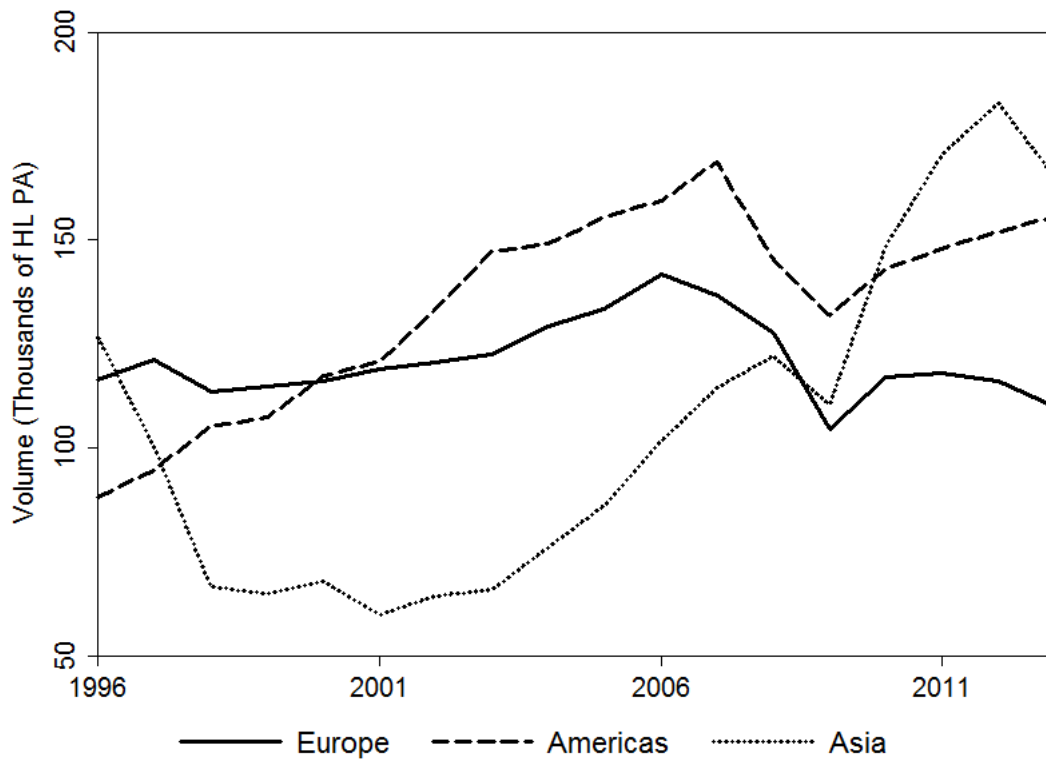
In 1996, Cognac was shipped to 160 countries. As shown in Figure 1.3, the number of importing countries decreases to 150 in 2013. The concentration of destination markets over time could be attributed to political factors, as some countries, particularly in Africa have experienced episodes of internal armed conflicts during the period we are examining (e.g., Chad, Libya, Syria and Uganda). These countries consecutively interrupted their imports of Cognac. Other countries that ceased to import Cognac are small and by nature volatile in terms of imports (e.g., Guyana, Northern Mariana Islands, Vanuatu, Wallis and Futuna).

Figure 1.3 – Number of Destinations of Cognac Exports from 1996 to 2013



Source: authors; raw data from BNIC.

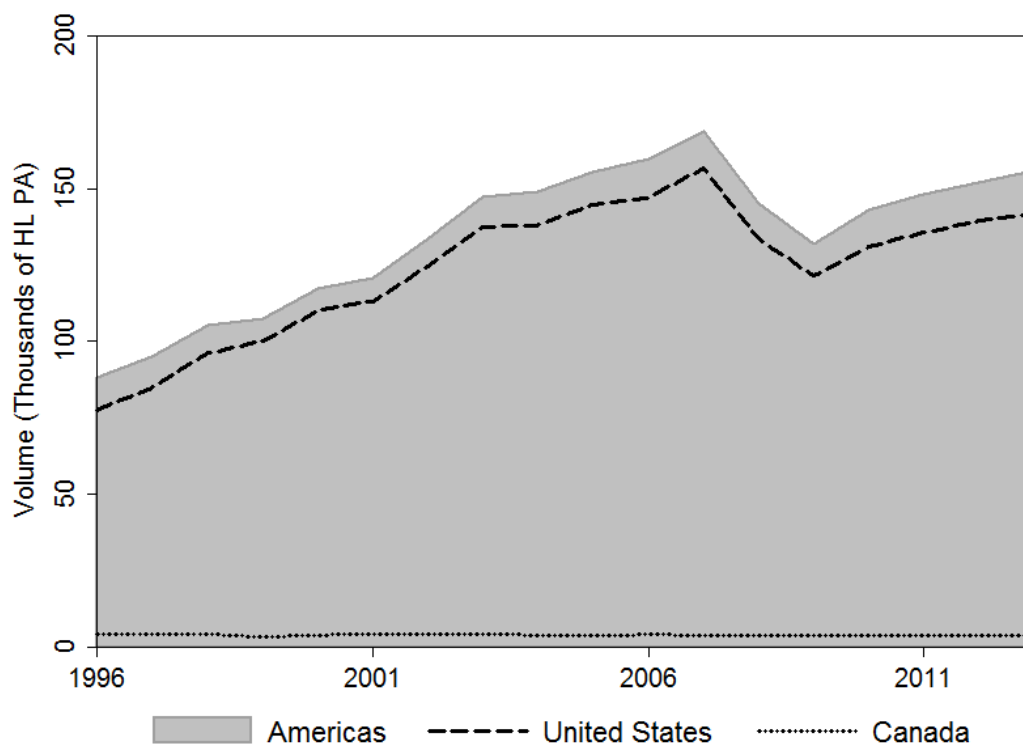
Figure 1.4 – Cognac Exports by Continent from 1996 to 2013



Source: authors; raw data from BNIC.

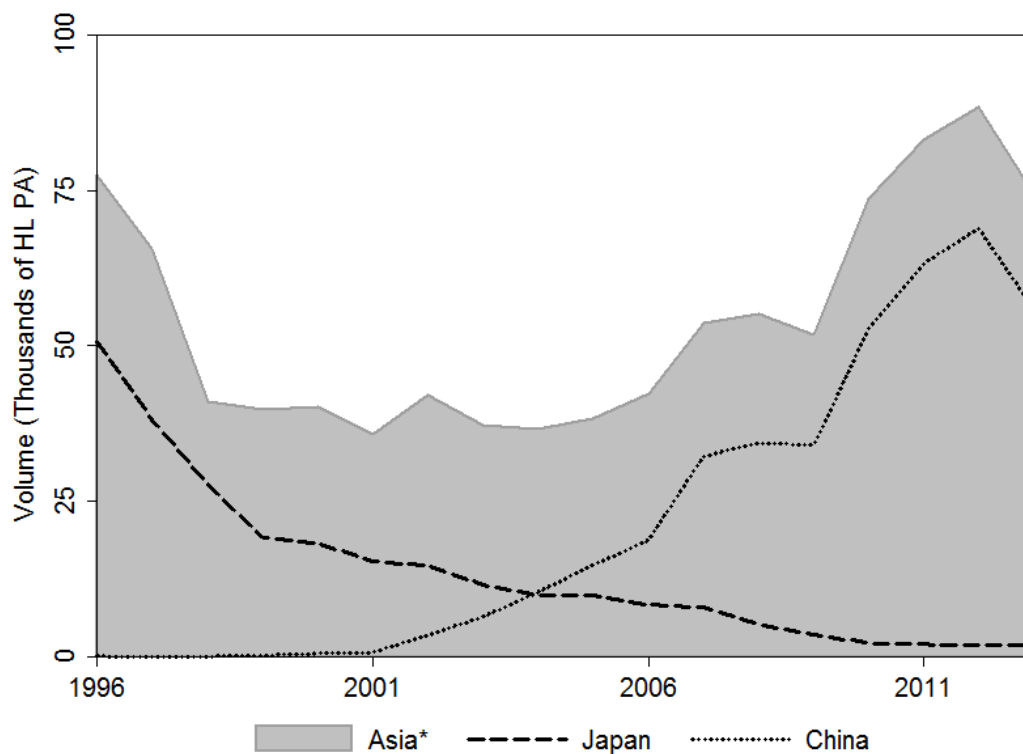
### 1.3. DATA AND DESCRIPTIVE STATISTICS

Figure 1.5 – Evolution of Cognac Exports to the Americas from 1996 to 2013



Source: authors; raw data from BNIC.

Figure 1.6 – Evolution of Cognac Exports to Asia\* (Singapore and Hong Kong excluded) from 1996 to 2013



Source: authors; raw data from BNIC.

Europe has long been the center of Cognac consumption. In the eighteenth century, the first exports of Cognac were sent to England and northern Europe. Nevertheless, as shown in Figure 1.4, since the beginning of the twenty-first century, the American and then the Asian markets have become the most dynamic destinations for Cognac sales.

Figure 1.5 shows the evolution of Cognac exports to the Americas between 1996 and 2013. The United States has always been by far the main destination on this continent; Cognac exports to Canada and Latin America have been quite marginal.

In 2010, Asia became the top Cognac-importing continent. It is worth noting that Cognac exports to Japan have continuously declined since the second half of the 1990s (see Figure 1.6). Exports to China, meanwhile, have substantially increased, making this destination a current priority for Cognac houses. Meanwhile, Africa and Oceania are only marginal destinations for Cognac exports, with less than 10,000 HL PA (around 3.6 million bottles) each.

### 1.3.2 The Protection Database

Two types of customs instruments restrict worldwide exports of Cognac: ad valorem duties (duties defined in percentage) and specific duties (defined in monetary units by units of volume). In the study, we do not take into account domestic fiscality and in particular consumption taxes levied on Cognac sales.<sup>7</sup>

Information on ad valorem and specific customs duties comes from the International Trade Centre. While ad valorem duties were easy to treat, the only difficulty being the identification of the trade regime, most-favored-nation (MFN) or regional, we met several difficulties in the treatment of specific duties. First, we converted all monetary amounts to euros using annual averages of daily exchange rates observations from fxtop.com.<sup>8</sup> Second, the units of volume used in defining specific duties were harmonized to hectoliters of pure alcohol. Specific duties were either defined by hectoliter, by hectoliter of pure alcohol, by liter, or by liter of pure alcohol. We also met gallons under several definitions, in particular either US gallons or imperial gallons.<sup>9</sup> Specific duties are sometimes applied

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<sup>7</sup>Available data at our disposal on excise duties cover only Organisation for Economic Co-operation and Development (OECD) countries and a period of five years. Due to the small number of observations, we do not include these data in any estimation.

<sup>8</sup>Whenever fxtop.com data are missing, we resort to annual averages of midpoint daily rates from oanda.com

<sup>9</sup>The imperial gallon is defined as 4.54609 liters, and it is used in the United Kingdom, Canada, and some Caribbean nations; the US gallon is defined as 3.785 liters and it is used in the US and some Latin American and Caribbean countries.

### 1.3. DATA AND DESCRIPTIVE STATISTICS

on “per proof” gallons or liters.<sup>10</sup>

Table 1.1<sup>11</sup> indicates the summary statistics from this database, covering eighteen years and more than a hundred importing countries. It shows that customs protections on Cognac exports are very high. The simple average of ad valorem duties on all destination\*year pairs is 42.8 percent when 0 are included, but 76.2 percent when 0 are excluded. The highest ad valorem duty is 3,000 percent, which is still assessed in Egypt as of 2015.

**Table 1.1 – Worldwide Customs Protection on Cognac: Statistics for more than 100 Importing Countries, 1996-2013**

	<i>AV Duty</i>	<i>AVE of Spec. Duty</i>	<i>Global AVE I</i>
Min	0.0 %	0.0 %	0.00%
Max	3,000 %	129.6%	3,000 %
Simple Average	42.8 %	3.3 %	46.1 %
Median	10 %	0 %	17.1 %
Simple Average (0 excl.)	76.2%	21%	64.7%

AV = Ad Valorem; AVE = Ad Valorem Equivalent; excl. = excluding.

Source: authors; raw data from ITC.

Note that Table 1.1 shows the average world protection on line HS6 220820: Spirits obtained by distilling grape wines or grape marcs (grape brandy).<sup>12</sup> Therefore this line mainly concerns Cognac. The world average customs duty on this line does not differ much from the one on other alcoholic beverages, except for beer, which is taxed at significantly lower rates (see Graph 1.7 in the appendix to chapter one).<sup>13</sup> Protection is already high on mineral waters, sodas, fruit and vegetable juice (lines 220110 to 220290), lower on vinegar (220900), and very high on alcoholic beverages (220300 to 220890). Consequently, protection on brandies is comparable to protection on other alcoholic beverages.

The simple average of specific duties in ad valorem equivalent, is 3.3 percent. To estimate

<sup>10</sup>A proof gallon is one liquid gallon of spirits that is 50 percent alcohol at 60 degrees Fahrenheit. So distilled spirits bottled at 80 proof (40 percent alcohol) are 0.8 proof gallons per gallon of liquid.

<sup>11</sup>The statistics displayed in Table 1.1 are calculated for the period from 1996 to 2013 and for countries that have registered positive Cognac trade flows.

<sup>12</sup>HS stands for *Harmonized Commodity Description and Coding Systems*, an international nomenclature for the classification of products. All countries use the same classification up to the six-digit level, the most specific one, of the HS (Source: United Nations Trade Statistics).

<sup>13</sup>Data on the world average customs duties (in *ad valorem* equivalent) for chapter 22 - Beverages, spirits and vinegar - of the HS6 nomenclature come from the MAcMap Database.

ad valorem equivalents of specific duties (column 3) we divide the specific duty by the yearly average unit value. We take the annual average unit value and not the bilateral unit value to avoid an endogeneity bias; high specific duties could lead to a change in the composition of the quality exported to decrease protection in relative terms. The last column of Table 1.1 indicates a global average by adding the different elements of customs protections. National customs protections on Cognac vary from 0 percent to 3,000 percent.

## 1.4 Econometric Estimation

In this section, we first detail our empirical strategy. Then, we present and discuss our results and conduct robustness checks.

### 1.4.1 Empirical Strategy and Data

Our evaluation of the determinants of Cognac exports is based on a gravity equation.<sup>14</sup> In this model, exports depend on demand (usually proxied by the GDP of importing country), supply (GDP of exporting country) and trade costs (tariffs and transportation costs proxied by distance and other geographical and historical factors).

Our equation presents specific features. First, as we perform estimations only on French exports, we do not need the exporter's GDP; supply can be controlled using time-fixed effects.

Second, we add importer's per-capita GDP and religious factors to take into consideration the characteristics of Cognac demand, as a luxury product and an alcoholic beverage.

Third, [Anderson and van Wincoop \(2003\)](#) recommend using relative trading costs in the gravity equation rather than absolute trading costs. In our specification, we do not need to construct a relative distance indicator and relative protection rate since all exports are from France.

Fourth, following [Helpman, Melitz, and Rubinstein \(2008\)](#), we consider the case where the sample of destinations of Cognac exports is nonrandom. In such a case conventional estimators, such as ordinary least squares (OLS), applied on a sample of nonzero exports would be biased; thus, it is best to adopt [Heckman's \(1979\)](#) procedure to correct the sample selection issue. In our case, a right selection variable is the armed conflict variable, a dummy equal to one if importing countries have experienced internal armed conflicts in

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<sup>14</sup>See [Head and Mayer \(2014\)](#) for a complete presentation.



## 1.4. ECONOMETRIC ESTIMATION

a given year. We explain in section 1.3.1 that many countries that have ceased importing Cognac have experienced episodes of internal armed conflict.

Let  $Q_{jt}$  be the volume of Cognac exported to country  $j$  at year  $t$ . We estimate the following equation, using Heckman’s (1979) procedure:

$$\begin{aligned} \ln(Q_{jt}) = & \alpha_0 + \alpha_1 \ln(Y_{jt}) + \alpha_2 \ln(y_{jt}) + \alpha_3 \ln(d_j) + \alpha_4 \ln(e_{jt}) \\ & + \alpha_5 \ln(AVE_{jt}) + \alpha_6 Ll_j + \alpha_7 Rel_j + \alpha_8 Conflict_{jt} + \nu_t + u_{jt} \end{aligned} \quad (1.1)$$

where  $Y_{jt}$  is country  $j$ ’s GDP at year  $t$ ,  $y_{jt}$  is the per-capita GDP of country  $j$  at year  $t$ ,  $d_j$  is the distance from France to country  $j$ ,  $e_{jt}$  is the nominal exchange rate of country  $j$ ’s currency against the euro,  $AVE_{jt}$  is the global average customs protection on brandy<sup>15</sup> (ad valorem equivalent), implemented by country  $j$  at year  $t$  (see section 1.3.2).

Other variables are dummies:  $Ll_j$  is a dummy taking the value 1 if country  $j$  is landlocked,  $Rel_j$  is a dummy taking the value 1 if fifty percent or more of country  $j$ ’s population is Muslim,  $Conflict_{jt}$  is a dummy taking the value 1 if country  $j$  has been involved in an internal armed conflict or internationalized internal armed conflict<sup>16</sup> in year  $t$  that resulted in at least one thousand battle-related deaths in that given year. Finally,  $\nu_t$  are time fixed effects and  $u_{jt}$  is the error term.<sup>17</sup>

Data on each country  $j$ ’s GDP and per-capita GDP are in constant 2005 U.S. dollars and were retrieved from the World Bank’s World Development Indicators DataBank. Nominal exchange rates are annual averages of daily observations from fxtop.com,<sup>18</sup> and we use Centre d’Études Prospectives et d’Informations Internationales’ (CEPII’s) weighted bilateral distance measure (in kilometers). The variables  $Ll_j$  and  $Rel_j$  are from CEPII

<sup>15</sup>HS6 220820: Spirits obtained by distilling grape wine or grape marc.

<sup>16</sup>The definition of *armed conflict* used here is given by the Uppsala Conflict Data Program (UCDP): “An armed conflict is a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths in one calendar year.” For more information on the definition and type of conflict see the UCDP/PRIO Armed Conflict Dataset Codebook1, version 4-2015; Gleditsch et al. (2002) and Pettersson and Wallensteen (2015).

<sup>17</sup>We use a gravity equation based on a standard approach in which products are considered to be normal goods, and we implicitly assume that income distribution within a country plays no role in the aggregate demand. To control for this assumption, we include the Gini index of the importing country. Data are retrieved from UNU-WIDER’s, World Income Inequality Database (WIID3c), September 2015. However, including this variable considerably reduces the size of the sample and yields biased estimation results. These results and further details on the sample bias are provided in the appendix to chapter one, section 1.A.

<sup>18</sup>Whenever fxtop.com data were missing, we resorted to annual averages of midpoint daily rates from oanda.com

and the CIA Factbook respectively.<sup>19</sup> Data on armed conflicts are retrieved from the UCDP/PRIO Armed Conflict Dataset v.4-2015.

Summary statistics of the aforementioned variables and the list of all importing countries in 2013 are provided in the appendix to chapter 1, Tables 1.10 and 1.11 respectively.

Equation 1.1 was estimated for the period 1996 – 2013.

## 1.4.2 Results

The top and bottom of Table 1.2 report the results of the estimation of equation 1.1, using Heckman’s (1979) procedure. The Wald test on the independence of equations suggests the presence of a selection bias.

In column 1 we use the full panel of importing countries. As the international Cognac trade is characterized by a high level of re-exportation from a limited number of countries (Hong Kong, the Netherlands, Panama, Singapore and United Arab Emirates; list provided by the BNIC), in column 2 of Table 1.2, we conduct a robustness test by excluding these destinations. The re-exporting status of these destinations has been confirmed by an analysis of their alcohol consumption.<sup>20</sup>

“Traditional” gravity variables have significant coefficients with the expected sign: the importing country’s GDP has a significant and positive impact on Cognac exports, whether on the probability of trade (the extensive margin) or the trade volume (the intensive margin). Distance, on the other hand, has the opposite effect, both on the probability of trade and on the trade volume.

The per-capita GDP of the destination country has a positive impact both on the extensive and intensive margins of trade. Being landlocked acts as a trade barrier, restricting both the positive trade volume and the probability of trade. The dummy variable controlling for religious factors in the destination markets has a negative impact on the extensive and intensive margins.

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<sup>19</sup>The list of Muslim-majority countries with the corresponding date of information according to the CIA Factbook is provided in the appendix to chapter 1, Table 1.12.

<sup>20</sup>Within the limits of data availability, we compared the average Cognac exports to these destinations from 1996 to 2013 with their average per-capita adult (fifteen years or older) consumption of alcohol. These data come from the World Health Organization. For the Netherlands, Panama, and United Arab Emirates we estimate that the per-capita Cognac consumption (exports) represents on average 0.6, 0.4 and 0.7 percent of the total per-capita alcohol consumption in these countries respectively. These figures are above our estimated world average (0.13). In the case of Singapore, it is as high as 56 percent. Note that data on adult per-capita alcohol consumption for Hong Kong were not available so no comparisons were made.

## 1.4. ECONOMETRIC ESTIMATION

The exchange rate has a significant positive impact on the probability of trade and the opposite effect on the intensive margin, which means that an appreciation of the euro increases the probability of trade but decreases Cognac trade volumes. The decision in favor of exporting Cognac to a given destination depends on whether local sales are enough to cover for fixed costs of establishing a positive trade flow. When the euro appreciates, the price of the local currency (destination's currency) against the euro decreases, which implies that fixed trade costs in local currency also decrease. Therefore, as long as these costs are in the local currency, it is not surprising that the impact of the exchange rate on the extensive margin is positive.<sup>21</sup> This positive effect of the exchange rate on the extensive margin of trade, as well as the negative effect on the intensive margin, have some theoretical foundations (see for example [Chaney, 2013](#)).<sup>22</sup>

Customs protections have no impact on the intensive margin but they have a positive and significant one on the extensive margin. These results are robust to the exclusion of re-exporting countries.

The significant positive impact of customs duties on the extensive margin of trade means that an increase of a tariff on Cognac leads to an increase in the probability of exporting the product. We suspect the presence of an endogeneity bias, so that the tariff may be induced by Cognac imports. Many importing countries are small and/or developing countries with a limited domestic fiscal base. Because Cognac imports are often associated with conspicuous consumption, governments may react to imports of this product on its territory by imposing customs duties. Customs duties are a politically appreciated source of public revenue (there is a large literature on endogenous protectionism)<sup>23</sup>. This effect is exacerbated considering that Cognac brandy is a vice product and might be the object of high taxation, not only excise duties but also customs duties. Increases in Cognac imports may encourage local authorities to augment customs duties on this product, in order to collect more revenues and fight the consumption of a vice product.

To correct for this potential bias, we use an instrumental variables (IV) approach for probit models. We use tax revenues in percentage of GDP as an instrument for the global ad valorem equivalent.<sup>24</sup> As explained in the previous paragraph, customs duties are a

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<sup>21</sup>When we correct for the endogeneity bias we find a nonsignificant impact of the exchange rate on the probability of trade; see Table 1.3.

<sup>22</sup>“Since the entry cost into the foreign market is paid in foreign currency, this means a relaxation of the liquidity constraint for constrained exporters” ([Chaney, 2013](#), p. 22).

<sup>23</sup>See for example [Mayer \(1984\)](#), [Baldwin \(1985\)](#), [Trefler \(1993\)](#).

<sup>24</sup>Annual data on tax revenues as percentage of GDP of the budgetary central governments of destination countries are collected from the International Monetary Fund's (IMF's) Government Finance

Table 1.2 – Baseline Estimation: Heckman Procedure

	(1) Full panel of countries	(2) Without re-exporting countries
<b>ln Total Volume<sub>jt</sub></b>		
ln GDP <sub>jt</sub>	0.70*** (0.02)	0.69*** (0.02)
ln GDP/cap <sub>jt</sub>	0.65*** (0.04)	0.58*** (0.04)
ln Distance <sub>j</sub>	-0.31*** (0.06)	-0.49*** (0.06)
Landlocked <sub>j</sub>	-0.36*** (0.11)	-0.40*** (0.12)
ln Exchange rate <sub>jt</sub>	-0.06*** (0.02)	-0.04** (0.02)
ln (Global AVE I +1) <sub>jt</sub>	-0.03 (0.13)	0.15 (0.11)
Religion <sub>j</sub>	-0.84*** (0.14)	-1.10*** (0.15)
<b>Probability of Trade<sub>jt</sub></b>		
Conflict <sub>jt</sub>	-1.01*** (0.16)	-1.00*** (0.16)
ln GDP <sub>jt</sub>	0.25*** (0.02)	0.25*** (0.02)
ln GDP/cap <sub>jt</sub>	0.16*** (0.03)	0.15*** (0.03)
ln Distance <sub>j</sub>	-0.57*** (0.06)	-0.60*** (0.07)
Landlocked <sub>j</sub>	-0.55*** (0.08)	-0.55*** (0.08)
ln Exchange rate <sub>jt</sub>	0.04*** (0.01)	0.05*** (0.01)
ln (Global AVE I +1) <sub>jt</sub>	0.29** (0.12)	0.33*** (0.12)
Religion <sub>j</sub>	-0.88*** (0.08)	-0.93*** (0.08)
Time FE	Yes	Yes
Observations	2686	2608
N cens	566.00	566.00
Ll	-5372.67	-5147.82
Lambda	0.41	0.41
Rho	0.21	0.22
Wald test (indep.) p-value	0.00	0.00
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

## 1.4. ECONOMETRIC ESTIMATION

**Table 1.3 – Baseline Estimation: IV Probit**

	(1)	(2)
	Full panel of countries	Without re-exporting countries
<b>Probability of Trade<sub>jt</sub></b>		
ln (Global AVE I +1) <sub>jt</sub>	-1.99*** (0.49)	-1.96*** (0.49)
ln GDP <sub>jt</sub>	0.13*** (0.04)	0.13*** (0.04)
ln GDP/cap <sub>jt</sub>	-0.07 (0.09)	-0.07 (0.08)
ln Distance <sub>j</sub>	-0.27 (0.17)	-0.27 (0.18)
Landlocked <sub>j</sub>	-0.79*** (0.14)	-0.79*** (0.14)
ln Exchange rate <sub>jt</sub>	-0.04 (0.02)	-0.04 (0.02)
Religion <sub>j</sub>	0.36 (0.26)	0.36 (0.25)
Conflict <sub>jt</sub>	-0.46** (0.19)	-0.46** (0.19)
Time FE	Yes	Yes
Observations	1261	1244
Ll	-985.05	-982.11
Wald test (exog.) p-value	0.03	0.03
Instrument	ln Tax Revenue	ln Tax Revenue
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

source of public revenue and therefore correlated with our instrument. On the other hand, we have no reason to believe that the volume of Cognac exports is correlated with tax revenues.<sup>25</sup>

Results of the IV estimation on the probability of trade are presented in Table 1.3. The hypothesis of exogeneity of the instrumented variable is rejected. Correcting for the

Statistics.

<sup>25</sup>We also conducted a Heckman test with lagged (one-year) customs duties in place of current customs duties; see Table 1.15 in the appendix to chapter one. We obtain the same results as those shown in Table 1.2. Since import duties are quite stable over time this is not surprising.

endogeneity bias shows that customs duties have a significant negative impact on the extensive margin, which is in line with the literature. The GDP of destination countries has a significant positive impact. The per-capita GDP, distance, exchange rate and religion variables no longer have a significant impact, while being landlocked and experiencing armed conflicts negatively influence the probability of trade. These results are robust to the exclusion of re-exporting countries.

### 1.4.3 Discussion

We compare the results of Table 1.2 with those in the existing literature, particularly with studies focusing on the determinants of high-end versus low-end export flows.

According to our estimations, the elasticity of Cognac exports to the GDP of the importing country is 0.7 (0.69 when excluding re-exporting countries; see column 2). This estimated coefficient is greater than that for all luxury products considered all together, according to [Fontagné and Hatte \(2013\)](#): 0.461 when considering worldwide export flows and 0.556 in the case of French export flows. The destination country's per-capita GDP impact on Cognac trade flows, estimated at an order of magnitude of 0.65 (0.58 when excluding re-exporting countries), is also greater compared to [Fontagné and Hatte's \(2013\)](#) estimations (0.3145 and 0.394 in the case of worldwide and French high-end export flows, respectively) but is lower than [Martin and Mayneris' \(2015\)](#) results, (0.87) which are based on aggregated French firm-level data for two-hundred products in 2005. The impact of distance on Cognac exports is lower in absolute value compared to all luxury products in [Fontagné and Hatte \(2013\)](#): -0.31 in the case of Cognac; -0.734 and -0.578 for worldwide and French exports, respectively. Thus, Cognac is a luxury product whose exports are negatively affected by distance, but it is much less sensitive to distance than other products, including other luxury products.<sup>26</sup> At the same time, customs protections have no significant impact on the intensive margin of trade.

We do not find this result surprising given the nature of our product. Using the same argument, one may expect a nonsignificant impact of the distance variable. However, even though distance is a relatively good proxy of transportation costs (in which case, for all else equal, a nonsignificant impact is indeed a plausible hypothesis), it includes influences of other factors like information costs.<sup>27</sup>

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<sup>26</sup>[Fontagné and Hatte \(2013\)](#) base their estimations on OLS with distance, GDP, and per-capita GDP as covariates. [Martin and Mayneris' \(2015\)](#) baseline estimation uses per-capita GDP, population and distance as covariates in an OLS regression. Note that our estimation methodology differs from that of these authors in that we evaluate the impact of the determinants of Cognac trade flows by correcting for a selection bias using [Heckman's \(1979\)](#) procedure.

<sup>27</sup>Another explanation for the nonsignificant impact of customs duties on Cognac trade flows is that

## 1.4. ECONOMETRIC ESTIMATION

### 1.4.4 Robustness tests

We perform three tests in order to check the robustness of our results. First, we estimate equation 1.1 using an alternative measure of customs protections. Second, we estimate equation 1.1 adding continents fixed effects. Third, we use the Poisson Pseudo Maximum Likelihood and the EK Tobit models (PPML and EK Tobit respectively) as alternative estimation methods.<sup>28</sup>

We use a different computation of the average protection on Cognac to test the robustness of our baseline results (see Table 1.4). The ad valorem equivalent of specific duties is either calculated by dividing the specific duty expressed in euros by HL PA by the annual average unit value on flows to all destinations (the methodology used in Table 1.1 and in central estimations) or by the unit value of the flow to a specific destination (*ln Global AVE II*). This alternative measure of customs protections leads to the same results—that is, customs duties have no impact on the intensive margin, but a significant and positive impact on the extensive margin. When correcting for the endogeneity bias using the IV estimation method (see Table 1.5), we find that customs protections have a significant but negative impact. Results concerning the rest of the variables remain the same.

In Table 1.6, we estimate equation 1.1 adding continents’ fixed effects. We add five dummies for: Africa, Americas, Asia, Europe and Oceania.<sup>29</sup> We exclude distance and religion variables because of possible intracontinent correlation. We find qualitatively similar results to our baseline estimation results when conducting the Heckman procedure (see Table 1.6) and correcting for the endogeneity bias (Table 1.7), regardless of whether we exclude re-exporting countries.

As additional robustness checks, we use a PPML approach to estimate the determinants of Cognac trade flows. The estimation considers “0” trade flows (see Table 1.8). In Table 1.9 we show the results of a Tobit estimation based on Eaton and Kortum’s (2001) method (EK Tobit). We find qualitatively similar results to the previous ones using both approaches.

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many importing countries also rely on excise duties on Cognac as a source of public revenue. This theory was confirmed during discussions with the BNIC. However, as stated previously, we cannot check their impact econometrically.

<sup>28</sup>In the appendix to chapter one, section 1.B we also provide some evidence on the determinants of Cognac export unit values.

<sup>29</sup>The list of countries by continents is shown in the appendix to chapter one, Table 1.16. The assignment of countries to continents is based on the United Nations Statistics Division’s list of geographic regions.

**Table 1.4 – Robustness Check I: Alternative Customs Protection Measure: Heckman Procedure**

	(1) Full panel of countries	(2) Without re-exporting countries
<b>ln Total Volume<sub>jt</sub></b>		
ln GDP <sub>jt</sub>	0.70*** (0.02)	0.69*** (0.02)
ln GDP/cap <sub>jt</sub>	0.65*** (0.04)	0.58*** (0.04)
ln Distance <sub>j</sub>	-0.31*** (0.06)	-0.49*** (0.06)
Landlocked <sub>j</sub>	-0.36*** (0.11)	-0.40*** (0.12)
ln Exchange rate <sub>jt</sub>	-0.06*** (0.02)	-0.04** (0.02)
ln (Global AVE II +1) <sub>jt</sub>	-0.03 (0.13)	0.15 (0.11)
Religion <sub>j</sub>	-0.84*** (0.14)	-1.10*** (0.15)
<b>Probability of Trade<sub>jt</sub></b>		
Conflict <sub>jt</sub>	-1.01*** (0.16)	-1.00*** (0.16)
ln GDP <sub>jt</sub>	0.25*** (0.02)	0.25*** (0.02)
ln GDP/cap <sub>jt</sub>	0.16*** (0.03)	0.15*** (0.03)
ln Distance <sub>j</sub>	-0.57*** (0.06)	-0.60*** (0.07)
Landlocked <sub>j</sub>	-0.55*** (0.08)	-0.55*** (0.08)
ln Exchange rate <sub>jt</sub>	0.04*** (0.01)	0.05*** (0.01)
ln (Global AVE II +1) <sub>jt</sub>	0.29** (0.12)	0.33*** (0.12)
Religion <sub>j</sub>	-0.88*** (0.08)	-0.93*** (0.08)
Time FE	Yes	Yes
Observations	2686	2608
N cens	566.00	566.00
Ll	-5372.67	-5147.82
Lambda	0.41	0.41
Rho	0.21	0.22
Wald test (indep.) p-value	0.00	0.00
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.



#### 1.4. ECONOMETRIC ESTIMATION

**Table 1.5 – Robustness Check I: Alternative Customs Protection Measure: IV Probit**

	(1) Full panel of countries	(2) Without re-exporting countries
<b>Probability of Trade<sub>jt</sub></b>		
ln (Global AVE II +1) <sub>jt</sub>	-1.99*** (0.49)	-1.96*** (0.49)
ln GDP <sub>jt</sub>	0.13*** (0.04)	0.13*** (0.04)
ln GDP/cap <sub>jt</sub>	-0.07 (0.09)	-0.07 (0.08)
ln Distance <sub>j</sub>	-0.27 (0.17)	-0.27 (0.18)
Landlocked <sub>j</sub>	-0.79*** (0.14)	-0.79*** (0.14)
ln Exchange rate <sub>jt</sub>	-0.04 (0.02)	-0.04 (0.02)
Religion <sub>j</sub>	0.36 (0.26)	0.36 (0.25)
Conflict <sub>jt</sub>	-0.46** (0.19)	-0.46** (0.19)
Time FE	Yes	Yes
Observations	1261	1244
Ll	-985.05	-982.11
Wald test (exog.) p-value	0.03	0.03
Instrument	ln Tax Revenue	ln Tax Revenue
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

Table 1.6 – Robustness Check II: Adding Continents' FE: Heckman Procedure

	(1)	(2)
	Full panel of countries	Without re-exporting countries
<b>ln Total Volume<sub>jt</sub></b>		
ln GDP <sub>jt</sub>	0.64*** (0.02)	0.65*** (0.02)
ln GDP/cap <sub>jt</sub>	0.62*** (0.04)	0.57*** (0.04)
Landlocked <sub>j</sub>	-0.54*** (0.11)	-0.54*** (0.11)
ln Exchange rate <sub>jt</sub>	-0.07*** (0.02)	-0.05*** (0.02)
ln (Global AVE I +1) <sub>jt</sub>	-0.21 (0.14)	-0.05 (0.13)
<b>Probability of Trade<sub>jt</sub></b>		
Conflict <sub>jt</sub>	-0.97*** (0.17)	-0.97*** (0.17)
ln GDP <sub>jt</sub>	0.24*** (0.02)	0.24*** (0.02)
ln GDP/cap <sub>jt</sub>	0.13*** (0.03)	0.12*** (0.03)
Landlocked <sub>j</sub>	-0.47*** (0.08)	-0.47*** (0.08)
ln Exchange rate <sub>jt</sub>	0.06*** (0.02)	0.06*** (0.02)
ln (Global AVE I +1) <sub>jt</sub>	0.26** (0.11)	0.29** (0.12)
Time FE	Yes	Yes
Continents FE	Yes	Yes
Observations	2694	2616
N cens	567.00	567.00
Ll	-5343.82	-5145.60
Lambda	0.22	0.33
Rho	0.12	0.18
Wald test (indep.) p-value	0.02	0.00
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

## 1.4. ECONOMETRIC ESTIMATION

**Table 1.7 – Robustness Check II: Adding Continents’ FE: IV Probit**

	(1)	(2)
	Full panel of countries	Without re-exporting countries
<b>Probability of Trade<sub>jt</sub></b>		
ln (Global AVE I +1) <sub>jt</sub>	-1.86*** (0.52)	-1.83*** (0.53)
ln GDP <sub>jt</sub>	0.14*** (0.04)	0.14*** (0.04)
ln GDP/cap <sub>jt</sub>	-0.08 (0.08)	-0.07 (0.07)
Landlocked <sub>j</sub>	-0.80*** (0.15)	-0.79*** (0.15)
ln Exchange rate <sub>jt</sub>	-0.03 (0.02)	-0.04 (0.03)
Conflict <sub>jt</sub>	-0.44** (0.18)	-0.45** (0.18)
Time FE	Yes	Yes
Continents FE	Yes	Yes
Observations	1261	1244
Ll	-1019.95	-1012.81
Wald test (exog.) p-value	0.04	0.04
Instrument	ln Tax Revenue	ln Tax Revenue
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

**Table 1.8 – Robustness Check IIIa: Alternative Estimation Method: PPML**

	(1) Full panel of countries
$\ln \text{GDP}_{jt}$	0.95*** (0.04)
$\ln \text{GDP}/\text{cap}_{jt}$	0.14 (0.10)
$\ln \text{Distance}_j$	0.02 (0.03)
$\text{Landlocked}_j$	-0.59*** (0.11)
$\ln \text{Exchange rate}_{jt}$	-0.15*** (0.02)
$\ln (\text{Global AVE I} + 1)_{jt}$	-0.67** (0.33)
$\text{Religion}_j$	-0.23 (0.19)
Time FE	Yes
Observations	2686

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

## 1.5. CONCLUSION

**Table 1.9 – Robustness Check IIIb: Alternative Estimation Method: EK Tobit**

	(1) Full panel of countries
$\ln \text{GDP}_{jt}$	0.78*** (0.03)
$\ln \text{GDP}/\text{cap}_{jt}$	0.77*** (0.05)
$\ln \text{Distance}_j$	-0.47*** (0.07)
$\text{Landlocked}_j$	-0.63*** (0.17)
$\ln \text{Exchange rate}_{jt}$	-0.05** (0.03)
$\ln (\text{Global AVE I} + 1)_{jt}$	0.15 (0.17)
$\text{Religion}_j$	-1.69*** (0.20)
Time FE	Yes
Observations	2503
N uncensored	2120.00
N left-censored	383.00
N right-censored	0.00
Ll	-5510.49

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

## 1.5 Conclusion

In this chapter, we present a new database on Cognac exports to more than one hundred countries spanning a period of eighteen years. We successively evaluate the extensive and the intensive margins of trade, and we confirm a result from the literature positing that the sale of luxury products is less sensitive to distance; in the case of Cognac, sales are even less sensitive than other luxury products.

On the other hand, customs duties have no significant impact on the intensive margin but a positive one on the probability of trade. While the former result is not surprising given the nature of Cognac, but the latter is counterintuitive. We suspect the presence of an endogeneity bias, because tariffs represent in many countries a significant source of public revenue. Correcting for this bias leads to a significant and negative impact of customs protection on the extensive margin. The other covariates have the expected impact on

Cognac exports.

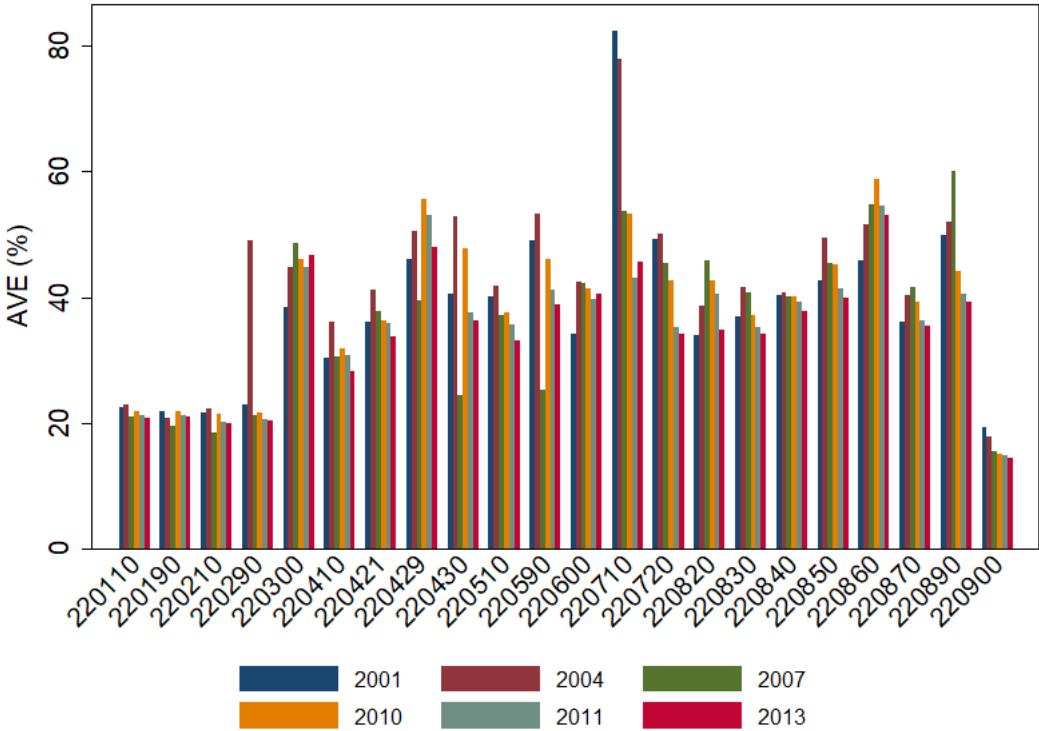
In the introduction to this chapter, we question the reasons behind Cognac's global success. The first determinant of the number of Cognac exports is economic growth worldwide. The second reason is that exports of Cognac are not very (relatively) affected by transportation costs.

Future work is still needed to fully understand the Cognac sector. In particular, the database of Cognac exports offers a precise measurement of quality, by the age of the youngest *eau-de-vie* incorporated in the brandy. This is a better measurement of quality than the unit value or price, which are often used in the literature, or than a subjective expert's ranking. The structure by quality of exports is the object of chapter two.



# Appendix to Chapter 1

Figure 1.7 – World Average Customs Duties: Chapter 22 at the HS6 Level



Source: authors; data from MAcMap.



**Table 1.10 – Summary Statistics**

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<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min.</b>	<b>Max.</b>
Total Volume (HL PA)	4,230	1,551.865	9,442.746	0	156,656.086
GDP (constant 2005 USD)	3,357	2.33e+11	1.05e+11	1.75e+07	1.45e+13
GDP/cap (constant 2005 USD)	3,357	10,559.387	17,203.069	73	158,603
Distance (km)	3,888	6,708.002	4,300.071	473.73	18,894.29
Exchange Rate (loc. curr. to 1 €)	4,117	2,408.157	49,052.639	0.002	1,777,042.822
AVE I	2,829	0.428	2.262	0	30
Landlocked	4,176			0	1
Religion	4,068			0	1
Conflict	4,230			0	1

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Source: authors.

**Table 1.11 – List of Cognac Importing Countries in 2013**

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Albania	Gabon	Nigeria
Algeria	Georgia	Norway
American Oceania	Germany	Oman
Andorra	Ghana	Panama
Angola	Gibraltar	Paraguay
Antigua and Barbuda	Greece	Peru
Argentina	Grenada	Philippines (the)
Armenia	Guatemala	Poland
Aruba	Guinea	Portugal
Australia	Haiti	Qatar
Austria	Honduras	Romania
Azerbaijan	Hong Kong	Russian Federation (the)
Bahamas (the)	Hungary	Saint Barthélemy
Bahrain	Iceland	Saint Kitts and Nevis
Barbados	India	Saint Lucia
Belarus	Indonesia	Saint Pierre and Miquelon
Belgium and Luxembourg	Iraq	Saint Vincent and the Grenadines
Benin	Ireland	Senegal
Bermuda	Israel	Serbia
Bosnia and Herzegovina	Italy	Seychelles
Brazil	Jamaica	Sierra Leone
Bulgaria	Japan	Singapore
Burkina Faso	Jordan	Slovakia
Cambodia	Kazakhstan	Slovenia
Cameroon	Kenya	South Africa
Canada	Korea (the Republic of)	Spain
Cayman Islands (the)	Kyrgyzstan	Sri Lanka
Chile	Lao People's Democratic Republic (the)	Suriname
China	Latvia	Sweden
Colombia	Lebanon	Switzerland
Congo	Lithuania	Taiwan (Province of China)
Congo (the Democratic Republic of the)	Macao	Tajikistan
Costa Rica	Macedonia (the former Yugoslav Republic of)	Tanzania, United Republic of
Croatia	Malaysia	Thailand
Cuba	Maldives	Togo
Cyprus	Mali	Trinidad and Tobago
Czech Republic (the)	Malta	Tunisia
Côte d'Ivoire	Mauritius	Turkey
Denmark	Mexico	Turkmenistan
Djibouti	Mongolia	Turks and Caicos Islands (the)
Dominican Republic (the)	Montenegro	Ukraine
Ecuador	Montserrat	United Arab Emirates (the)
Egypt	Morocco	United Kingdom (the)
El Salvador	Myanmar	United States (the)
Equatorial Guinea	Nepal	Uruguay
Estonia	Netherlands (the)	Uzbekistan
Ethiopia	Netherlands Antilles	Venezuela, Bolivarian Republic of
Fiji	New Caledonia	Viet Nam
Finland	New Zealand	Virgin Islands (British)
French Polynesia	Niger (the)	Virgin Islands (U.S.)

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Source: authors; raw data from BNIC.

**Table 1.12 – List of Muslim-Majority Countries with their Dates of Information according to the CIA Factbook**

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Afghanistan	NA	Malaysia	2010
Albania	2011	Maldives	NA
Algeria	2012	Mali	2009
Azerbaijan	1995	Mauritania	NA
Bahrain	2010	Morocco	2010
Bangladesh	2004	Niger (the)	NA
Brunei Darussalam	2011	Nigeria	NA
Burkina Faso	2006	Oman	2010
Chad	1993	Pakistan	2010
Cocos (Keeling) Islands (the)	2002	Panama	NA
Comoros	NA	Qatar	2004
Djibouti	NA	Saudi Arabia	2013
Egypt	2012	Senegal	NA
Eritrea	NA	Sierra Leone	NA
French Polynesia	NA	Somalia	NA
Gambia (The)	NA	Sudan (the)	NA
Guinea	NA	Syrian Arab Republic (the)	NA
Indonesia	2010	Tajikistan	2003
Iran (the Islamic Republic of)	2011	Tunisia	NA
Iraq	2010	Turkey	NA
Jordan	2010	Turkmenistan	NA
Kazakhstan	2009	United Arab Emirates (the)	2005
Kuwait	2013	Uzbekistan	NA
Kyrgyzstan	NA	Western Sahara*	NA
Lebanon	2012	Yemen	2010
Libya	2010		

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NA = Not Available. Source: CIA Factbook.

## 1.A Income Disparity and the Gravity Equation

We control for income disparity in equation 1.1 adding the GINI index. However, this variable is documented for only 56 countries (or less, depending on the period) and its inclusion considerably reduces the size of the sample (from 2686 to 1099 observations). Moreover, the information we have on the GINI index is not randomly distributed as shown in Table 1.13, leading to a potential sample bias. Countries for which we have information on the GINI index appear to have in average higher GDP, per-capita GDP, exchange rates and apply lower tariffs on Cognac imports.

The estimation of our baseline specification on this reduced sample confirms the bias (see Table 1.14; the Heckman estimator does not converge on the reduced sample). For example, while the religion dummy has a negative impact on Cognac's volumes of exports, when we consider the entire database, it does not have any effect in the reduced sample. On the other hand, the estimated coefficient of the tariff is positive and significant on the reduced sample whereas it was not significant on the entire database. We therefore conclude that including this variable yields biased estimation results.

**Table 1.13 – Summary Statistics: Full Sample vs. Gini Sample**

Variable	Sample	Obs.	Mean	Std. Dev.	Min.	Max.
GDP <sub>jt</sub>	Full	3,357	2.33e+11	1.05e+11	1.75e+07	1.45e+13
	Gini	1,264	4.62e+11	1.56e+12	2.38e+07	1.45e+13
GDP/cap <sub>jt</sub>	Full	3,357	10,559.387	17,203.069	73	158,603
	Gini	1,264	12,677.293	16,072.835	133	69,095
Distance <sub>j</sub>	Full	3,888	6,708.002	4,300.071	473.73	18,894.29
	Gini	1,288	5,148.109	4,017.131	473.73	18,894.29
Exchange rate <sub>jt</sub>	Full	4,117	2,408.157	49,052.639	0.002	1,777,042.822
	Gini	1,271	3,834.084	64,437.231	0.036	1,694,851.106
Global AVE I <sub>jt</sub>	Full	2,829	0.428	2.262	0	30
	Gini	1,160	0.322	1.986	0	30

Source: authors.

## 1.A. INCOME DISPARITY AND THE GRAVITY EQUATION

Table 1.14 – Including the Gini Index: Intensive Margin (OLS)

	(1) Full Sample	(2) Gini Sample	(3) Gini Sample
$\ln \text{GDP}_{jt}$	0.68*** (0.02)	0.76*** (0.04)	0.76*** (0.04)
$\ln \text{GDP}/\text{cap}_{jt}$	0.64*** (0.04)	0.41*** (0.06)	0.47*** (0.06)
$\ln \text{Distance}_j$	-0.27*** (0.06)	-0.14* (0.07)	-0.27*** (0.07)
$\text{Landlocked}_j$	-0.27** (0.12)	-0.36** (0.14)	-0.24* (0.15)
$\ln \text{Exchange rate}_{jt}$	-0.07*** (0.02)	-0.16*** (0.02)	-0.15*** (0.02)
$\text{Religion}_j$	-0.73*** (0.14)	-0.38 (0.23)	-0.31 (0.23)
$\ln (\text{Global AVE I} + 1)_{jt}$	-0.08 (0.13)	-0.52** (0.26)	-0.43* (0.25)
$\ln \text{Gini}_{jt}$		-1.06*** (0.26)	
Time FE	Yes	Yes	Yes
Observations	2120	982	982
Adjusted $R^2$	0.606	0.684	0.680

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

Table 1.15 – Heckman Procedure with Lagged Customs Duties

	(1) Full panel of countries	(2) Without re-exporting countries
<b>ln Total Volume<sub>jt</sub></b>		
ln GDP <sub>jt</sub>	0.69*** (0.02)	0.68*** (0.02)
ln GDP/cap <sub>jt</sub>	0.65*** (0.04)	0.57*** (0.04)
ln Distance <sub>j</sub>	-0.32*** (0.06)	-0.51*** (0.06)
Landlocked <sub>j</sub>	-0.36*** (0.12)	-0.40*** (0.12)
ln Exchange rate <sub>jt</sub>	-0.06*** (0.02)	-0.04** (0.02)
ln (Global AVE I + 1) <sub>jt-1</sub>	-0.05 (0.13)	0.13 (0.12)
Religion <sub>j</sub>	-0.86*** (0.15)	-1.12*** (0.15)
<b>Probability of Trade<sub>jt</sub></b>		
Conflict <sub>jt</sub>	-1.06*** (0.17)	-1.05*** (0.17)
ln GDP <sub>jt</sub>	0.26*** (0.02)	0.25*** (0.02)
ln GDP/cap <sub>jt</sub>	0.17*** (0.03)	0.16*** (0.03)
ln Distance <sub>j</sub>	-0.58*** (0.07)	-0.62*** (0.07)
Landlocked <sub>j</sub>	-0.54*** (0.09)	-0.55*** (0.09)
ln Exchange rate <sub>jt</sub>	0.04*** (0.02)	0.05*** (0.02)
ln (Global AVE I + 1) <sub>jt-1</sub>	0.31** (0.13)	0.35*** (0.13)
Religion <sub>j</sub>	-0.90*** (0.08)	-0.95*** (0.09)
Time FE	Yes	Yes
Observations	2511	2438
N cens	521.00	521.00
Ll	-5023.30	-4810.34
Lambda	0.45	0.46
Rho	0.23	0.24
Wald test (indep.) p-value	0.00	0.00
Method	ml	ml

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

**Table 1.16 – List of Countries by Continents**

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<b>Africa</b>	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic (the), Chad, Comoros, Congo, Congo (the Democratic Republic of the), Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia (the), Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger (the), Nigeria, Rwanda, Saint Helena, Ascension and Tristan de Cunha, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan (the), Swaziland, Tanzania (United Republic of), Togo, Tunisia, Uganda, Western Sahara*, Zambia, Zimbabwe.
<b>Americas</b>	American Oceania, Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas (the), Barbados, Belize, Bermuda, Bolivia (Plurinational State of), Bouvet Island, Brazil, Canada, Cayman Islands (the), Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic (the), Ecuador, El Salvador, Falkland Islands (the) (Malvinas), Greenland, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Montserrat, Nicaragua, Panama, Paraguay, Peru, Saint Barthélemy, Saint Kitts and Nevis, Saint Lucia, Saint Martin (French part), Saint Pierre and Miquelon, Saint Vincent and the Grenadines, South Georgia and the South Sandwich Islands, Suriname, Trinidad and Tobago, Turks and Caicos Islands (the), United States (the), United States Minor Outlying Islands (the), Uruguay, Venezuela (Bolivarian Republic of), Virgin Islands (British), Virgin Islands (U.S.).
<b>Asia</b>	Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh, Bhutan, British Indian Ocean Territory (the), Brunei Darussalam, Cambodia, China, Cyprus, Georgia, Hong Kong, India, Indonesia, Iran (the Islamic Republic of), Iraq, Israel, Japan, Jordan, Kazakhstan, Korea (the Republic of), Kuwait, Kyrgyzstan, Lao People's Democratic Republic (the), Lebanon, Macao, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, Palestine, State of, Philippines (the), Qatar, Saudi Arabia, Singapore, Sri Lanka, Syrian Arab Republic (the), Taiwan (Province of China), Tajikistan, Thailand, Timor-Leste, Turkey, Turkmenistan, United Arab Emirates (the), Uzbekistan, Viet Nam, Yemen.
<b>Europe</b>	Albania, Andorra, Austria, Belarus, Belgium and Luxembourg, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic (the), Denmark, Estonia, Faroe Islands (the), Finland, French Southern Territories (the), Germany, Gibraltar, Greece, Guernsey, Hungary, Iceland, Ireland, Isle of Man, Italy, Jersey, Latvia, Liechtenstein, Lithuania, Macedonia (the former Yugoslav Republic of), Malta, Moldova (the Republic of), Monaco, Montenegro, Netherlands (the), Netherlands Antilles, Norway, Poland, Portugal, Romania, Russian Federation (the), San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom (the), Aland Islands.
<b>Oceania</b>	Antarctica, Australia, Christmas Island, Cocos (Keeling) Islands (the), Cook Islands (the), Fiji, French Polynesia, Heard Island and McDonald Islands, Kiribati, Marshall Islands (the), Micronesia (the Federated States of), Nauru, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands (the), Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands (the), Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna.

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Source: United Nations Statistics Division.

## 1.B Determinants of Export Unit Values

Table 1.17 shows the results of the OLS estimation of the determinants of the export unit values of Cognac. We base our estimation on equation 1.2:

$$\ln(UV_{jt}) = \alpha_0 + \alpha_1 \ln(Y_{jt}) + \alpha_2 \ln(y_{jt}) + \alpha_3 \ln(d_j) + \nu_t + u_{jt} \quad (1.2)$$

with  $UV_{jt}$  the export unit value to destination country  $j$  at year  $t$ . The unit value for each importing country is calculated as the ratio of the value of Cognac shipments (in €) to the volume of exports (in HL PA). Our sample consists only of non-zero observations.

Our econometric strategy is similar to Baldwin and Harrigan (2011)<sup>30</sup>. Consistent with their results, we find that distance has a positive and significant impact on export unit values, while the GDP and per-capita GDP of importing countries have the opposite effect. These results can be driven by quality sorting within Cognac, which is the object of chapter two.

**Table 1.17 – OLS Estimation of the Determinants of Export Unit Values**

	(1) Full panel of countries
$\ln \text{GDP}/\text{cap}_{jt}$	-0.04*** (0.01)
$\ln \text{Distance}_j$	0.11*** (0.01)
$\ln \text{GDP}_{jt}$	-0.01** (0.00)
Time FE	Yes
Observations	2460
Adjusted $R^2$	0.144

Robust standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

<sup>30</sup>The authors estimate within-product variation in unit values at the HS10 level using US export data for 2005. They use characteristics of importing countries as regressors: market size, distance, remoteness, and several dummy variables (sharing a common border, being landlocked, being an island, and speaking English). The latter have an insignificant impact on export unit values.





# Chapter 2

## International Trade, Quality Sorting and Trade Costs: The Case of Cognac<sup>1</sup>

### 2.1 Introduction

It is well known since the seminal works of [Falvey \(1979\)](#), [Krugman \(1979\)](#) and [Lancaster \(1980\)](#), that international trade flows are not only composed of different products, but also of similar products either horizontally- or vertically-differentiated. The latter type of trade is based on an objective product differentiation, where a good is considered qualitatively superior to another and recognized as such by all consumers. While trade liberalization policies have contributed to the intensification of these trade flows, trade costs continue to play an important role as determinants of the volumes and quality of traded goods. The impact of trade costs, whether *natural* (i.e. transportation costs) or *policy-related* (i.e. tariffs), on the quality structure of international trade flows has been examined extensively by both theoretical and empirical studies.

In this respect, a key pillar in the theoretical literature, yet less documented empirically, is the Alchian and Allen effect. This effect, first highlighted by Alchian and Allen in 1964, stipulates that per-unit transportation costs increase the relative demand for higher quality goods. This point gave rise to several theoretical analyses ([Borcherding and Silberberg, 1978](#); [Razzolini, Shughart II, and Tollison, 2003](#); [Bauman, 2004](#); [Baldwin and Harrigan, 2011](#); [Sorensen 2014](#); [Irarrazabal, Moxnes, and Opromolla, 2015](#)), but to seldom empirical verifications. The main challenge of empirical analyses of the Alchian and Allen effect resides in having or rather lacking an objective measure of product quality.

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<sup>1</sup>This chapter is based on the paper written with Charlotte Emlinger (CEPII) that will soon be issued as a CEPII Working Paper.

## 2.1. INTRODUCTION

In this chapter, we have overcome this challenge by examining Cognac export flows, a product that has an objective and time-invariant measure of quality, which is based on the minimum time in oak of the youngest *eau-de-vie* used in creating the blend. This ageing system and indications are closely supervised by the Cognac inter-profession (the *Bureau National Interprofessionnel du Cognac*, the BNIC). As a consequence, the measure of quality for this product is objective and invariant over time, contrary to the measures of product quality used by other empirical analyses of the quality mix in the literature, such as the difference observed in the unit values for a given category (see for example [Hummels and Skiba, 2004](#); [Schott, 2004](#)) or ratings from experts or guidebooks (see for example [Crozet, Head, and Mayer, 2012](#), for Champagne).

Our objective is to test the validity of the Alchian and Allen effect using a unique database of Cognac exports by volume, destination and quality from 1967 to 2013 and a database on customs protection. We do so by exploiting both the cross-sectional and time-series dimensions of trade costs. More specifically, we first estimate the impact of the cross-sectional variation of trade costs through distance and tariffs. Second, we evaluate the impact of a reduction in trade costs over time as a result of the technological revolution in maritime transport following the adoption of containerization.

Our work contributes to the literature on trade costs and their impact on product quality. As we said above, despite distinguished theoretical studies, empirical work on the subject remains relatively scarce. Moreover, the majority of papers studying the effects of trade costs estimate the impact of transport charges (usually distance) and/or customs duties on unit values, using either country-level data ([Schott, 2004](#); [2008](#); [Hummels and Klenow, 2005](#); [Baldwin and Harrigan, 2011](#)) or firm-level data ([Bastos and Silva, 2010](#); [Manova and Zhang, 2012](#); [Martin, 2012](#)).

Instead of using unit values to define/measure a product's quality, in this chapter, we estimate the impact of distance and customs duties on the quality mix of Cognac exports based on an objective definition and direct measure of quality. All Cognac houses comply with such a definition, under the supervision of the BNIC.

This chapter also relates to the literature on luxury goods. We discuss in detail the fact that Cognac is a luxury product in section 1.2 of chapter one. We therefore investigate the impact of trade costs on the quality mix for a given luxury product, Cognac.

This study is also related to the literature on the economic impact of containerization. The adoption of containerization (i.e. the method of shipping goods via containers) revolutionized shipping methods in the twentieth century. According to [Hummels \(2007\)](#), it

is one of the major postwar technological changes in ocean transport. The use of containers in different modes of transport, ship, rail or truck, made possible for goods to be shipped to distant destinations without the necessity of “being unpacked and repacked” (Hummels, 2007, p. 141). The overall quality of transportation improved, productivity of dock labor increased, and insurance costs dropped. Intermodal transport also reduced the speed of delivery. Trade and transport facilitation as a result of the introduction of containerization has been well documented in the literature<sup>2</sup>, but only a few studies quantify empirically the effects of the shipping container.<sup>3</sup> To the extent of our knowledge, we are the first to analyze empirically the impact of containerization on trade flows by quality. Using Rua’s (2014) and Bernhofen et al.’s (2016) data on the first port containerized by country, we empirically assess the effects of the variation in trade costs as a result of containerization on the quality mix of Cognac exports.

The contribution of this analysis is threefold. First, we validate empirically the Alchian and Allen effect based on a direct and “physical” rather than perceived definition of product quality, during a long time-span covering almost forty-seven years of Cognac export flows. Second, we assess empirically the impact of customs protection on trade flows by quality by distinguishing between per-unit and ad valorem tariffs. Third, our results confirm the Alchian and Allen effect when analyzing the time variation of trade costs through containerization.

The chapter is organized as follows. First, we review the theoretical and empirical literature on the Alchian and Allen theorem. Section 2.3 presents our original database of Cognac exports and gives details on the different quality designations. In section 2.4 we perform an econometric estimation on the share and relative price of high quality Cognac exports to different countries. In section 2.5 we test empirically the impact of containerization on the Cognac quality mix. Finally in section 2.6 we conclude.

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<sup>2</sup>See for example Levinson (2006).

<sup>3</sup>See for example Bernhofen, El-Sahli, and Kneller (2016) for an empirical assessment of the impact of containerization on world trade flows.

## 2.2 The Alchian and Allen Effect

In this section we first present the Alchian and Allen effect. Then we discuss several extensions to the original theoretical framework. Finally, we review the empirical examinations of the Alchian and Allen conjecture.

### 2.2.1 Theoretical Framework

What came to be known as the Alchian and Allen effect or the “shipping the good apples out” theorem, originally presented in their *University Economics* book in 1964, was considered by the two authors as an indirect validation of the laws of demand, a solution to the problem of: “[...]how does one explain the larger proportion of good quality relative to poor quality oranges or grapes sold in New York than in California? Why is a larger proportion of the good, rather than bad, shipped to New York?” (p. 70-71 of the 1972 edition). [Alchian and Allen \(1964\)](#) answer this question arguing that the relative price of the high quality to the poor quality good is lower to more distant markets, therefore the relative consumption of the high quality good is greater at more distant markets compared to the market of origin.

For a better understanding of the effect, consider a competitive sector in country  $i$  that exports two quality grades of the same good denoted by  $k = H, L$  for high and low quality respectively. Note that this model can be extended to a three and/or n-good world.<sup>4</sup>

We focus on the quality mix exported to different countries and suppose that supply is fixed in the country of origin.<sup>5</sup> For each quality grade, consider the following Hicksian demand functions (i.e. income held constant) at destination country  $j$ :<sup>6</sup>

$$X_{jk} = f(p_{jH}, p_{jL}, U), \quad k = H, L.$$

$p_{jH}$ ,  $p_{jL}$  are the prices of the high and low quality good respectively at country  $j$ .  $U$  is the utility level.

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<sup>4</sup>In the appendix to chapter two, section [2.A.2](#), we provide a mathematical demonstration of how the original framework can be extended to a three-good world. The same logic can be applied to an n-good world, see [Bauman \(2004\)](#), for example

<sup>5</sup>See [Hummels and Skiba \(2004\)](#).

<sup>6</sup>A Hicksian or compensated demand function minimizes a consumer’s expenditure while the utility or income level is held constant. [Borcherding and Silberberg \(1978\)](#) justify the use of compensated demand curves in their theoretical development of the Alchian and Allen model by “[...]income effects are always indeterminate and if strong enough, can destroy this or virtually any other proposition in economics” (p. 134). The use of Hicksian demand functions is also explained in [Hummels and Skiba \(2004\)](#).

Prices at destination country  $j$  depend on prices at origin country  $p_{iH}, p_{iL}$ , with  $p_{iH} > p_{iL}$ , and a per-unit charge (typically a per-unit transport cost and/or a specific duty) denoted by  $t_j$ , such as:

$$p_{jk} = p_{ik} + t_j, \quad k = H, L.$$

We suppose that there is no loss in quality due to shipment. It is important to note, as pointed out by [Borcherding and Silberberg \(1978\)](#) that: “there must be one measurable characteristic common to both [qualities], to which the transport cost (or other common change) is applied” (p. 134). Indeed, for the analysis to hold, consumers at destination country  $j$  must perceive the high and low quality as two grades of the same good, rather than two different goods. The high and low quality grades must be substitutes.<sup>7</sup>

The Alchian and Allen theorem can be stated: *An increase in the per-unit cost increases the relative price of the higher compared to the lower quality good leading to an increase in the quantity share of the higher quality good.*

Mathematically:<sup>8</sup>

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} > 0. \quad (2.1)$$

We test empirically the Alchian and Allen conjecture stated above in sections 2.4 and 2.5. Because we do not have data on freight rates, we use distance as a proxy instead. In the case of Cognac, shipping fees resemble per-unit rather than iceberg charges as it is the case for wine and Champagne.<sup>9</sup> The ad valorem component is however still present in freight rates as insurance costs for example are likely to depend on the price of Cognac. If we assume that the per-unit charge increases more with distance than the ad valorem one as in [Crozet, Head, and Mayer \(2012\)](#), we expect a positive relation between distance and the relative consumption of higher quality Cognac. Specific duties are expected to have the same impact. As for containerization, we provide evidence in section 2.5.1 of a reduction of per-unit charges as a result of this technological change. We therefore expect that entering the age of containerization has the opposite impact compared to distance on the relative consumption of XO Cognac.

We review several extensions to the original framework in the following subsection.

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<sup>7</sup>As [Hummels and Skiba \(2004\)](#) point out: “the Alchian-Allen conjecture is primarily a statement about substitution effects” (p. 1388).

<sup>8</sup>A detailed proof of equation 2.1 is provided in the appendix to chapter two, section 2.A

<sup>9</sup>See [Crozet, Head, and Mayer \(2012\)](#).

## 2.2. THE ALCHIAN AND ALLEN EFFECT

### 2.2.2 Extensions

The theoretical literature following the work of Alchian and Allen is quite large. Here we review some of the theoretical examinations more closely related to our work.

[Borcherding and Silberberg \(1978\)](#) extend the original Alchian and Allen conjecture by building a theoretical model in a three-good world with two close-substitutes qualities of the same good and a third composite (i.e. Hicksian) good. They show that the theorem holds under the plausible condition that the elasticities of substitution/complementarity between the two quality-differentiable goods and the composite good are similar.<sup>10 11</sup>

The validity of the theorem is questioned by [Razzolini, Shughart II and Tollison \(2003\)](#) when taking into account the supply side. Under an increasing cost-industry or a monopolistic market structure, it is shown that a per-unit charge would reduce the relative price of the higher quality good if the price-elasticity of the lower quality good is less or at most equal to the price elasticity of the higher quality good. The condition for the Alchian and Allen proposition to hold is considered therefore implausible from an empirical point of view.

Another extension of the model is proposed by [Hummels and Skiba \(2004\)](#). While their paper's main contribution is in providing empirical evidence of the Alchian and Allen effect (see section 2.2.3), their work also relates to the theoretical literature. The authors consider the effect on the relative prices and demand of both per-unit and ad valorem charges. They show that an increase in the ad valorem charges (in presence of per-unit transportation costs) would increase the relative price of the higher quality good, invalidating therefore the Alchian and Allen effect.<sup>12</sup> Given the data on ad valorem duties at our disposal we are also able to test in section 2.4.2 the validity of the extension to the original framework developed by [Hummels and Skiba \(2004\)](#).

The majority of the theoretical analyses have focused on two quality grades of the same good with the exception of [Liu \(2010\)](#).<sup>13</sup> The author builds a model with consumers purchasing a bundle of low, medium and high quality grades of a given good where the

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<sup>10</sup>The authors argue that “we should be surprised if the cross elasticities of Golden Delicious and McIntosh apples with other goods differ widely” (p. 135).

<sup>11</sup>An extension of [Borcherding and Silberberg's \(1978\)](#) analysis to an n-good world is developed by [Bauman \(2004\)](#).

<sup>12</sup>Considering that transportation charges may have both a per-unit and ad valorem components, the authors also argue that the validity of the Alchian and Allen effect depends on the price-elasticity of transportation costs.

<sup>13</sup>A previous working paper by [Saito \(2006\)](#) also explores the validity of the Alchian and Allen proposition for various qualities.

*quality* of the bundle depends on the shares of medium and high quality grades. Under several assumptions on consumers' demand functions, [Liu \(2010\)](#) demonstrates that a per-unit increase in the prices of the three qualities in the bundle, leads to an increase in the *quality* of the bundle, extending therefore the Alchian and Allen effect to three quality-differentiable goods.<sup>14</sup>

### 2.2.3 Empirical Verification

Despite the extensive theoretical literature, the empirical verifications of the Alchian and Allen conjecture are relatively scarce. One of the major difficulties comes from the definition of quality. In the vast literature regarding the quality mix, we distinguish between three definitions of quality: i) based on unit values<sup>15</sup>; ii) extrapolated from an econometric estimation<sup>16</sup>; and iii) based on ratings from experts or guidebooks<sup>17</sup>.

To our knowledge, [Hummels and Skiba \(2004\)](#) are the first to validate empirically the Alchian and Allen theorem<sup>18</sup>. Using bilateral trade data on six importers and world-wide exporters for 1994, they first estimate the price-elasticity of transportation costs and then proceed to evaluate the impact of freight rates and ad valorem duties on the average unit prices of more than 5000 products. In contrast to standard trade theory where transportation costs are considered to have an iceberg form (proportional to the value of the good), the authors find that the price-elasticity of freight rates is 0.6 and conclude that shipping fees have a per-unit rather than per-value structure.<sup>19</sup> Lacking a direct measure of quality, the authors consider the unit value by product to be a weighted average of prices for each quality within product and interpret an increase (decrease) of such value as an increase (decrease) in the share of the high quality goods. Their theoretical predictions are confirmed since their results show that freight rates have a significant positive impact on the average unit value, while ad valorem duties have the opposite effect.

[Lawson and Raymer \(2006\)](#) offer an empirical analysis of the gasoline market distinguishing between three quality grades of gasoline: regular, mid and premium grade. Using daily observations of gasoline sales at a single station from 1992 to 1999, their study reveals that the market share of premium grade gasoline decreased by a 1.4 percentage

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<sup>14</sup>Other theoretical analyses of the Alchian and Allen effect are developed by [Gould and Segall \(1969\)](#), [Umbeck \(1980\)](#), [Kaempfer and Brastow \(1985\)](#).

<sup>15</sup>See for example [Hummels and Skiba \(2004\)](#), [Schott \(2004\)](#).

<sup>16</sup>See for example [Khandelwal, Schott, and Wei \(2013\)](#).

<sup>17</sup>See for example [Crozet, Head, and Mayer \(2012\)](#).

<sup>18</sup>A previous study by [Bertonazzi, Maloney, and McCormick \(1993\)](#) provides empirical evidence of the validity Alchian and Allen proposition in the case of consumers being "shipped" to goods.

<sup>19</sup>Otherwise the price-elasticity of freight rates would be equal to 1. They also find that freight rates increase with distance while the cost per unit decreases with units shipped.



## 2.3. COGNAC QUALITY DESIGNATIONS

point in response to an increase of ten cents of the average prices. They find therefore no evidence of the Alchian and Allen effect and conclude that: “these results are simply inconsistent with the expectations of the model” (p. 3). Another study focusing on the gasoline market is [Nesbit \(2007\)](#). Contrary to his predecessors, the author finds a negative (positive) and significant effect of unit taxes on regular (premium) market shares of gasoline using state-level daily data on gasoline sales from 1991 to 2001.<sup>20</sup>

Finally, [Crozet, Head, and Mayer \(2012\)](#) develop a [Melitz \(2003\)](#)-type model and study the Champagne market. They use experts (Parker’s and Juhlin’s) ratings to distinguish between different qualities of Champagne. They conclude that “Alchian-Allen effects are not entirely absent, but they have little impact on the main finding: higher quality generally increases FOB prices and export values over all distances” (p. 630-631).

## 2.3 Cognac Quality Designations

In this section we explain the definition of the different Cognac qualities and present a unique dataset of Cognac exports from 1967 to 2013. As stated in the introduction, Cognac makes a compelling case for empirically testing the impact of trade costs and the Alchian and Allen conjecture given that the definition of quality is objective and constant over time.

### 2.3.1 Qualities Depending on the Ageing System

The definition of the different qualities of Cognac depends on the production and ageing system, which are closely supervised by the BNIC. We have therefore a direct measure of product quality, a “physical” quality which is different than perceived quality. More precisely, the classification in a given designation is based on the minimum time in oak of the youngest *eau-de-vie* used in creating the blend.<sup>21</sup> Cognac VS (for Very Special) is the lowest quality of Cognac: the minimum time in oak legally required by the youngest *eau-de-vie* used in creating a VS Cognac is two years. Cognac VSOP (for Very Superior Old Pale) is the medium quality of Cognac: the minimum time in oak legally required by the youngest *eau-de-vie* used in creating a VSOP Cognac is four years. Cognac XO (for Extra Old) is the highest quality of Cognac: the minimum time in oak legally required by the youngest *eau-de-vie* used in creating a XO Cognac is six years (see figure 2.1).<sup>22</sup> The

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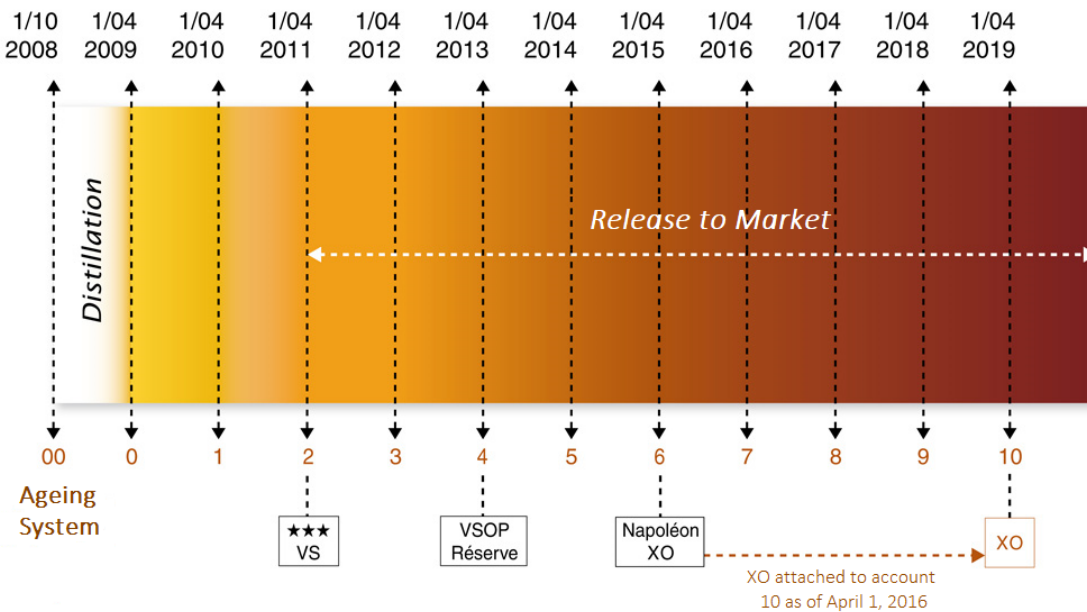
<sup>20</sup>[Nesbit’s \(2007\)](#) contribution is more relevant as an empirical validation of [Barzel’s \(1976\)](#) tax theory.

<sup>21</sup>Unlike wine, Cognac does not mature in bottle.

<sup>22</sup>The quality designations *VS*, *VSOP*, *XO* to be used based on the age of the Cognac in the blend were codified by a decision of the Government Commissioner to the BNIC in 1983. Raw data on Cognac exports at our disposal between 1967-1987 were classified only by the Cognac age. For this period of time we associated quality designations to the corresponding Cognac age based on the aforementioned

ageing system and indications are adopted by all the *Maisons de Cognac*. The quality of the different designations are reflected in the French market prices, as Cognac VS prices range from 25 to 45 euros per bottle, Cognac VSOP from 32 to 57 euros per bottle and finally Cognac XO from 45 to 94 euros per bottle.<sup>23</sup>

Figure 2.1 – Definition of Cognac Qualities



Source: BNIC (English translation by authors).

### 2.3.2 An Original Dataset

We build a unique database of Cognac exports based on raw data of shipments in volume and value terms by year, destination and quality designations provided by the BNIC. Our database covers a 47 year-long period of time from 1967 to 2013 with information on more than 160 countries.<sup>24</sup>

Figure 2.2 shows the Kernel distribution of the log of unit values by quality designations for 2013. Our objective is to see if the three objective Cognac quality definitions are in-definitions.

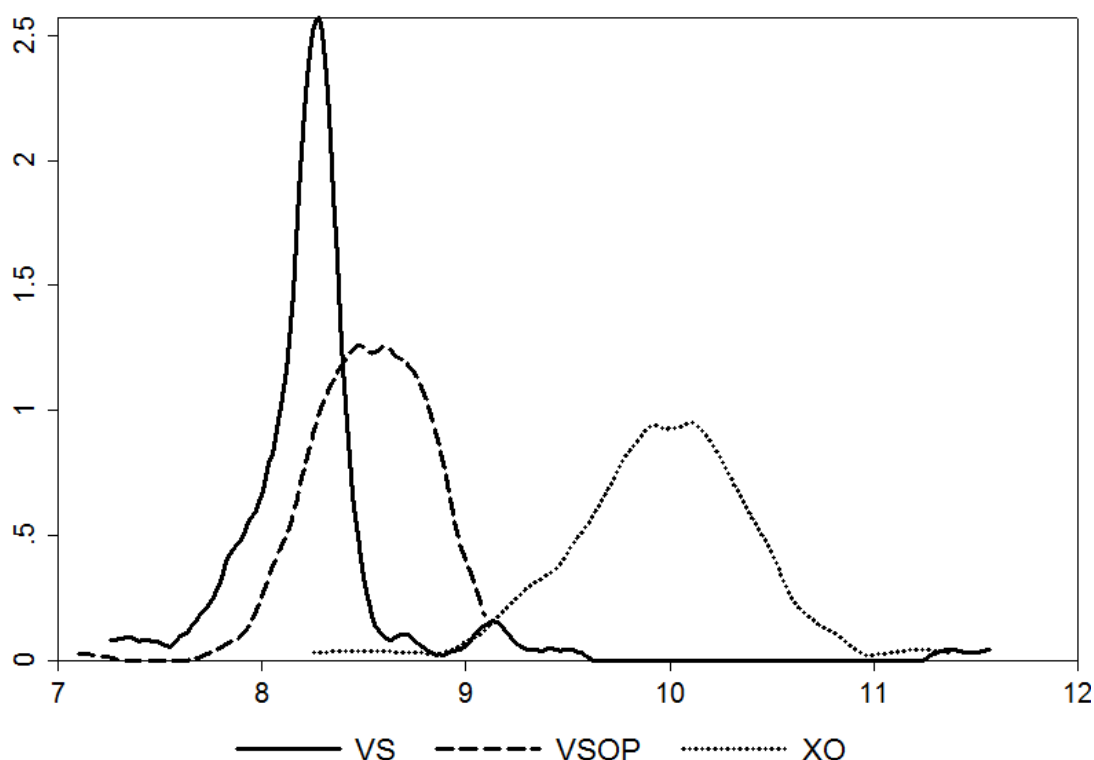
<sup>23</sup>All these figures are from Sud-Ouest - April 11, 2015. Some bottles of Cognac are much more expensive. The price of a bottle of Cognac Hennessy Paradis was 924 euros on February 2015 on the website LaCognatheque. On the same website you could buy at the same date a bottle of Richard Hennessy for 2780 euros. Paradis is made of eau-de-vie of at least 25 years (40 years in the case of a bottle of Richard Hennessy).

<sup>24</sup>Sections A.3 and A.4 of the global appendix provide respectively, details on the compilation of this database and more stylized facts on the evolution of Cognac shipments from 1967 to 2013.

### 2.3. COGNAC QUALITY DESIGNATIONS

deed perceived as different qualities by foreign consumers based on their price differences. The highest Cognac quality has distinctly a larger price range and is more expensive than VS and VSOP. The VS unit price is lower and more concentrated. While VSOP's price is in the mid-range segment, it is closer to the lower than higher quality Cognac.

**Figure 2.2 – Kernel Density of Export Unit Values (in Log) by Quality Designations, 2013**

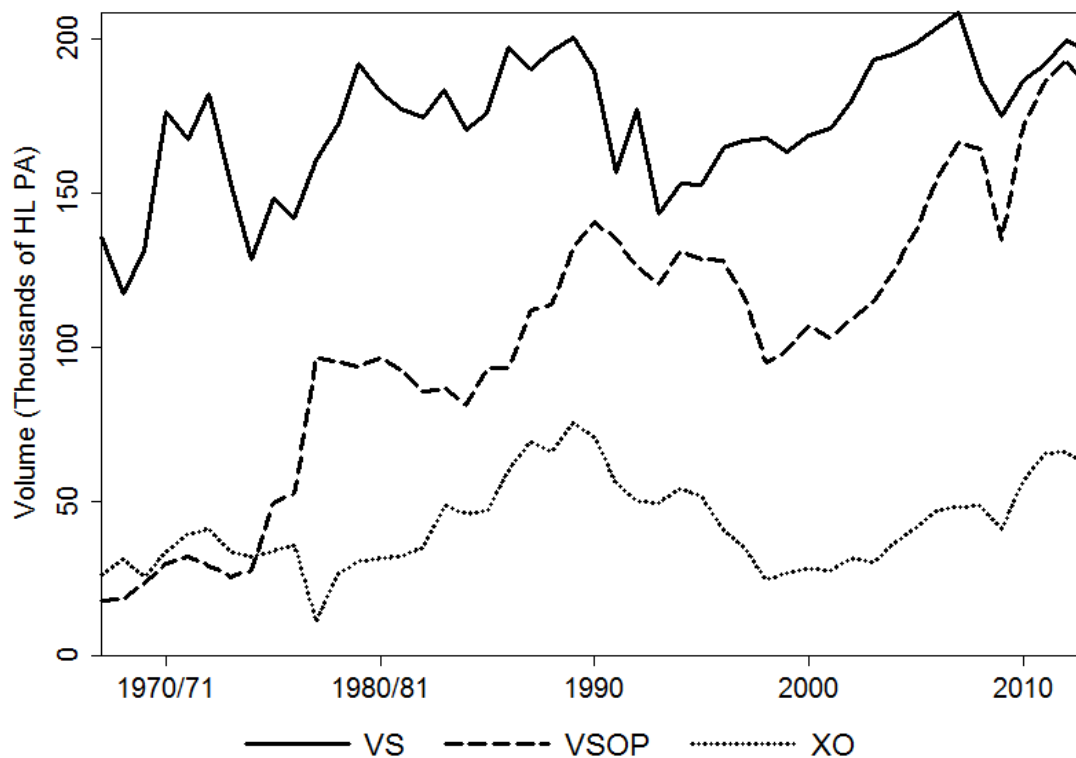


Source: authors; raw data from BNIC.

Figure 2.3 shows the evolution of the quality mix of French Cognac exports to all destinations for 1967-2013. While the low quality Cognac has always dominated total shipments in terms of volume, its relative importance has decreased from 76% in 1967 to 44% of total exports in 2013. VSOP Cognac shares have more than quadrupled during the same period of time, from 10% to 42% of total exports. The highest quality Cognac exports have increased in volume terms but their relative importance was the same in 2013 compared to 1967: 14% of total exports.

In the following sections, we use this original dataset of Cognac exports to analyze the impact of trade cost on the Cognac quality mix, first by focusing on the impact of distance and tariffs, and second by exploiting time variations in transport costs, through containerization.

Figure 2.3 – Evolution of Cognac Exports by Quality Designations, 1967-2013



Source: authors; raw data from BNIC.

## 2.4 Distance, Tariffs and Quality Mix

In this section, we assess the determinants of the quality mix of French exports of Cognac. We study in particular to what extent trade costs (distance, ad valorem and specific duties), impact the share and the relative price of high quality Cognac in the destination country.

### 2.4.1 Stylized Facts

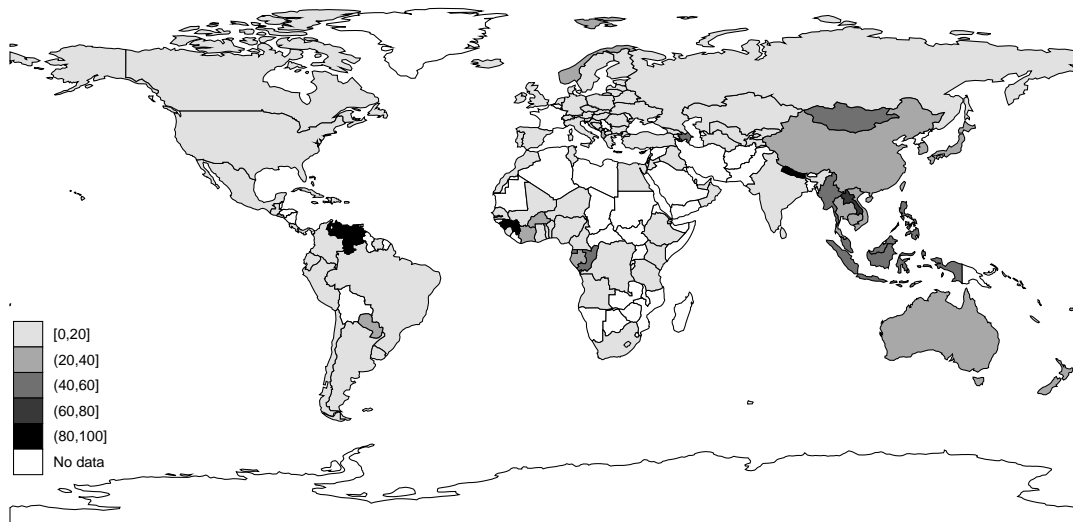
Figure 2.4 shows the share of the highest (XO) quality of Cognac in countries' imports in 2013.<sup>25</sup> The quality mix appears to vary among countries. High quality (XO) accounts for more than a third of Cognac imports in some distant Asian countries as China and Hong Kong. European and American countries on the other hand, exhibit the opposite pattern, importing therefore higher shares of low and medium quality Cognac.<sup>26</sup>

<sup>25</sup>Figure 2.8 in the appendix to chapter two shows the share of the lowest (VS) quality of Cognac in countries' imports in 2013.

<sup>26</sup>See details for the main markets for XO and VS in Tables 2.5 and 2.6 respectively, in the appendix to chapter two.

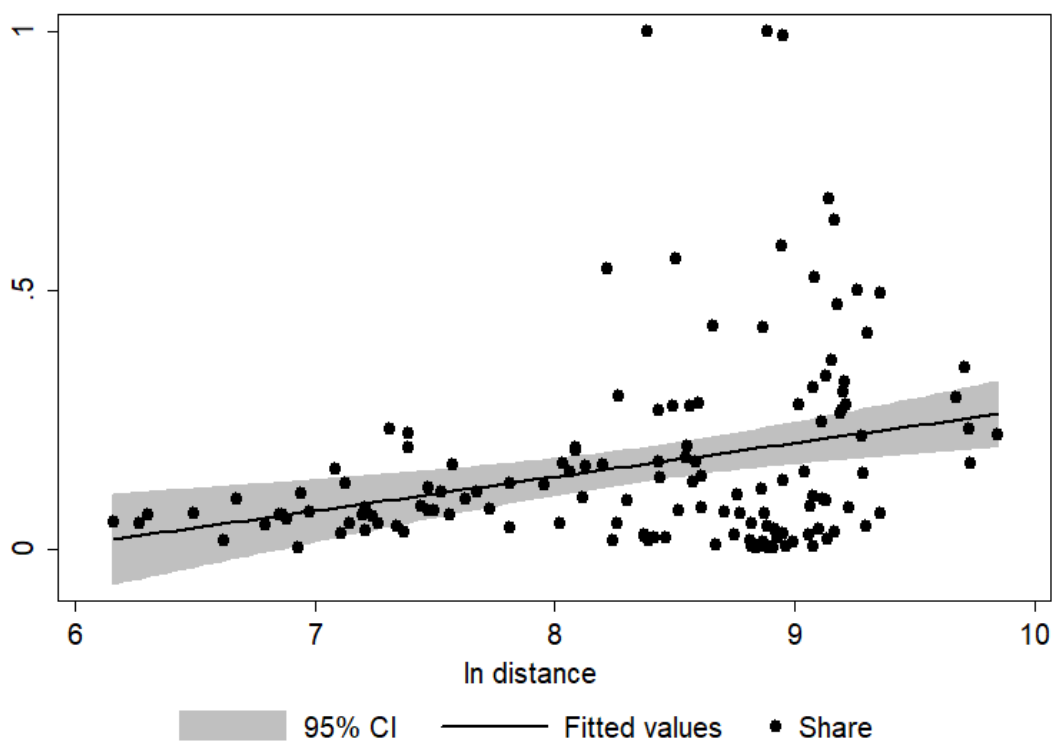
## 2.4. DISTANCE, TARIFFS AND QUALITY MIX

Figure 2.4 – Share of XO in Cognac’s Imports by Country, 2013



Source: authors; raw data from BNIC.

Figure 2.5 – Share of XO in Cognac’s Exports According to Distance, 2013



Source: authors; raw data from BNIC.

To go further, Figure 2.5 plots the share of the highest quality in imports of various countries in 2013, according to their distance to France.<sup>27</sup> It shows an increasing relationship between the XO share in a country's imports and its distance from France. This stylized fact seems to confirm the Alchian and Allen conjecture, stating that transport costs increase the relative demand for more expensive/higher quality goods.

## 2.4.2 Empirical Strategy and Data

To test the predictions of the Alchian and Allen conjecture, we investigate the determinants of the share of high quality (XO) Cognac and its relative price in the country of destination. We expect distance and per-unit duties to have a positive impact on the share of higher quality Cognac and a negative effect on its relative price.

We estimate the following equation:

$$X_{jt} = \alpha_0 + \alpha_1 \ln(Y_{jt}) + \alpha_2 \ln(y_{jt}) + \alpha_3 \ln(d_j) + \alpha_4 \ln(e_{jt}) + \alpha_5 \ln(adv_{jt}) + \alpha_6 \ln(spe_{jt}) + \nu_t + u_{jt} \quad (2.2)$$

$X_{jt}$  is our dependent variable: i) the share of XO in Cognac exports to country  $j$  at year  $t$ , in volume and ii) the price of XO exported to country  $j$  at year  $t$ , relative to the mean price of the three qualities in  $j$  at year  $t$ .  $Y_{jt}$  and  $y_{jt}$  are respectively the GDP and the per-capita GDP of country  $j$  at year  $t$ ,  $d_j$  the distance from France to country  $j$ ,  $e_{jt}$  the nominal exchange rate of country  $j$ 's currency vis-a-vis the Euro at year  $t$ .  $adv_{jt}$  and  $spe_{jt}$  are ad valorem (defined in percentage) and specific duties (defined in monetary units by units of volume), implemented by country  $j$  at year  $t$ .<sup>28</sup> Finally, time fixed effects  $\nu_t$  are included to control for the supply side and  $u_{jt}$  is the error term.

The data sources of our independent variables are specified in chapter one, section 1.4.1

Equation 2.2 is estimated using OLS over the period from 1996 to 2013, because tariffs data are not available before 1996. We only keep in our panel countries that import all three qualities of Cognac at a given year. We purposefully restrict our panel in order to comply with one of the assumptions of the Alchian and Allen proposition that all qualities be consumed at destination country.<sup>29</sup> We also exclude from our panel "small island" countries that exhibit a pattern in tariffs data that might bias our results.<sup>30</sup>

<sup>27</sup>Figure 2.9 in the appendix to chapter two plots the share of VS in Cognac's exports according to distance in 2013.

<sup>28</sup>We take the power of the ad valorem and specific duties, i.e.  $(1 + adv_{jt})$  and  $(1 + spe_{jt})$  respectively.

<sup>29</sup>Including the dropped observations (121) does not significantly alter our results.

<sup>30</sup>The excluded countries are the following: American Oceania, Andorra, Anguilla, Antigua and Bar-

## 2.4. DISTANCE, TARIFFS AND QUALITY MIX

### 2.4.3 Results

Table 2.1 reports our baseline estimate of equation 2.2 on the share of XO in Cognac exports.<sup>31</sup> The first column of Table 2.1 shows the estimation of equation 2.2 without customs protection data. The distance exhibits a positive coefficient, meaning that France exports a higher proportion of high quality varieties to remote destinations, due to transport cost. This outcome is in line with the predictions of the Alchian and Allen theorem. The result remains unchanged when we include tariffs and total per-capita Cognac imports in columns (2) and (3).

Specific tariffs have a positive impact on the quality mix (column 2). This result also confirms the Alchian and Allen effect as per-unit duties, same as distance, increase the share of exports of high-quality Cognac. This result is robust to the inclusion of the total per-capita Cognac imports in column (3). The coefficient of the ad valorem duties on the other hand is insignificant. In line with the findings of [Hummels and Skiba \(2004\)](#), we could expect a negative effect of ad valorem duties on the share of XO Cognac exports. We find no evidence of such an effect. Our finding could be explained considering the nature of Cognac as a luxury product. Examining the quality mix of a luxury product becomes therefore more complex than what the original theoretical model and its extensions predicted (see sections 2.2.1 and 2.2.2). It is therefore not implausible that ad valorem duties have an insignificant impact on the share of XO exports.<sup>32</sup>

In columns (4) and (5), we propose two robustness checks of our baseline estimation by excluding countries with a high level of Cognac re-exportation (Hong Kong, the Netherlands, Panama, Singapore and United Arab Emirates)<sup>33</sup> or main importing countries (US, China and Japan). Our results remain unchanged.

In all specifications, the GDP of country  $j$  appears to have an insignificant impact on the share of XO, while the coefficient of the per-capita GDP is positive and significant. The latter result seems to confirm [Linder's \(1961\)](#) theory and [Hallak's \(2006\)](#) empirical findings that rich countries have a preference for imports of higher quality goods.

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buda, Aruba, Bahamas, Barbados, Belize, Cayman Islands, Djibouti, Fiji, Gibraltar, Grenada, Guyana, Macao, New Caledonia, Netherlands Antilles, Northern Mariana Islands, Saint Barthélemy, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, San Marino, Seychelles, Trinidad and Tobago, Turks and Caicos Islands, Vanuatu, British Virgin Islands, US. Virgin Islands.

<sup>31</sup>We “lump” VS and VSOP together and present only the estimation results for the share of XO exports, because the low and mid qualities’ price ranges diverge more when compared to the XO unit price range than to each other (see section 2.3.2 and Figure 2.2 for more details).

<sup>32</sup>[Bouët et al. \(2017\)](#) show that Cognac export flows are less sensitive to distance compared to other goods and even other luxury goods. Moreover, our estimated coefficient of the per-unit duties is relatively small: 0.01.

<sup>33</sup>The list of re-exporting countries is provided by the BNIC.

**Table 2.1 – OLS Estimation: Share of XO in Total Cognac Exports, 1996-2013**

	(1)	(2)	(3)	(4)	(5)
	Full panel of countries	Full panel of countries	Full panel of countries	W/O. Re-exp. countries	W/O. US, China & Japan
$\ln \text{Distance}_j$	0.05*** (0.00)	0.05*** (0.00)	0.05*** (0.00)	0.04*** (0.00)	0.05*** (0.00)
$\ln \text{Per-unit Duty}_{jt}$		0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
$\ln \text{Ad valorem Duty}_{jt}$		0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
$\ln \text{GDP}_{jt}$	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
$\ln \text{GDP}/\text{cap}_{jt}$	0.01*** (0.00)	0.01*** (0.00)	0.02*** (0.00)	0.02*** (0.00)	0.03*** (0.00)
$\ln \text{Exchange rate}_{jt}$	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
$\ln \text{Cognac Imports}/\text{cap}_{jt}$			-0.00*** (0.00)	-0.01*** (0.00)	-0.00** (0.00)
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1852	1668	1668	1607	1615
Adjusted $R^2$	0.122	0.138	0.141	0.135	0.147

Robust standard errors in parentheses. In all columns we exclude “small island” countries.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

The estimated coefficient of the exchange rate is positive. The appreciation of the Euro increases the share of XO in Cognac exports. This result suggests a Veblen effect in the case of Cognac’s highest quality. The demand for this product increases with its price, due to the appreciation of the Euro.<sup>34</sup>

So far our results confirm the predictions of the Alchian and Allen conjecture as to the impact of distance and per-unit duties on the the share of high quality Cognac in total exports. We now estimate equation 2.2 on the relative price of XO (high quality) to test

<sup>34</sup>While this variable plays an important role as a determinant of Cognac exports, we believe that Cognac Houses’ management of the exchange rate risk and its volatility is quite complex and goes beyond the scope of the present analysis.



## 2.4. DISTANCE, TARIFFS AND QUALITY MIX

**Table 2.2 – OLS Estimation: XO Relative Export Price, 1996-2013**

	(1)	(2)	(3)	(4)	(5)
	Full panel of countries	Full panel of countries	Full panel of countries	W/O. Re-exp. countries	W/O. US, China & Japan
ln Distance <sub><i>j</i></sub>	-0.02*** (0.01)	-0.02** (0.01)	-0.02*** (0.01)	-0.03*** (0.01)	-0.02** (0.01)
ln Per-unit Duty <sub><i>jt</i></sub>		-0.01** (0.00)	-0.01 (0.00)	-0.00 (0.00)	-0.01* (0.00)
ln Ad valorem Duty <sub><i>jt</i></sub>		-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.02 (0.01)
ln GDP <sub><i>jt</i></sub>	-0.01*** (0.00)	-0.01*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)	-0.01* (0.00)
ln GDP/cap <sub><i>jt</i></sub>	-0.01 (0.01)	-0.01* (0.01)	0.02** (0.01)	0.02** (0.01)	0.01 (0.01)
ln Exchange rate <sub><i>jt</i></sub>	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
ln Cognac Imports/cap <sub><i>jt</i></sub>			-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)
Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1852	1668	1668	1607	1615
Adjusted $R^2$	0.107	0.113	0.127	0.123	0.115

Robust standard errors in parentheses. In all columns we exclude “small island” countries.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

the predictions on the relative prices. Table 2.2 follows exactly the same specifications as Table 2.1, but with  $UV_{jt}$  the price of the quality XO relative to the mean price of the three qualities as dependent variable. The results are consistent with those on the share of high qualities. The relative price of high quality cognac (XO) decreases with distance, while this variable increases the share of XO in the destination market. This result is robust to several specifications (see columns (3) to (5)). We find a similar impact for specific duties.<sup>35</sup> These findings support the predictions of the Alchian and Allen model on relative prices. The ad valorem duties’ estimated coefficient on the other hand is non-significant.

<sup>35</sup>With the exception of columns (3) and (4) of Table 2.2: the estimated coefficient of per-unit duties becomes nonsignificant.

The estimated coefficient of the GDP is negative and significant. The per-capita GDP has a less robust effect, that depends on the specifications. The effect of the exchange rate on the relative export price of XO Cognac is consistent with our findings on the XO share.

In Table 2.7 (see appendix to chapter two) we perform another robustness check, using an alternative estimation method: the Pseudo-Poisson-Maximum Likelihood (PPML) method. Columns (1) and (2) report respectively the results of the share of XO exports and their relative export prices. Our findings are qualitatively similar to those presented in Tables 2.1 and 2.2.

## 2.5 Containerization and Quality Mix

Until now we have studied the impact of trade costs across countries. In this last empirical section, we take interest in the effect of trade costs within countries. To do so, we exploit the variation over time in transport costs using the historical episode of the containerization and investigate its impact on the quality mix of Cognac exports.

### 2.5.1 Stylized Facts on Containerization

Maritime transport has played a key role in Cognac history starting as early as the birth of the product itself, and later on with the establishment of regular trade links between the French region and northern Europe in the 18<sup>th</sup> century.<sup>36</sup> Since then, Cognac has been and continues to be an export product. Major changes to the maritime shipping methods and overall transport technology such as the introduction of containerization in the 20<sup>th</sup> are unlikely to have left unaffected the international trade of Cognac.

Containerization is the method of shipping goods via containers. First introduced in the United States in the second half of the 1950s<sup>37</sup>, containerization revolutionized transportation in the 20<sup>th</sup> century. According to [Bernhofen, El-Sahli, and Kneller \(2016\)](#) (p. 39):

*“From a transportation technology perspective, containerization resulted in the introduction of intermodal freight transport, since the shipment of a container can use multiple modes of transportation - ship, rail or truck - without any handling of the freight when changing modes. By eliminating sometimes as many as a dozen separate handlings of the cargo, the container resulted in linking the producer directly to the customer.”*

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<sup>36</sup>Cognac was first shipped in barrels. It has been shipped in bottles from the 19<sup>th</sup> century onward.

<sup>37</sup>For a detailed description and empirical analysis of the determinants of the diffusion of containerization see [Rua \(2014\)](#).

## 2.5. CONTAINERIZATION AND QUALITY MIX

The overall quality of transport services improved and expenses decreased as a result of the introduction of containerization. We are interested in studying its impact and the resulting variation in trade costs on the Cognac quality mix.

Containerization is responsible for a reduction in the total costs of shipment from producers to customers through different channels: improvement of dock labor productivity, increase of shipment sizes, reduction of cargo damage and pilferage, decrease in the duration of travel journeys etc. It is however difficult to quantify the impact of containerization on port-to-port freight costs. There is nevertheless evidence brought forward by [Bernhofen et al. \(2016\)](#) based on [McKinsey's \(1972\)](#) work regarding *resource savings* as a result of the adoption of containerization between 1965 and 1970/1971.<sup>38</sup> In this respect, the authors point out that insurance costs for a journey between Australia and Europe dropped from “an average of 24 pennies per ton to 4 pennies per ton” (p.39). Moreover, as a result of a significant reduction in the duration of travel journeys (from 70 to 34 days between the two continents), the “capital cost of inventory” decreased from 2 pounds per ton to 1 pound per ton (p. 39).

This evidence points toward a reduction of the per-unit trade costs as a result of countries entering the age of containerization. We expect therefore this technological change to have the opposite impact of distance on the Cognac quality mix, namely a negative effect on the share of higher quality Cognac and a positive effect on its relative price.

As previously stated, it is difficult to exactly quantify the impact of containerization on freight costs. It is also highly likely that containerization led not only to a decrease of per-unit trade costs, but also of ad valorem charges. Unfortunately we do not have data on their magnitude. However, based on the information we display, we believe to be plausible that the reduction of per-unit trade costs as a result of containerization was relatively bigger than the reduction in the ad valorem charges.

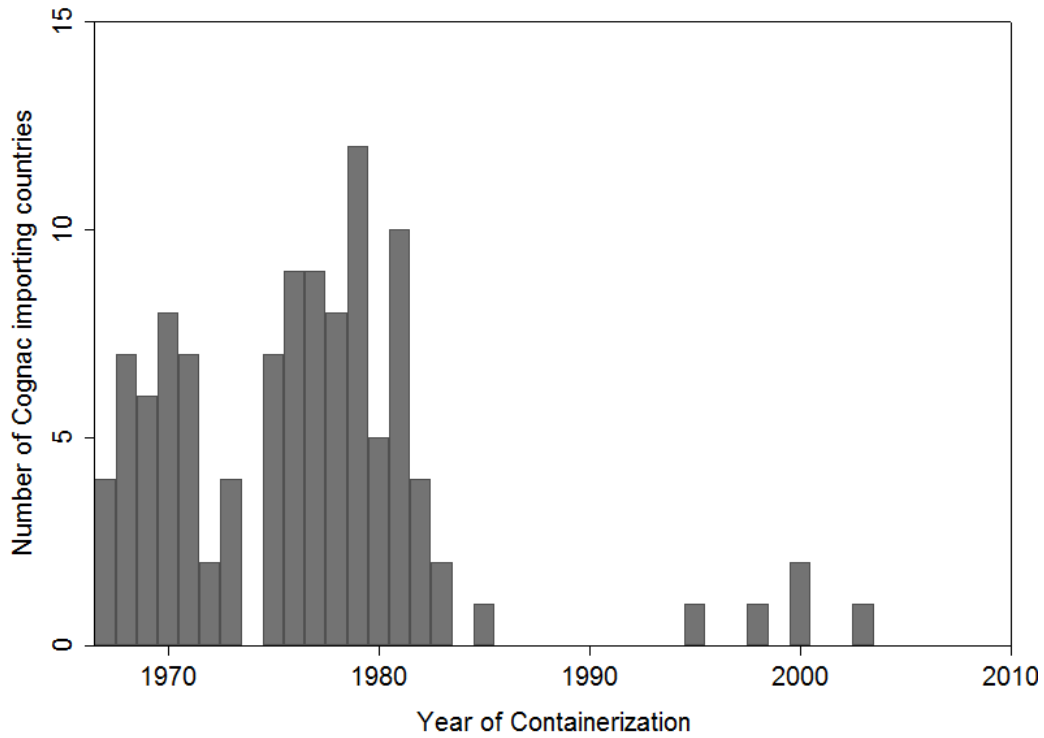
Using [Rua's \(2014\)](#) data on the years of adoption of containerization by country (i.e. when the first port was containerized), figure 2.6 shows that the majority of Cognac importing countries adopted containerization in the mid 1970s and beginning of the 1980s.<sup>39</sup> The United States was the first country to adopt containerization in 1956, while France's first port was containerized in 1968. The most recent adopters include: Cambodia (2003), Vietnam (2000) and Cuba (2000).

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<sup>38</sup>For further details, see Table 1, page 39 in [Bernhofen et al. \(2016\)](#).

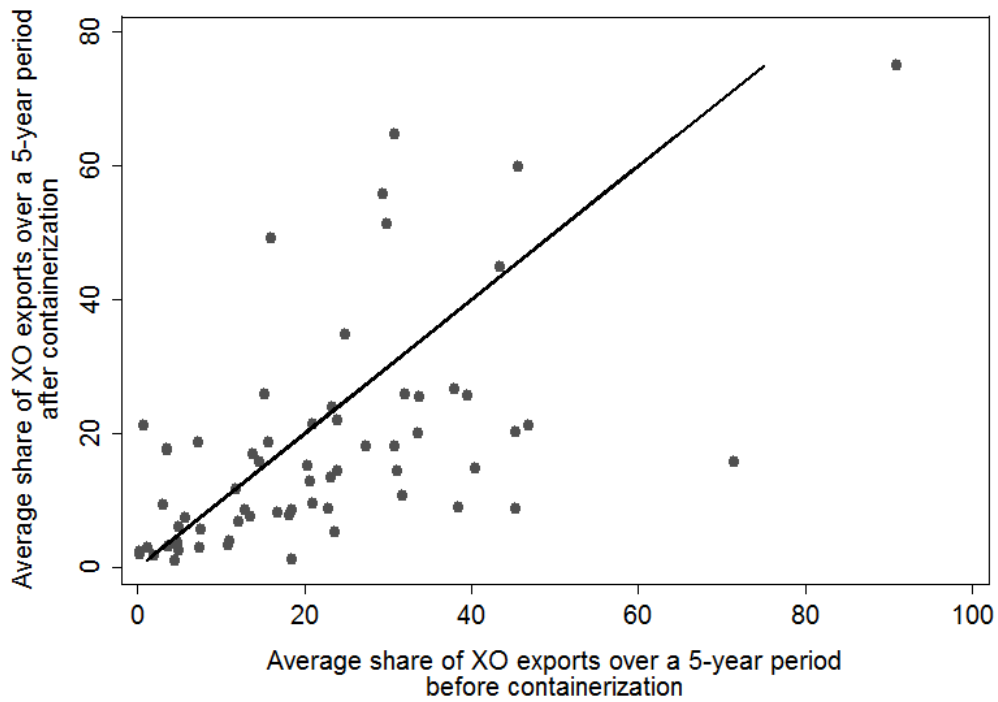
<sup>39</sup>A complete list of Cognac importing countries and their containerization dates is provided in the appendix, Table 2.8.

Figure 2.6 – Number of Cognac Importing Countries by Containerization Date



Source: authors; containerization dates from Rua (2014).

Figure 2.7 – Share of XO Exports Before and After Containerization



Source: authors; containerization dates from Rua (2014).

## 2.5. CONTAINERIZATION AND QUALITY MIX

In order to see if there is indeed a difference in the share of XO Cognac in total exports after the adoption of containerization, we have a first glance at the data in figure 2.7. We show the evolution of the average share of exports of higher quality Cognac during a 5-year period before and after the containerization. There seems to be a negative relation between the share of XO in Cognac exports and the *post-containerization* period. This would confirm the Alchian and Allen conjecture. We empirically assess this effect in the next section.

### 2.5.2 Empirical Strategy and Data

Despite extensive literature on transportation economics acknowledging the change and improvement in shipping methods brought by containerization<sup>40</sup>, there are seldom empirical studies quantifying this effect, and fewer regarding the impact of containerization on the trade of goods. A notable exception is the study by Bernhofen et al. (2016) that estimates the impact of containerization during 1962-1990 and finds that containerization is associated with statistically significant and larger bilateral trade whether between North-North countries or worldwide trade.

Following the same empirical strategy as in section 2.4.2, we test the Alchian and Allen conjecture by investigating the impact of the reduction of trade costs as a result of the adoption of containerization on the XO share and its relative price in the country of destination.

We estimate the following equation:

$$\begin{aligned} Z_{jt} = & \beta_0 + \beta_1 \ln(Y_{jt}) + \beta_2 \ln(y_{jt}) + \beta_3 \ln(e_{jt}) + \beta_4 \text{Container}_{jt} + \beta_5 \text{After}_{jt} \\ & + \nu_t + \nu_j + u_{jt} \end{aligned} \quad (2.3)$$

$Z_{jt}$  is our dependent variable: (i) the share of XO in Cognac exports to country  $j$  at year  $t$ , in volume and (ii) the price of XO exported to country  $j$  at year  $t$ , relative to the mean price of the three qualities in  $j$  at year  $t$ .  $\text{Container}_{jt}$  is a dummy equal to 1 if country  $j$  adopted containerization at year  $t$ , 0 otherwise.  $\text{After}_{jt}$  is a dummy equal to 1 if country  $j$  adopted containerization at least 1 year before  $t$ , 0 otherwise.  $\nu_t$  and  $\nu_j$  are time and country fixed effects respectively.  $u_{jt}$  is the error term.<sup>41</sup>

Note that we distinguish between the adoption date and subsequent years because containerization initially involved major changes in port facilities to accommodate this tech-

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<sup>40</sup>See for example Levinson (2006).

<sup>41</sup>Data on customs protection are available from 1996 to 2013, therefore we do not include the customs protection variables when estimating equation 2.3.

nological advancement. Therefore, we do not expect the impact of containerization to be visible since the first year of adoption.

We use [Rua's \(2014\)](#) data on the dates when the first ports by destination countries were containerized to construct the containerization dummies. The rest of the independent variables sources are the same to those explained in section [2.4.2](#).

Equation [2.3](#) is estimated for the 1969-2013 period using OLS.<sup>42</sup> As stated in section [2.4.2](#), we only keep in our panel countries that import all three qualities of Cognac at a given year.

### 2.5.3 Results

Table [2.3](#) presents the results of our baseline equation [2.3](#) on the share of XO Cognac in total exports. In the first column, the year of adoption of containerization by the first port in the destination country has no significant impact which is not surprising. The  $After_{jt}$  dummy is significant and negative. Our predictions are therefore confirmed. The reduction in trade costs as a result of the adoption of containerization impacts negatively the share of the higher quality Cognac.

As we only have data on the year of containerization by the *first* port in destination countries, we desegregate the  $After_{jt}$  dummy in columns (2) and (3), in order to capture more precisely after how many years the adoption of containerization has an impact.

We find a negative and significant effect on the shares of XO after three years of the containerization of the first port and onward. This result is robust when we add the per-capita Cognac consumption at destination countries as a control (column 3). These results confirm our expectations and provide further empirical evidence of the Alchian and Allen proposition.

The market size does not appear to have a significant impact on the XO share. The impact of the GDP on the XO share is qualitatively similar to our previous results of our baseline estimation in section [2.4.3](#). On the other hand, the per-capita GDP of destination countries' impact on the XO share depends on the specification. The exchange rate has no significant impact on the share of XO Cognac.

In columns (4) to (6) we perform several robustness checks. In column (4) we use an alternative source for the containerization dates based on [Bernhofen et al. \(2016\)](#). They cover

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<sup>42</sup>France's first port was containerized in 1968, therefore we exclude from our panel the 1967 and 1968 Cognac trade data.

## 2.5. CONTAINERIZATION AND QUALITY MIX

**Table 2.3 – OLS Estimation: Share of XO in Total Cognac Exports, 1969-2013**

	(1)	(2)	(3)	(4)	(5)	(6)
	Full panel of countries	Full panel of countries	Full panel of countries	Bernhofen & al. (2016)	W/O. re-export. countries	W/O. U.S., China & Japan
Container. $_{jt}$	-0.01 (0.02)	-0.01 (0.02)	-0.01 (0.02)	-0.04 (0.02)	-0.01 (0.02)	-0.03* (0.02)
After $_{jt}$	-0.04*** (0.01)					
1Y after container. $_{jt}$		-0.02 (0.02)	-0.02 (0.02)	-0.03 (0.02)	-0.03 (0.02)	-0.03* (0.02)
2Y after container. $_{jt}$		-0.01 (0.02)	-0.01 (0.02)	-0.03 (0.02)	-0.01 (0.02)	-0.02 (0.02)
3Y after container. $_{jt}$		-0.06*** (0.02)	-0.06*** (0.02)	-0.04** (0.02)	-0.06*** (0.02)	-0.06*** (0.02)
4Y after container. $_{jt}$		-0.05*** (0.02)	-0.05*** (0.02)	-0.05*** (0.02)	-0.05*** (0.02)	-0.06*** (0.01)
5+Y after container. $_{jt}$		-0.05*** (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.05*** (0.01)	-0.06*** (0.01)
ln GDP $_{jt}$	0.01 (0.02)	0.01 (0.02)	-0.00 (0.02)	0.01 (0.02)	0.01 (0.02)	-0.00 (0.02)
ln GDP/cap $_{jt}$	-0.06*** (0.02)	-0.06*** (0.02)	-0.02 (0.02)	-0.04 (0.02)	-0.03 (0.02)	-0.02 (0.02)
ln Exchange rate $_{jt}$	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ln Tot Cognac Imp./cap $_{jt}$			-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2793	2793	2793	2429	2682	2662
Adjusted $R^2$	0.481	0.482	0.487	0.504	0.450	0.496

Robust standard errors in parentheses. In all columns we exclude “small island” countries.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

countries that have containerized up until 1983.<sup>43</sup> A full list of countries and their con-

<sup>43</sup>The two databases differ in the years of adoption of containerization for almost half of the Cognac importing countries. These differences are probably due to data sources. Rua (2014) constructs her database based on the: *Containerisation International Yearbook*, *Shipping Statistics Yearbook* and *Lloyd’s Ports of the World*. Bernhofen et al. (2016) mention gathering information “scattered in transportation industry journals” (p. 36).

**Table 2.4 – OLS Estimation: XO Relative Export Price, 1969-2013**

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	Full	Bernhofen	W/O.	W/O.
	panel of	panel of	panel of	& al.	re-export.	U.S.,
	countries	countries	countries	(2016)	countries	China &
						Japan
Container. $_{jt}$	0.01 (0.03)	0.02 (0.03)	0.02 (0.03)	0.05 (0.04)	0.02 (0.03)	0.02 (0.03)
After $_{jt}$	0.04* (0.02)					
1Y after container. $_{jt}$		-0.01 (0.03)	-0.00 (0.03)	0.01 (0.03)	-0.00 (0.03)	-0.01 (0.03)
2Y after container. $_{jt}$		0.02 (0.04)	0.02 (0.04)	0.08** (0.03)	0.03 (0.04)	0.02 (0.04)
3Y after container. $_{jt}$		0.04 (0.03)	0.04 (0.03)	0.06* (0.03)	0.04 (0.03)	0.04 (0.03)
4Y after container. $_{jt}$		0.04 (0.03)	0.04 (0.03)	0.05 (0.03)	0.05 (0.03)	0.04 (0.03)
5+Y after container. $_{jt}$		0.06** (0.03)	0.07*** (0.03)	0.11*** (0.03)	0.08*** (0.03)	0.06** (0.03)
ln GDP $_{jt}$	-0.03 (0.04)	-0.04 (0.04)	-0.02 (0.04)	0.00 (0.05)	-0.02 (0.04)	-0.06 (0.04)
ln GDP/cap $_{jt}$	0.01 (0.04)	0.02 (0.04)	-0.04 (0.04)	-0.05 (0.05)	-0.04 (0.05)	-0.00 (0.04)
ln Exchange rate $_{jt}$	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)
ln Tot Cognac Imp./cap $_{jt}$			0.02*** (0.01)	0.02*** (0.01)	0.02*** (0.01)	0.02*** (0.01)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2793	2793	2793	2429	2682	2662
Adjusted $R^2$	0.604	0.605	0.607	0.615	0.600	0.626

Robust standard errors in parentheses. In all columns we exclude “small island” countries.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

tainerization dates is provided in the appendix 2.D. Our results are robust. In columns (5) and (6) we exclude from our panel re-exporting countries and the US, Japan and China, respectively. Our main finding is unaltered: post-containerization has impacted negatively the shares of higher quality Cognac, providing further empirical evidence of the validity of the Alchian and Allen conjecture.



## 2.6. CONCLUSION

Table 2.4 shows the results of our estimation of equation 2.3 on the relative price of the higher quality Cognac. Post-containerization (column 1) has a positive impact on the relative price of XO which is in line with our predictions. By decomposing the  $After_{jt}$  dummy variable, we find that the impact on the relative price becomes apparent starting 5 years after the containerization. This result is unaltered when we control for the per-capita Cognac consumption at destination countries (column 3). Our results with respect to the impact of the adoption of containerization on the relative price of higher quality Cognac are overall in line with our results of its impact on the share of XO Cognac.

Our robustness tests shown in columns (4) to (6) confirm our previous findings. Containerization has a positive impact on the relative price of XO Cognac starting from 5 years after its adoption. When we use the Bernhofen et al. (2016) database, the effect is present starting from three years after the initial adoption. This result confirms our predictions.

In Table 2.9 in the appendix to chapter two we perform further robustness checks, using the PPML estimation method and find qualitatively similar results.

## 2.6 Conclusion

Using a unique database of annual Cognac shipments by volume, destination and quality designations, we test empirically the validity of Alchian and Allen's thesis according to which per-unit transportation costs increase the relative demand for higher quality goods. We test empirically the impact of trade costs on the share of higher quality (XO) Cognac and its relative price. First, we evaluate the impact of trade costs (distance and customs protection) across countries. Second, we investigate the effect of the variation in trade costs within countries as per the adoption of containerization. Our results validate the Alchian and Allen effect meaning that per-unit trade costs increase the relative demand of higher quality Cognac.

In the introduction to this chapter we stated that Cognac is a luxury product. We show that the Alchian and Allen effect is present even for a luxury product.

An object of our future consideration is to obtain producing firms' data and analyze their strategies and the determinants of their export performance. It would allow us to examine if the Alchian and Allen effect is due to cross-firm selection (only firms that produce higher quality goods export to more distant markets) or within-firm selection (firms choose higher quality and more expensive goods when they decide to export to more distant markets).

# Appendix to Chapter 2

## 2.A General Framework: Mathematical Proofs

### 2.A.1 The Alchian and Allen Effect in a Two-Good World

Proof of equation 2.1:

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{\frac{\partial X_{jH}}{\partial t_j} X_{jL} - X_{jH} \frac{\partial X_{jL}}{\partial t_j}}{X_{jL}^2} \quad (2.4)$$

From the chain rule we have:

$$\frac{\partial X_{jk}}{\partial t_j} = \frac{\partial X_{jk}}{\partial p_{jH}} + \frac{\partial X_{jk}}{\partial p_{jL}} \quad k = H, L.$$

Substituting into (2.4):

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{(\frac{\partial X_{jH}}{\partial p_{jH}} + \frac{\partial X_{jH}}{\partial p_{jL}})X_{jL} - X_{jH}(\frac{\partial X_{jL}}{\partial p_{jH}} + \frac{\partial X_{jL}}{\partial p_{jL}})}{X_{jL}^2}$$

<=>

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{(\epsilon_{HH} \frac{X_{jH}}{p_{jH}} + \epsilon_{HL} \frac{X_{jH}}{p_{jL}})X_{jL} - X_{jH}(\epsilon_{LH} \frac{X_{jL}}{p_{jH}} + \epsilon_{LL} \frac{X_{jL}}{p_{jL}})}{X_{jL}^2}, \text{ with } \epsilon_{km} = \frac{\partial X_{jk}}{\partial p_{jk}} \frac{p_{jk}}{X_{jk}}$$

<=>

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{X_{jH}}{X_{jL}} \left( \frac{\epsilon_{HH}}{p_{jH}} + \frac{\epsilon_{HL}}{p_{jL}} - \frac{\epsilon_{LH}}{p_{jH}} - \frac{\epsilon_{LL}}{p_{jL}} \right) \quad (2.5)$$

From Hick's third law (1946, p. 310-311) for two goods:  $\sum_{n=1}^2 \epsilon_{ln} = 0$ ,  $l = 1, 2$ . Substituting  $\epsilon_{HH}$  with and  $-\epsilon_{HL}$  and  $-\epsilon_{LH}$  with  $\epsilon_{LL}$  into (2.5), we have:

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{X_{jH}}{X_{jL}} \left( \frac{-\epsilon_{HL}}{p_{jH}} + \frac{\epsilon_{HL}}{p_{jL}} + \frac{\epsilon_{LL}}{p_{jH}} - \frac{\epsilon_{LL}}{p_{jL}} \right)$$

<=>

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{X_{jH}}{X_{jL}} \left( \frac{1}{p_{jL}} - \frac{1}{p_{jH}} \right) (\epsilon_{HL} - \epsilon_{LL}) \quad (2.6)$$

## 2.A. GENERAL FRAMEWORK: MATHEMATICAL PROOFS

The term  $\frac{1}{p_{jL}} - \frac{1}{p_{jH}}$  in (2.6) is positive because  $p_{iH} > p_{iL}$ .

Indeed,  $p_{iH} > p_{iL} \Leftrightarrow p_{iH} + t_j > p_{iL} + t_j \Rightarrow p_{jH} > p_{jL} \Leftrightarrow \frac{1}{p_{jH}} < \frac{1}{p_{jL}}$

As long as  $X_{jH}$  and  $X_{jL}$  are close substitutes,  $\epsilon_{HL} > 0$ . Given that the own price-elasticity  $\epsilon_{LL} < 0$ , the term  $\epsilon_{HL} - \epsilon_{LL} > 0$ , therefore  $\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} > 0$ , verifying the Alchian and Allen effect.

Now consider that prices at destination country  $j$  depend on prices at origin country  $i$  and a per-value charge  $d_j$  such as:

$$p_{jk} = p_{ik} * d_j, \quad k = H, L.$$

We study how a change in  $d_j$  impacts the relative demand  $\frac{X_{jH}}{X_{jL}}$ .

Following the same mathematical steps of the demonstration above, we have:

$$\frac{\partial(X_{jH}/X_{jL})}{\partial d_j} = \frac{X_{jH}}{X_{jL}} \left( \frac{p_{iL}}{p_{jL}} - \frac{p_{iH}}{p_{jH}} \right) (\epsilon_{HL} - \epsilon_{LL}) \quad (2.7)$$

The term in the middle  $\frac{p_{iL}}{p_{jL}} - \frac{p_{iH}}{p_{jH}}$  is equal to zero. Proof:

$$\frac{p_{iL}}{p_{jL}} - \frac{p_{iH}}{p_{jH}} = \frac{p_{iL}p_{jH} - p_{iH}p_{jL}}{p_{jL}p_{jH}} = \frac{p_{iL}p_{iH} * d_j - p_{iH}p_{iL} * d_j}{p_{jL}p_{jH}} = 0$$

Consequently,  $\frac{\partial(X_{jH}/X_{jL})}{\partial d_j} = 0$ . For all else equal, the Alchian and Allen conjecture does not hold when an ad valorem charge (e.g. an “iceberg” transport cost or ad valorem duty) is added to the prices of the high and low quality goods.

### 2.A.2 The Alchian and Allen Effect in a Three-Good World

Let us suppose now that the demand for the high and low quality good at destination country  $j$  depends not only on  $p_{jH}$  and  $p_{jL}$ , but also on the price of a composite good (i.e. Hicksian good) denoted by  $p_{jC}$ <sup>44</sup>, such as:

$$X_{jk} = f(p_{jH}, p_{jL}, p_{jC}, U), \quad k = H, L.$$

From equation 2.5 and Hicks’ third law for three goods:  $\sum_{n=1}^3 \epsilon_{ln} = 0$ ,  $l = 1, 2, 3$ , we have:

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{X_{jH}}{X_{jL}} \left( \frac{-\epsilon_{HL} - \epsilon_{HC}}{p_{jH}} + \frac{\epsilon_{HL}}{p_{jL}} + \frac{\epsilon_{LL} + \epsilon_{LC}}{p_{jH}} - \frac{\epsilon_{LL}}{p_{jL}} \right)$$

<sup>44</sup>A composite good represents “all other goods”: “If the prices of a group of goods change in the same proportion, than that group of goods behaves as if it were a single commodity” (Hicks, 1946, p. 313).

## 2.A. GENERAL FRAMEWORK: MATHEMATICAL PROOFS

<=>

$$\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} = \frac{X_{jH}}{X_{jL}} \left[ \left( \frac{1}{p_{jL}} - \frac{1}{p_{jH}} \right) (\epsilon_{HL} - \epsilon_{LL}) + \frac{1}{p_{jH}} (\epsilon_{LC} - \epsilon_{HC}) \right] \quad (2.8)$$

The sign of  $\frac{\partial(X_{jH}/X_{jL})}{\partial t_j}$  depends on the sign of  $(\epsilon_{LC} - \epsilon_{HC})$ . The sign of the rest of the terms in brackets is positive as previously demonstrated.

[Borcherding and Silberberg \(1978\)](#) argue that if the two quality grades of the same good are close substitutes, “there is little reason to presume that their interactions with the composite commodity should be widely disparate” (p. 135). Therefore,  $\epsilon_{LC} - \epsilon_{HC}$  tends to zero and  $\frac{\partial(X_{jH}/X_{jL})}{\partial t_j} > 0$ , verifying the Alchian and Allen effect.

## 2.B Stylized facts: Main Markets

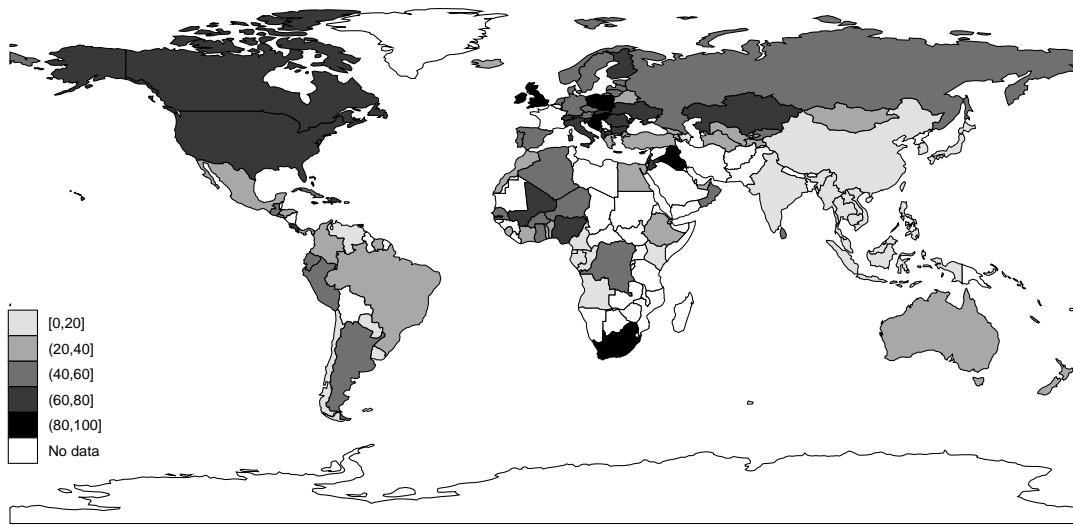
Table 2.5 – Descriptive Statistics - Share of XO in Imports of Main Markets

	Share in total exports	Share in XO exports	Nb. Obs.	mean	sd	min	max
Total	-	-	2842	13.64	14.47	0.01	95.01
USA	32.20	8.80	22	3.37	1.26	1.89	7.22
Singapore	17.62	27.54	22	27.48	6.36	18.98	39.08
China	12.66	28.24	22	34.94	15.69	10.16	73.42
UK	6.43	0.71	22	1.53	0.18	1.22	2.00
Germany	3.73	2.54	22	5.63	2.14	2.20	9.50
Hong Kong	2.93	9.93	22	38.80	9.19	17.93	53.78
Netherlands	2.27	1.11	22	4.73	1.87	1.89	7.92
Norway	1.73	2.75	22	18.12	7.93	2.13	26.05
Finland	1.42	1.11	22	11.21	4.44	6.16	23.68
Russia	1.33	0.94	22	12.25	4.56	2.43	22.23
Latvia	1.30	1.02	21	11.42	5.71	1.15	27.46
Malaysia	1.04	3.72	22	29.50	12.33	12.98	49.93
Nigeria	1.03	0.19	22	1.96	0.95	0.38	4.36
Ireland	0.93	0.01	22	0.25	0.08	0.11	0.44
Canada	0.89	0.43	22	6.68	1.21	3.66	8.46

Table 2.6 – Descriptive Statistics - Share of VS in Imports of Main Markets

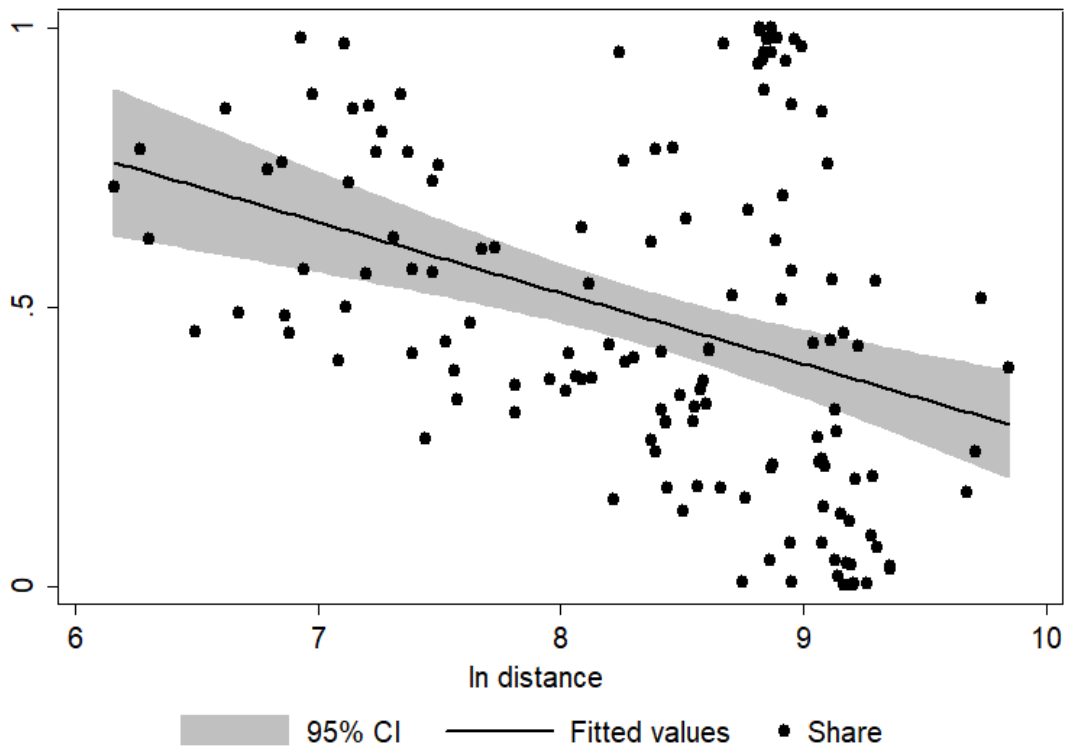
	Share in total exports	Share in VS exports	Nb. Obs.	Share of VS			
				mean	sd	min	max
Total	-	-	2842	45.22	27.57	0.00	99.57
USA	32.20	50.61	22	74.56	2.92	69.72	79.97
Singapore	17.62	3.52	22	1.95	2.15	0.32	8.89
China	12.66	2.16	22	8.30	16.41	0.00	71.15
UK	6.43	12.35	22	86.42	1.69	81.99	89.03
Germany	3.73	4.11	22	56.45	5.05	47.60	63.03
Hong Kong	2.93	0.26	22	1.75	1.07	0.64	3.99
Netherlands	2.27	2.33	22	60.59	8.93	45.54	74.46
Norway	1.73	1.62	22	51.47	9.65	35.19	66.01
Finland	1.42	1.93	22	60.82	3.52	53.90	67.71
Russia	1.33	1.62	22	37.00	11.62	8.24	55.01
Latvia	1.30	1.28	21	39.64	10.15	7.84	51.06
Malaysia	1.04	0.01	22	0.60	0.38	0.18	1.62
Nigeria	1.03	1.42	22	34.36	19.93	0.02	67.00
Ireland	0.93	2.07	22	97.96	0.60	96.68	98.96
Canada	0.89	1.35	22	65.40	4.88	51.57	73.35

Figure 2.8 – Share of VS in Cognac’s Imports by Country, 2013



Source: authors; raw data from BNIC.

Figure 2.9 – Share of VS in Cognac’s Exports According to Distance, 2013



Source: authors; raw data from BNIC.

## 2.C Distance, Tariffs and Quality Mix: An Additional Test

Table 2.7 – Alternative Estimation Method: PPML, 1996-2013

	(1) XO Share <sub>jt</sub>	(2) XO UV <sub>jt</sub>
ln Distance <sub>j</sub>	0.37*** (0.02)	0.37*** (0.02)
ln Per-unit Duty <sub>jt</sub>	0.04*** (0.01)	0.04*** (0.01)
ln Ad valorem Duty <sub>jt</sub>	0.07 (0.05)	0.07 (0.05)
ln GDP <sub>jt</sub>	-0.02* (0.01)	-0.02* (0.01)
ln GDP/cap <sub>jt</sub>	0.14*** (0.03)	0.14*** (0.03)
ln Exchange rate <sub>jt</sub>	0.06*** (0.01)	0.06*** (0.01)
ln Cognac Imports/cap <sub>jt</sub>	-0.03** (0.01)	-0.03** (0.01)
Time FE	Yes	Yes
Observations	1668	1668

Robust standard errors in parentheses.

In both columns we exclude “small island” countries.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

## 2.D Containerization: Databases

**Table 2.8 – Adoption of Containerization (First Port Containerized) by Cognac Importing Countries**

Country Name	Containerization Date ( <a href="#">Rua, 2014</a> )	Containerization Date ( <a href="#">Bernhofen et al., 2016</a> )
Algeria	1979	1979
Angola	1979	1979
Argentina	1977	1976
Aruba	1976	
Australia (and Papua New Guinea)	1964	1968
Austria	1982	1968 (*)
Bahamas	1972	1973
Bahrain	1977	1977
Bangladesh	1981	1981
Belgium (and Luxembourg)	1966	1968
Belize	1981	1981
Benin	1976	1976
Bermuda	1983	1983
Brazil	1971	1973
Bulgaria	1972	1972 (R)
Cambodia	2003	
Cameroon	1973	1974
Canada	1968	1968
Cayman Islands	1998	
Chile	1973	1974
China	1979	1979
Colombia	1971	1974 (R)
Congo	1979	1979
Congo, Democratic Republic of the	1981	1981
Costa Rica	1980	1981
Côte d'Ivoire	1970	1971
Cuba	2000	
Cyprus	1977	1977
Denmark	1969	1968
Djibouti	1979	1979
Dominican Republic	1976	1981

[Bernhofen et al. \(2016\)](#) database reports the dates of containerization by port or rail, whichever took place first.

Countries marked with (R) containerized by rail first and are dropped from the estimations. Countries marked with (\*) also containerized by rail first. Because the adoption occurred before port containerization comparing it to [Rua's \(2014\)](#) data, we substitute the latter to the former date.



## 2.D. CONTAINERIZATION: DATABASES

### Adoption of Containerization (First Port Containerized) by Cognac Importing Countries (Continued)

Country Name	Containerization Date ( <a href="#">Rua, 2014</a> )	Containerization Date ( <a href="#">Bernhofen et al., 2016</a> )
Ecuador	1970	1978
Egypt	1978	1978
El Salvador	1978	1979
Ex-Czechoslovakia	1979	1972 (*)
Ex-Yugoslavia	1970	1969 (*)
Finland	1970	1969
Former URSS	1971	1970 (R)
French Polynesia	1978	
Gambia	1982	1982
Germany	1968	1966
Ghana	1978	1977
Gibraltar	1978	1978
Greece	1971	1970
Guatemala	1976	1980
Guinea	1983	1983
Haiti	1976	1978
Honduras	1975	1975
Hong Kong	1970	1970
Hungary	1969	1968 (*)
Iceland	1973	1973
India	1971	1966 (*)
Indonesia	1975	1975
Iran, Islamic Republic of	1977	1977
Iraq	1977	1978
Ireland	1967	1968 (R)
Israel	1970	1970
Italy	1968	1968
Jamaica	1969	1973
Japan	1968	1969
Jordan	1976	1977
Kenya	1975	1976
Korea, Republic of	1975	1975
Kuwait	1977	1977
Lebanon	1977	1977
Liberia	1980	1980
Libya	1979	1980
Madagascar	1980	1980
Malta	1979	1983
Mauritania	1982	1982
Mexico	1976	1976
Morocco	1977	1977
Mozambique	1975	1978
Myanmar	1982	1983

[Bernhofen et al., 2016](#) database reports the dates of containerization by port or rail, whichever took place first.

Countries marked with (R) containerized by rail first and are dropped from the estimations. Countries marked with (\*) also containerized by rail first. Because the adoption occurred before port containerization comparing it to [Rua's \(2014\)](#) data, we substitute the latter to the former date.

### Adoption of Containerization (First Port Containerized) by Cognac Importing Countries (Continued)

Country Name	Containerization (Rua, 2014)	Containerization (Bernhofen et al., 2016)
Netherlands	1966	1966
Netherlands Antilles	1979	1979
New Caledonia	1981	1976
New Zealand	1967	1971
Nicaragua	1977	1979
Nigeria	1967	1974
Norway	1968	1969 (R)
Pakistan	1980	1979
Panama	1976	1974 (*)
Peru	1969	1975
Philippines	1971	1971
Poland	1970	1971
Portugal	1970	1969
Qatar	1979	1979
Romania	1981	1970 (*)
Samoa	1981	1978
Saudi Arabia	1976	1976
Senegal	1985	
Sierra Leone	1978	1978
Singapore	1969	1970
South Africa	1971	1974
Spain	1967	1968 (R)
Sudan	1979	1980
Sweden	1968	1968 (R)
Switzerland	1968	1968 (R)
Syrian Arab Republic	1979	1979
Taiwan, Province of China	1969	1968
Tanzania, United Republic of	1975	1978
Thailand	1975	1975
Togo	1981	1981
Trinidad and Tobago	1973	1971
Tunisia	1981	1981
Turkey	1981	1981
United Kingdom	1966	1966
United States	1956	1966
Uruguay	1980	1980
Vanuatu	1978	
Venezuela, Bolivarian Republic of	1981	1981
Viet Nam	2000	
Yemen	1978	

Bernhofen et al., 2016 database reports the dates of containerization by port or rail, whichever took place first.

Countries marked with (R) containerized by rail first and are dropped from the estimations. Countries marked with (\*) also containerized by rail first. Because the adoption occurred before port containerization comparing it to Rua's (2014) data, we substitute the latter to the former date.

## 2.E Containerization and Quality Mix: An Additional Test

Table 2.9 – Alternative Estimation Method: PPML, 1969-2013

	(1) XO Share <sub>jt</sub>	(2) XO UV <sub>jt</sub>
Containerization <sub>jt</sub>	-0.14 (0.13)	0.04* (0.02)
1Y after container. <sub>jt</sub>	-0.16 (0.11)	0.01 (0.02)
2Y after container. <sub>jt</sub>	-0.11 (0.11)	0.06** (0.02)
3Y after container. <sub>jt</sub>	-0.22** (0.10)	0.04* (0.02)
4Y after container. <sub>jt</sub>	-0.25*** (0.09)	0.03 (0.02)
5+Y after container. <sub>jt</sub>	-0.33*** (0.08)	0.08*** (0.02)
ln GDP <sub>jt</sub>	0.22* (0.13)	-0.01 (0.03)
ln GDP/cap <sub>jt</sub>	-0.16 (0.16)	-0.01 (0.03)
ln Exchange rate <sub>jt</sub>	0.00 (0.01)	-0.00 (0.00)
ln Tot Cognac Imports/cap <sub>jt</sub>	-0.06*** (0.02)	0.01*** (0.00)
Time FE	Yes	Yes
Country FE	Yes	Yes
Observations	2429	2429

Robust standard errors in parentheses.

In both columns we exclude “small island” countries.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Source: authors.

# Chapter 3

## Vertical Differentiation, Uncertainty, Product R&D and Policy Instruments in a North-South Duopoly<sup>1</sup>

### 3.1 Introduction

In the aftermath of the global economic crisis from which many developed and developing countries have still not fully recovered, decision makers' attention is increasingly drawn to structural reforms needed to raise their countries' competitiveness as one of the main drivers of economic prosperity.<sup>2</sup> Determining and implementing the right policies to improve competitiveness is a challenging issue and so it has been for years, especially in high-income economies facing growing competition from low-income ones.

According to the [Global Competitiveness Report for 2014-2015](#), economies which have successfully managed to stay the most competitive “are able to develop...and constantly introduce new and higher value-added products and services into the market” (see Key Findings, Smart Investing). Countries such as Switzerland, Singapore, the United States, Finland, Germany are ranked among the most competitive.<sup>3</sup> Not surprisingly, the ma-

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<sup>1</sup>This chapter is a substantially revised version of the LAREFI Working Paper N. 2016-02, jointly written with Julien Berthoumieu ([Berthoumieu and Lamani, 2016](#)). It has been submitted for publication in the *Canadian Journal of Economics*.

<sup>2</sup>Competitiveness (in international trade) may be defined as a measure of a country's advantage or disadvantage in selling its products on international markets (OECD).

<sup>3</sup>This ranking is based on the Global Competitiveness Index, developed by the World Economic Forum. The rest of the countries in the top ten of most competitive economies are: Japan, Hong Kong, the Netherlands, the United Kingdom and Sweden.

### 3.1. INTRODUCTION

majority of these economies have registered the highest Research and Development (R&D) expenditures as percentage of GDP.<sup>4</sup> Process and/or product innovation<sup>5</sup> are therefore among the key factors to achieve economic growth.

Investing in R&D contributes to the improvement of firms' competitiveness and their export performance. Determining whether a country's government can support its domestic firms' innovation activities is an important issue. Indeed, as mentioned in the introduction to chapter two, it is well established in the theoretical literature and well supported by empirical evidence that countries trade in similar (horizontally and/or vertically differentiated) products.<sup>6</sup> In this respect, product innovation induced by product R&D investment, influences features of finished goods, such as quality. Investing in R&D and producing higher quality goods is a way for firms, especially in high-income countries, to counter growing competition from developing countries with a cost-competitive advantage. Firms' product R&D activities may however be affected by policy-related costs such as customs barriers.

The objective of this chapter is to develop a theoretical model and evaluate the impact of several and different trade policy instruments on product R&D investment. We also examine the impact of these instruments on firms' profits, consumer surplus, public revenues. We also conduct a welfare analysis.

Extensive theoretical studies focus on the impact of trade policy instruments on *cost-reducing (process) R&D* (Bhagwati, 1968; Krishna, 1989; Reitzes, 1991). Theoretical examinations of product R&D and vertical differentiation, concentrate primarily on identifying strategic product R&D policies (Park, 2001; Jinji, 2003; Jinji and Toshimitsu, 2006; Ishii, 2014). Furthermore, most of these analyses consider the R&D activity to have a certain outcome, that is to say that process R&D investment, for example, reduces marginal cost with certainty. In our study we explore the impact of both traditional (an import tariff and an import quota) and more modern (a quality standard) trade policy instruments on product R&D investment and welfare. We follow Bouët (2001) and introduce uncertainty in the modeling of the R&D activity. We believe it yields more realistic results.

We design a framework with a North-South duopoly where firms with asymmetric pro-

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<sup>4</sup>Source: World Bank's WDI.

<sup>5</sup>Process innovation involves "significant changes in techniques, equipment and/or software" that lead to the "implementation of a new or significantly improved production or delivery method." Product innovation is "introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses (OECD)."

<sup>6</sup>See for example: Falvey (1979), Krugman (1979) and Lancaster (1980).

duction costs compete in prices on both markets. We assume that the Northern country's government is the only one to be policy active. The Northern firm bears higher production costs and has an incentive to invest in product R&D. The outcome of this investment is uncertain. There exists a probability of success. If successful, the Northern firm produces a higher quality version of the same good compared to its Southern competitor. If the Northern firms' R&D outcome is unsuccessful, then no quality improvement is implemented and the goods are horizontally differentiated due to their different cost structure.

Our model involves a three-stage game. First, the Northern firm's government selects the optimal instrument level by anticipating the Northern firm's product R&D investment and levels of price. Second, the Northern firm decides on the product R&D expenditures that maximize its expected profit. In the final stage, firms set their price levels. Our framework relates to the automobile industry, for example, in which Northern firms invest in product R&D in order to face growing competition from Southern firms that benefit from lower production costs.

In this chapter, we study the impact of the implementation of an import tariff, an import quota and a quality standard by the Northern government on the domestic product R&D. Traditional forms of instruments such as tariffs and quotas represented less than half of all implemented measures in 2013 (Evenett, 2013). However, in the automobile industry for example, the European Union's ad valorem import tariff in 2014 amounted to ten percent.<sup>7</sup> Moreover, many developed countries still implement import quotas in the automobile industry. The number of quantitative restrictions in force on automobile vehicles imports in 2015 is 18 in Australia, 6 in Canada, 4 in the European Union, 12 in Japan, 8 in New-Zealand, and 7 in Switzerland.<sup>8</sup> Quality standards, are on the contrary, modern policy instruments. A good example in the automobile industry is the implementation of the ISO technical specification ISO/TS 16949 aimed at quality improvement and defect prevention.

The main finding of our analysis is that the import tariff and the quality standard increase the Northern firm's R&D expenditures while the import quota decreases them.<sup>9</sup> Therefore, a government whose only aim is to enhance non-price competitiveness by encouraging product R&D investments should implement one of these policy instruments. Nevertheless, the latter may have opposite effects on the expected consumer surplus, pub-

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<sup>7</sup>Source: MAcMap HS6.

<sup>8</sup>Source: WTO.

<sup>9</sup>The positive impact of policy instruments such as subsidies or tax cuts on the R&D investment has been illustrated in empirical studies: Mansfield (1986), Berger (1993) and Hall (1993) - for US firms; Mansfield and Switzer (1985) and Bernstein (1986) - for Canadian firms; Mansfield (1986) - for Swedish firms; and Bloom et al., (2002) - for nine OECD countries.

## 3.2. REVIEW OF LITERATURE

lic revenues and welfare. We illustrate this result through numerical simulations.

The contribution of our work is twofold. First, we develop a theoretical framework and analyze the impact of several trade policy instruments on product R&D investment. It is an issue that has been less well-studied in the literature. Second, we consider the outcome of such an investment to be uncertain. Vertical differentiation only occurs if the R&D activity is successful.

The rest of this chapter is organized as follows. Section 3.2 reviews the literature. Section 3.3 describes the theoretical model. Section 3.4 presents an example under linear demand functions. Section 3.5 analyzes the impact of two traditional policy instruments on the Northern firms' R&D investment: an import tariff and an import quota. Section 3.6 analyzes the impact of a modern policy instrument: a quality standard. Section 3.7 conducts a welfare analysis and compares the efficiency of the policy instruments. Section 3.8 illustrates an extension with a non-prohibitive quality standard. Section 3.9 concludes.

## 3.2 Review of Literature

The economic literature focusing on cost-reducing/process R&D and product R&D is extensive. It has been shown empirically that firms invest in both product and process R&D (Capon et al., 1992; Landau and Rosenberg, 1992). Studies show that firms invest in product R&D at the beginning of a product's lifecycle, and invest in process R&D at the end (Utterback and Abernathy, 1975; Klepper, 1996). It explains why firms invest more in product R&D (Chenavaz, 2011). We, however, focus on product R&D, which is more important than process R&D in countries such as Germany, the United States, and Japan according to empirical data (Fritsch and Meschede, 2001; Nagaoka and Walsh, 2009).<sup>10</sup> Product R&D is particularly more prevalent than process R&D in high-tech industries like automobile or electricity (Scherer and Ross, 1990; Fritsch and Meschede, 2001; Park, 2001; Toshimitsu, 2003; Jinji and Toshimitsu, 2013).

Early theoretical studies with product R&D examining firms' choices of product quality include Mussa and Rosen (1978) and Shaked and Sutton (1982). Mussa and Rosen (1978) compare the quality levels under two market structures - monopoly and competition - and conclude that producers sell lower quality goods under the former market structure than the latter. This result explains why the cost for consumers under monopoly increases with their taste for quality. Prices are also higher under monopoly. Shaked and Sutton (1982)

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<sup>10</sup>Fritsch and Meschede (2001) note that product R&D accounts for 61 percent of all R&D expenditures for German firms. Nagaoka and Walsh (2009) show that process innovations accounted for only 25 percent and 17 percent of all R&D projects in the US and Japan respectively.

develop a theoretical model in which firms set first the optimal level of quality, and then the optimal level of price. Under duopoly firms select different quality levels, while they select the same level when the number of firms is greater than two.

There are relatively few studies related to our analysis (Park, 2001; Zhou, Spencer, and Vertinsky, 2002; Jinji, 2003; Jinji and Toshimitsu, 2006; Jinji and Toshimitsu, 2013; Ishii, 2014). These authors develop theoretical models of international trade with vertically-differentiated products. Their main objective is to identify optimal strategic product R&D policies.<sup>11</sup>

Park (2001) designs a duopoly with a high- and a low-tech firm. They compete in Bertrand or Cournot fashion on a third market. They produce vertically-differentiated products, whose quality is determined endogenously through product R&D investment.<sup>12</sup> The main result of the paper is that the governments' incentives targeting their domestic firms' R&D activities depend on the nature of market competition. Under Bertrand competition, the optimal strategic policy is to tax (respectively subsidize) the high-tech (respectively low-tech) firm's product R&D. Results are reversed in case of Cournot competition. Furthermore, the author briefly discusses the case where different instruments are combined to serve the high-tech firm's government strategic policy. A combination of an export subsidy and an R&D tax is demonstrated to be optimal.

The model of Zhou, Spencer, and Vertinsky (2002) is very similar to Park (2001) in its framework and results regarding unilateral optimal strategic product R&D policies. They extend the analysis by examining the governments' incentives when there is policy coordination between the two countries. The authors find that when firms compete in prices, the jointly optimal policy is to subsidize (tax) product R&D activities of the high-quality (low-quality) producing firm. Under Cournot competition on the other hand, the optimal policy is to implement an R&D tax in both countries. Nevertheless, empirical examples of R&D taxes are scarce (Audretsch and Yamawaki, 1988; Gabriele, 2002; Impullitti, 2010).

While both of these papers' analyses apply to competition between firms with large asymmetries in R&D costs, as it is the case for firms from developed and developing countries, Jinji (2003) studies strategic product R&D policy choices in a third-market trade model

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<sup>11</sup>The economic literature also studies the case of vertical differentiation under an asymmetric framework between a high-tech firm from a rich country and a low-tech firm from a developing country (Das and Donnenfeld, 1989; Park, 2001; Zhou, Spencer, and Vertinsky, 2002; Moraga-Gonzalez and Viaene, 2005; Ishii, 2014).

<sup>12</sup>Park (2001) assumes that the difference in terms of product R&D costs between firms is large enough so that firms with lower quality improvement costs (high-tech firms) produce and export higher-quality goods compared to low-tech competitors.



### 3.3. GENERAL FRAMEWORK

in which domestic and foreign firms are identical, facing the same product R&D costs. In his vertically-differentiated duopoly framework, the author shows that governments' optimal strategies involve different subsidy/tax schedules which depend on the mode of competition. This result is qualitatively similar to [Park \(2001\)](#) and [Zhou et al. \(2002\)](#) except for the high quality exporter's identity which is undetermined. Either firm can produce and export the high quality good, so that its government will choose to tax or subsidize its product R&D investment accordingly.

Meanwhile, [Jinji and Toshimitsu \(2006\)](#) study strategic product R&D policies when firms have asymmetric R&D costs. Their analysis differs from [Park \(2001\)](#) and [Zhou et al. \(2002\)](#) since a small technology gap between firms is assumed. The quality ordering is endogenously determined. The firm with superior technology produces the high quality good, while its competitor produces the low quality one. This is achieved by implementing a firm-specific subsidy schedule that depends on the nature of market competition.

[Jinji and Toshimitsu \(2013\)](#) extend previous studies by including a third exporting firm (and country) in their model. Firms export their entire production to a fourth country. They have different R&D capabilities, but their R&D cost functions are identical as long as their products qualities are below their R&D capabilities. Contrary to earlier studies, the authors find that the optimal strategic R&D policy is influenced by the nature of market competition only in the case of the high-quality exporter. Governments of middle and low-quality exporters would respectively tax and subsidize their domestic firm's R&D under both price and quantity competition. If firms coordinate, the joint optimal R&D policies differ depending on the countries' coordination pairs and mode of competition.

Finally, [Ishii \(2014\)](#) develops a theoretical third-country trade model of price competition with less stringent demand and cost functions. He finds that the optimal R&D policy does not only necessarily depend on the mode of competition, given that in certain situations, both governments' optimal policy involves a product R&D subsidy even when firms compete in Bertrand fashion.

### 3.3 General Framework

We develop a theoretical model of international trade with product innovation in a North-South duopoly with a firm from a Northern country and another from a Southern country. Each firm sells one share of its output domestically and exports the other share to the foreign market. The Southern firm has a cheaper labor force compared to its competitor. Assuming that the Northern firm is located in a developed country, while its Southern trade partner is from an emerging country, considering that the latter has lower labor costs

is not unrealistic. The Northern firm has an incentive to invest in R&D and vertically differentiate its product since the Southern firm benefits from a competitive advantage.

Our theoretical framework relates to an empirical example, for instance the mobile phone industry. In the past decade handset manufacturing firms from Northern countries which continue to export their finished goods to foreign markets, have been facing growing competition even in their local markets from firms in emerging countries. Indeed, while Seoul-based Samsung and California-based Apple continue to dominate the worldwide smartphone industry in the third quarter of 2016, as they have in the past couple of years, the remaining players in the top-five are Chinese companies: Huawei, OPPO, and vivo (International Data Corporation, IDC). While OPPO' and vivo's increasing market shares are driven by sales to local and other emerging markets, Huawei has successfully penetrated developed country markets, especially in Europe.<sup>13</sup> The company, whose own smartphone brand has been on the markets for less than ten years, attracted customers with its cheaper prices according to the Financial Times.<sup>14</sup> Although Huawei has started to shift its focus from low- and mid-end to high-end phones in the past two years, demand for less expensive and/or low-end phones is increasing rapidly in both developed and emerging markets.<sup>15</sup>

The mobile phone industry becomes even more relevant as an empirical example, when considering that handset manufacturers have invested continuously on product R&D and not only at the beginning of their products' life cycle. As shown by [Giachetti and Marchi \(2010\)](#), in their case study of the global mobile phone industry over the 1980-2009 period, "when the demand is increasingly penetrated, product innovations continue to play a key role in the OEMs' [Original Equipment Manufacturers] product strategy. The product innovation is even stronger in the stage of maturity, driven by the impact of technological convergence" (p. 1148).

Another empirical example comes from the automobile industry. The North-South duopoly works because Northern automobile firms face competition from Southern automobile firms. A significant example is Tata, an Indian firm which sells on its domestic market and exports to Northern markets. The firm operates "in over 175 markets" and has "over 6,600 sales and service touch points."<sup>16</sup> The European Union represents an important market. Maruti Suzuki is another good example. The competition from Southern automobile firms is growing owing to lower production costs compared to Northern firms.

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<sup>13</sup>Source: "China's Huawei 'growing up' to become the world's No.1 smartphone brand", by Wade Shepard, May 25, 2016, Forbes.

<sup>14</sup>Source: "Huawei lifts smartphone sales 25%", by Charles Clover, July 26, 2016, Financial Times.

<sup>15</sup>In 2014 The Economist described this trend as "The rise of the cheap smartphone", April 5.

<sup>16</sup>Source: Tata 69th Annual Report 2013-2014, p. 16.

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The Indian market symmetrically represents a great opportunity for Northern automobile firms like Renault and Honda. For example, Renault sold 43,384 vehicles between January and April 2015.<sup>17</sup> It also launched a new car model called “Kwid” for the Indian market on September 2015.

Furthermore, the automobile industry is a good case in point because firms invest in product R&D. As previously said, the economic literature shows that firms invest more in product R&D than in process R&D in high-tech industries (Scherer and Ross, 1990; Fritsch and Meschede, 2001; Park, 2001; Toshimitsu, 2003; Jinji and Toshimitsu, 2013). R&D expenditures are generally higher for Northern firms compared to Southern firms. It is the reason why the quality of Northern automobile firms’ vehicles is generally higher compared to those of Southern automobile firms’. But a limit to our model is that we consider a simple case in which the Southern firm does not invest in R&D at all.

We denote by  $p_n$  ( $p_s$ ) the price set by the Northern firm on the Northern (Southern) market and  $x_n$  ( $x_s$ ) the Northern firm’s domestic sales (exports). We also denote by  $p_n^*$  ( $p_s^*$ ) the Southern firm’s price on the Northern (Southern) market and  $y_n$  ( $y_s$ ) the Southern firm’s exports (domestic sales).

**Assumption 1:** There is Bertrand competition on every market. Firms select the optimal levels of price.

In our model, the outcome of the Northern firm’s R&D investment is uncertain. If successful, two different quality levels of the same commodity variety are on markets. We denote by  $\phi$  the degree of differentiation between the two products.

Consider a probability of R&D success. We use the superscript  $d$  to denote the case of a successful R&D (i.e. with vertical differentiation) and the superscript  $h$ , otherwise. For example,  $p_n^d$  ( $p_n^h$ ) denotes the Northern firm’s price when the R&D outcome is successful (unsuccessful).

**Assumption 2:** The probability of R&D success is denoted by  $\alpha$  with  $0 < \alpha < 1$ . The probability that the R&D investment fails is  $(1 - \alpha)$ . The probability of success depends on the R&D investment level denoted by  $r$  :  $\alpha = \alpha(r)$ . It increases with the R&D level:  $\alpha'(r) > 0$ . Nevertheless, the returns are decreasing:  $\alpha''(r) \leq 0$ .

The economic literature has also considered decreasing returns for R&D expenditures (Spencer and Brander, 1983; Reitzes, 1991).<sup>18</sup> A product R&D investment is an invest-

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<sup>17</sup>Source: The Economic Times.

<sup>18</sup>For example, Spencer and Brander (1983) consider cost-reducing R&D expenditures. They assume that the second derivative of total production costs with respect to R&D expenditures is negative.

ment in knowledge. A good example is labor training. The training focuses on developing the labor to ensure that the quality of the output increases. In this case, decreasing returns mean that the marginal effect of training may decrease over time. This assumption is really important since it influences a large part of our results, in particular the impact of any policy instrument on the Northern firm's R&D. The total cost of the Northern firm's R&D investment is  $\nu r$ , where  $\nu$  denotes the unit cost of the R&D investment. The Northern firm faces such a cost regardless of the R&D outcome.

**Assumption 3:** The quality of the Northern firm's good increases with its R&D investment. Consequently, the degree of vertical differentiation is an increasing function of the R&D investment level  $r$ :  $\phi = \phi(r)$ ;  $\phi'(r) > 0$ . We consider a linear function:  $\phi''(r) = 0$ .

Therefore, the R&D investment influences: (i) the probability of R&D success  $\alpha$ ; (ii) the level of the quality of the Northern firm's good i.e. the degree of the vertical differentiation  $\phi$ .

If the investment is successful:  $\phi > 0$ . Otherwise goods produced by both firms are similar in terms of quality. In this case,  $\phi = 0$ . In this model, there are two possible levels of quality. The Northern firm does not select an optimal level of quality. It only invests in R&D in order to benefit from the vertical differentiation.

When no trade policy instruments are implemented, our model involves a two-stage game. First, the Northern firm selects the level of R&D investment that maximizes its expected profit by anticipating the levels of price. Second, each firm sets the levels of price that maximize its profit. The equilibrium solution is obtained by backward induction from the second stage of price competition. We provide a separate analysis of when the R&D outcome is successful, and subsequently when it is unsuccessful.

### 3.3.1 Successful R&D

First consider the case of a successful R&D investment. Goods are vertically differentiated.

**Assumption 4:** Each country's consumer has a preference for quality denoted by  $\theta$  that increases with the degree of vertical differentiation  $\phi$ :  $\theta = \theta[\phi(r)]$ ;  $\theta'[\phi(r)] > 0$ . We consider that the preference for quality is the same for each consumer in both the North and the South. Demand for a given good therefore depends on prices and on such a preference for quality:  $x_i^d = x_i^d\{p_i^d, p_i^{*d}, \theta[\phi(r)]\}$ ,  $y_i^d = y_i^d\{p_i^d, p_i^{*d}, \theta[\phi(r)]\}$ ,  $\forall i = \{n, s\}$ . The demand for the Northern (Southern) firm's product increases (decreases) with the degree of differentiation:  $\partial x_i^d / \partial \phi(r) > 0$ ,  $\partial y_i^d / \partial \phi(r) < 0$ .

### 3.3. GENERAL FRAMEWORK

We denote by  $C^d$  ( $C^{*d}$ ) the Northern (Southern) firm's total production cost. Consider linear total production costs functions such as marginal costs are constant. We denote by  $c^d$  ( $c^*$ ) the Northern (Southern) firm's marginal cost. The level of  $c^*$  does not depend on the R&D outcome.

**Assumption 5:** The Northern firm's marginal cost is an increasing function of the degree of vertical differentiation:  $c^d = c^d[\phi(r)]; dc^d/d\phi(r) > 0$ .

Producing a higher quality good is costly: i) a cost of knowledge appears (measured by the R&D total cost  $\nu r$ ); and ii) it involves a further production cost (measured by the impact of the increase in quality on the marginal cost). The economic literature considers that quality improvement influences either variable costs or fixed costs (Maskus et al., 2013; Cheng, 2014). Here we consider an endogenous variable cost for the Northern firm. The cost of the last unit of output increases with its level of quality. The total cost functions are the following:

$$C^d = c^d[\phi(r)]\{x_n^d[p_n^d, p_n^{*d}, \theta[\phi(r)]] + x_s^d[p_s^d, p_s^{*d}, \theta[\phi(r)]]\} + gx_s^d[p_s^d, p_s^{*d}, \theta[\phi(r)]] + F$$

$$C^{*d} = c^*\{y_n^d[p_n^d, p_n^{*d}, \theta[\phi(r)]] + y_s^d[p_s^d, p_s^{*d}, \theta[\phi(r)]]\} + g^*y_n^d[p_n^d, p_n^{*d}, \theta[\phi(r)]] + F^*$$

The parameters  $g$  and  $g^*$  denote unit transport costs, and  $F$  and  $F^*$  denote fixed costs. Introducing transport costs is more credible for this model. Exports involve higher costs compared to domestic sales. Such a transport cost depends on the geographic distance between countries. We introduce fixed costs in order to integrate increasing returns.

$\Pi^d$  ( $\Pi^{*d}$ ) denotes the Northern (Southern) firm's profit with a successful R&D i.e. with vertical differentiation. We have:

$$\Pi^d = p_n^d x_n^d + p_s^d x_s^d - c^d[\phi(r)](x_n^d + x_s^d) - gx_s^d - F - \nu r \quad (3.1)$$

$$\Pi^{*d} = p_n^{*d} y_n^d + p_s^{*d} y_s^d - c^*(y_n^d + y_s^d) - g^*y_n^d - F^* \quad (3.2)$$

#### 3.3.2 Unsuccessful R&D

Consider now the case in which the R&D is unsuccessful. We denote by  $C^h$  ( $C^{*h}$ ) the Northern (Southern) firm's total production cost. The parameter  $c^h$  denotes the Northern firm's constant marginal cost. According to Assumption 5, we have:  $c^d[\phi(r)] > c^h$ . Consider specific linear functions for total production costs:

$$C^h = c^h[x_n^h(p_n^h, p_n^{*h}) + x_s^h(p_s^h, p_s^{*h})] + gx_s^h(p_s^h, p_s^{*h}) + F$$

$$C^{*h} = c^*[y_n^h(p_n^h, p_n^{*h}) + y_s^h(p_s^h, p_s^{*h})] + g^*y_n^h(p_n^h, p_n^{*h}) + F^*$$

**Assumption 6:** Each firm produces a similar quality product. We introduce horizontal differentiation in order to avoid a Bertrand paradox. Demand functions are:  $x_i^h = x_i^h(p_i^h, p_i^{*h}), y_i^h = y_i^h(p_i^h, p_i^{*h})$ , for each market  $i$  such as  $i = n, s$ . Domestic sales and exports decrease (increase) with the domestic (foreign) firm's price:  $\partial x_i^h / \partial p_i^h < 0, \partial x_i^h / \partial p_i^{*h} > 0, \partial y_i^h / \partial p_i^h > 0, \partial y_i^h / \partial p_i^{*h} < 0$ . Own effects are stronger than crossed effects:  $|\partial x_i^h / \partial p_i^h| > \partial x_i^h / \partial p_i^{*h}, \partial y_i^h / \partial p_i^h < |\partial y_i^h / \partial p_i^{*h}|$ .

Profit expressions are the following:

$$\Pi^h = p_n^h x_n^h + p_s^h x_s^h - c^h(x_n^h + x_s^h) - g x_s^h - F - \nu r \quad (3.3)$$

$$\Pi^{*h} = p_n^{*h} y_n^h + p_s^{*h} y_s^h - c^*(y_n^h + y_s^h) - g^* y_n^h - F^* \quad (3.4)$$

### 3.3.3 Choice of R&D Investment

Let us call  $E[.]$  the expectation operator with respect to the R&D outcome. We denote by  $\pi$  ( $\pi^*$ ) the Northern (Southern) firm's profit, fixed and R&D costs excluded:  $\pi = \Pi + F + \nu r, \pi^* = \Pi^* + F^*$ . We also use the superscripts  $d$  and  $h$  for the two cases.

**Assumption 7:** The Northern firm is encouraged to differentiate its product with respect to the product of its competitor. The Northern firm's profit increases with the degree of differentiation:  $d\pi^d/d\phi(r) > 0$ . The profit is stronger in case of a successful R&D:  $\pi^d > \pi^h$ . The Northern firm would not be encouraged to invest in R&D, otherwise. We also consider that the marginal profit is stronger when the R&D is successful:  $p_i^d - c^d > p_i^h - c^h, \forall i = \{n, s\}$ .

The Northern firm's expected profit is:

$$E[\Pi(r)] = \alpha(r)\widehat{\pi}^d[\phi(r)] + [1 - \alpha(r)]\widehat{\pi}^h - F - \nu r \quad (3.5)$$

The Northern firm selects the optimal R&D investment level that maximizes such an expected profit. From the First and Second Order Conditions, we have:

$$\frac{\partial E[\Pi(r)]}{\partial r} = E[\Pi(r)]_r = \alpha'(r)\widehat{\pi}^d[\phi(r)] + \alpha(r)\widehat{\pi}_\phi^d \Phi'(r) - \alpha'(r)\widehat{\pi}^h - \nu$$

$$E[\Pi(r)]_{rr} = \alpha''(r)\widehat{\pi}^d[\phi(r)] + 2\alpha'(r)\widehat{\pi}_\phi^d \phi'(r) + \alpha(r)\widehat{\pi}_\phi^d \phi''(r) - \alpha''(r)\widehat{\pi}^h < 0 \quad (3.6)$$

### 3.4. EQUILIBRIUM WITH LINEAR DEMAND FUNCTIONS

The Northern firm's R&D investment can be rewritten as a function of the difference in profit  $\widehat{\pi}^d[\phi(r)] - \widehat{\pi}^h$ , of the R&D unit cost  $\nu$  and of the marginal effect of quality  $\widehat{\pi}_\phi^d : r = \psi[\nu, (\widehat{\pi}^d[\phi(r)] - \widehat{\pi}^h), \widehat{\pi}_\phi^d]$ , with  $\partial\psi/\partial(\widehat{\pi}^d[\phi(r)] - \widehat{\pi}^h) > 0$ ,  $\partial\psi/\partial\nu < 0$ ,  $\partial\psi/\partial\widehat{\pi}_\phi^d > 0$ . Therefore, we can study the impact of policy instruments on the R&D investment by analyzing their impact on the difference in profit.

## 3.4 Equilibrium with Linear Demand Functions

Let us use now linear examples for demand functions and total cost functions for an easier demonstration. First consider the following function of consumers' taste for quality on each market:

$$\theta[\phi(r)] = \phi(r)\eta \quad (3.7)$$

The parameter  $\eta$  denotes the sensitivity of the preference for quality with respect to the degree of differentiation, with  $0 < \eta \leq 1$ . Demands now depend on  $\phi(r)\eta$ . For each market  $i$ , we set the following demand functions:

$$x_i = \begin{cases} x_i^h(p_i^h, p_i^{*h}) = a_i - b_i p_i^h + p_i^{*h}, & \text{if } \phi = 0 \\ x_i^d(p_i^d, p_i^{*d}, \phi(r)\eta) = a_i(1 + \phi(r)\eta) - b_i(1 - \phi(r)\eta)p_i^d + (1 + \phi(r)\eta)p_i^{*d}, & \text{otherwise.} \end{cases} \quad (3.8)$$

$$y_i = \begin{cases} y_i^h(p_i^h, p_i^{*h}) = a_i + p_i^h - b_i p_i^{*h}, & \text{if } \phi = 0 \\ y_i^d(p_i^d, p_i^{*d}, \phi(r)\eta) = a_i(1 - \phi(r)\eta) + (1 - \phi(r)\eta)p_i^d - b_i(1 + \phi(r)\eta)p_i^{*d}, & \text{otherwise.} \end{cases} \quad (3.9)$$

The parameter  $a_i, \forall i = \{n, s\}$  denotes the fixed part of demand functions that does not depend on prices and quality. The parameter  $b_i, \forall i = \{n, s\}$  denotes the horizontal differentiation between the two goods. We have:  $b_i > 1$ . Under the unsuccessful case, each demand is more sensitive to the domestic firm's price compared to the foreign firm's price. Under the successful case, the following condition is necessary:  $b_i > (1 + \phi(r)\eta)/(1 - \phi(r)\eta)$ .

Note that in previous studies, authors first set a utility function to infer demand functions (Sutton, 1997; Symeonidis, 2003). Our methodology is reversed. We first set demand functions. The expression of the consumer surplus is then given by integrating the demand functions. The consumer surplus increases with  $\phi(r)\eta$  (Mussa and Rosen, 1978).

### 3.4. EQUILIBRIUM WITH LINEAR DEMAND FUNCTIONS

Each firm selects the optimal levels of prices that maximize its profit. Under a successful R&D, we have:

$$\begin{aligned}
 \widehat{p}_n^d &= \frac{a_n(2b_n + 1) + 2b_n^2 c^d[\phi(r)] + b_n(c^* + g^*) + \phi(r)\eta[a_n(2b_n - 1) - 2b_n^2 c^d[\phi(r)] + b_n(c^* + g^*)]}{(4b_n^2 - 1)(1 - \phi(r)\eta)}, \\
 \widehat{p}_n^{*d} &= \frac{a_n(2b_n + 1) + b_n c^d[\phi(r)] + 2b_n^2(c^* + g^*) - \phi(r)\eta[a_n(2b_n - 1) + b_n c^d[\phi(r)] - 2b_n^2(c^* + g^*)]}{(4b_n^2 - 1)(1 + \phi(r)\eta)}, \\
 \widehat{p}_s^d &= \frac{a_s(2b_s + 1) + 2b_s^2[c^d[\phi(r)] + g] + b_s c^* + \phi(r)\eta[a_s(2b_s - 1) - 2b_s^2(c^d[\phi(r)] + g) + b_s c^*]}{(4b_s^2 - 1)(1 - \phi(r)\eta)}, \\
 \widehat{p}_s^{*d} &= \frac{a_s(2b_s + 1) + b_s[c^d[\phi(r)] + g] + 2b_s^2 c^* - \phi(r)\eta[a_s(2b_s - 1) + b_s(c^d[\phi(r)] + g) + 2b_s^2 c^*]}{(4b_s^2 - 1)(1 + \phi(r)\eta)}
 \end{aligned} \tag{3.10}$$

The Northern (Southern) firm's prices increase (decrease) with the degree of differentiation. When two goods are vertically differentiated, the higher quality good is more expensive. The difference in price between the two goods increases with the degree of differentiation. The Southern firm reduces its prices when the R&D is successful because the demand function for its finished product decreases with the degree of differentiation.

The levels of domestic sales and exports for each firm are:

$$\begin{aligned}
 \widehat{x}_n^d &= \frac{bn\{a_n(2b_n + 1) - (2b_n^2 - 1)c^d[\phi(r)] + b_n(c^* + g^*) + \phi(r)\eta[a_n(2b_n - 1) + (2b_n^2 - 1)c^d[\phi(r)] + b_n(c^* + g^*)]\}}{(4b_n^2 - 1)}, \\
 \widehat{y}_n^d &= \frac{b_n\{a_n(2b_n + 1) + b_n c^d[\phi(r)] - (2b_n^2 - 1)(c^* + g^*) - \phi(r)\eta[a_n(2b_n - 1) + b_n c^d[\phi(r)] + (2b_n^2 - 1)(c^* + g^*)]\}}{(4b_n^2 - 1)}, \\
 \widehat{x}_s^d &= \frac{b_s\{a_s(2b_s + 1) - (2b_s^2 - 1)[c^d[\phi(r)] + g] + b_s c^* + \phi(r)\eta[a_s(2b_s - 1) + (2b_s^2 - 1)(c^d[\phi(r)] + g) + b_s c^*]\}}{(4b_s^2 - 1)}, \\
 \widehat{y}_s^d &= \frac{b_s\{a_s(2b_s + 1) + b_s[c^d[\phi(r)] + g] - (2b_s^2 - 1)c^* - \phi(r)\eta[a_s(2b_s - 1) + b_s(c^d[\phi(r)] + g) + (2b_s^2 - 1)c^*]\}}{(4b_s^2 - 1)}
 \end{aligned} \tag{3.11}$$

Finally, consider that each firm's profit equals the sum of the profit earned on the domestic market and the profit earned on the foreign market:  $\widehat{\pi}^d = \widehat{\pi}_n^d + \widehat{\pi}_s^d$ ;  $\widehat{\pi}_n^{*d} + \widehat{\pi}_s^{*d}$ . We have:

$$\begin{aligned}
 \widehat{\pi}_n^d &= \frac{bn\{a_n(2b_n + 1) - (2b_n^2 - 1)c^d[\phi(r)] + b_n(c^* + g^*) + \phi(r)\eta[a_n(2b_n - 1) + (2b_n^2 - 1)c^d[\phi(r)] + b_n(c^* + g^*)]\}^2}{(4b_n^2 - 1)^2(1 - \phi(r)\eta)}, \\
 \widehat{\pi}_s^d &= \frac{b_s\{a_s(2b_s + 1) - (2b_s^2 - 1)[c^d[\phi(r)] + g] + b_s c^* + \phi(r)\eta[a_s(2b_s - 1) + (2b_s^2 - 1)(c^d[\phi(r)] + g) + b_s c^*]\}^2}{(4b_s^2 - 1)^2(1 - \phi(r)\eta)},
 \end{aligned}$$



### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

$$\begin{aligned}\widehat{\pi}_n^{*d} &= \frac{b_n\{a_n(2b_n + 1) + b_n c^d[\phi(r)] - (2b_n^2 - 1)(c^* + g^*) - \phi(r)\eta[a_n(2b_n - 1) + b_n c^d[\phi(r)] + (2b_n^2 - 1)(c^* + g^*)\}^2}{(4b_n^2 - 1)^2(1 + \phi(r)\eta)}, \\ \widehat{\pi}_s^{*d} &= \frac{b_s\{a_s(2b_s + 1) + b_s[c^d[\phi(r)] + g] - (2b_s^2 - 1)c^* - \phi(r)\eta[a_s(2b_s - 1) + b_s(c^d[\phi(r)] + g) + (2b_s^2 - 1)c^*]\}^2}{(4b_s^2 - 1)^2(1 + \phi(r)\eta)}\end{aligned}\tag{3.12}$$

According to Assumption 7, the Northern (Southern) firm's profit increases (decreases) with the degree of differentiation. There is a direct positive impact on the Northern firm's profit via the increase in prices and an indirect uncertain impact via the impact on domestic sales and exports. Therefore, the difference in profit ( $\widehat{\pi}^d[\phi(r)] - \widehat{\pi}^h$ ) is positive.

Under an unsuccessful R&D, we can find the equilibrium expressions of prices, outputs and profits by setting  $\phi = 0$  and  $c^d[\phi(r)] = c^h$ .

The Northern firm selects the optimal level of R&D investment that maximizes its expected profit by taking into account the previous results. We know now the expressions of  $\widehat{\pi}^d[\phi(r)]$  and  $\widehat{\pi}^h$ . We use the following function for the probability of R&D success:

$$\alpha(r) = r^k, \text{ with } 0 < k < 1\tag{3.13}$$

## 3.5 The Implementation of Two Traditional Policy Instruments

Let us study the impact of two policy instruments: an import tariff and an import quota. The Northern country's government may justify the implementation of these instruments by the increasing competition from an emerging country that benefits from a competitive advantage. Policy instruments aim to enhance the Northern firm's non-price competitiveness by increasing the probability of a successful R&D outcome and to increase the Northern country's national welfare. Figure 3.1 illustrates the structure of the model.

The Northern country's government implements trade policy instruments that maximize the expected national welfare. The expression of the national welfare is:

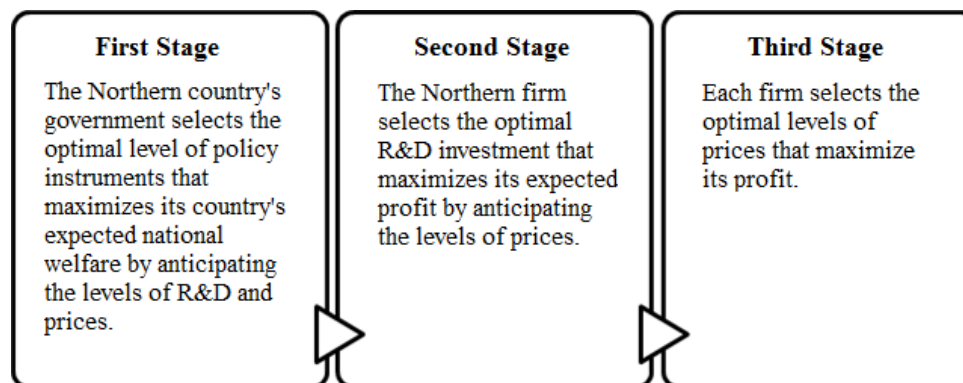
$$E(W) = E(\Pi) + E(CS) + E(PR)\tag{3.14}$$

The term  $W$  denotes the Northern country's national welfare;  $CS$  denotes the Northern

### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

country's consumer surplus; and  $PR$  denotes the governmental surplus i.e. public revenues. First, we look for the equilibrium price levels. Then, we evaluate the impact of each policy instrument on the R&D investment.

**Figure 3.1 – Structure of the Model**



Source: authors.

#### 3.5.1 A Specific Import Tariff

Consider that the Northern country's government implements an import tariff. We denote by  $t$  the specific tariff on the Southern firm's exports. The Southern firm's profit expression changes as compared to free trade:

$$\pi^* = \begin{cases} \pi^{*h} = p_n^{*h} y_n^h + p_s^{*h} y_s^h - c^*(y_n^h + y_s^h) - (t + g^*) y_n^h, & \text{if } \phi = 0 \\ \pi^{*d} = p_n^{*d} y_n^d + p_s^{*d} y_s^d - c^*(y_n^d + y_s^d) - (t + g^*) y_n^d, & \text{otherwise.} \end{cases} \quad (3.15)$$

The tariff is a further marginal cost for the Southern firm, its economic impact is the same as that of an increase of  $g^*$ . As a result, the price levels on the Northern market increase. The tariff also increases the Northern firm's domestic sales and profit, while it impacts negatively the Southern firm's exports and profit.<sup>19</sup> Total sales on the Northern market decrease, therefore the implementation of an import tariff has a direct negative impact on the Northern country's consumer surplus. These results hold regardless of the outcome of the R&D investment.

The Northern firm selects the optimal level of R&D that maximizes its expected profit by taking into account the previous results.

<sup>19</sup>We note that there is no impact whatsoever on the Northern (Southern) firm's foreign (domestic) sales and prices. An increase (decrease) of the Northern (Southern) firm's profit is therefore due to an increase (decrease) of the profit earned on its domestic (foreign) market.

### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

**Proposition 1:** Under the specific functions, the Northern firm's R&D investment increases with its domestic government's import tariff as compared to free trade.

**Proof:** From the First Order Condition:

$$E[\Pi(r, t)]_r = E[\Pi(r, t)]_{rr}dr + E[\Pi(r, t)]_{rt}dt = 0$$

$$\frac{dr}{dt} = \frac{-E[\Pi(r, t)]_{rt}}{E[\Pi(r, t)]_{rr}}$$

From the Second Order Condition:  $E[\Pi(r, t)]_{rr} < 0$ , therefore the impact of the tariff on the R&D investment depends on the sign of  $E[\Pi(r, t)]_{rt}$ :

$$E[\Pi(r, t)]_{rt} = \alpha'(r)(\widehat{\pi}^d[\phi(r)] - \widehat{\pi}_t^h) + \alpha(r)\widehat{\pi}_{\phi t}^d\phi'(r)$$

The sign of  $E[\Pi(r, t)]_{rt}$  therefore depends on: a) the impact of the tariff on the difference in profit; and b) the sign of  $\widehat{\pi}_{\phi t}^d$ .

- (a) *Impact of the tariff on the difference in profit:* We know that the Northern firm's profit increases with the tariff regardless of the R&D outcome. We can study the impact of the degree of vertical differentiation on the positive impact of the tariff on the Northern firm's profit. Therefore, we have to study the sign of the second derivative  $d^2\widehat{\pi}^d[\phi(r), \eta, t]/(dtd\phi(r))$ . In this case, we analyze the impact of an increase in  $\phi$  from 0 to 1 on  $d\widehat{\pi}^d[\phi(r), \eta, t]/dt$ . A positive result means that the positive impact of the tariff is higher when  $\phi = 1$  compared to the unsuccessful case when  $\phi = 0$ .

To simplify the expressions, we set:  $\widehat{\pi}^d = \widehat{\pi}^d[\phi(r), \eta, t]$ . We have:

$$\frac{d^2\widehat{\pi}^d}{dtd\phi(r)} = \frac{b_n^{3/2}(\widehat{\pi}^d)^{1/2}\{2\eta + [(d\widehat{\pi}^d/d\phi(r))(\widehat{\pi}^d)^{-1} + \eta(1 - \phi(r)\eta)^{-1}](1 + \phi(r)\eta)\}}{(4b_n^2 - 1)(1 - \phi(r)\eta)^{1/2}} > 0 \quad (3.16)$$

The previous expression is positive because, from Assumption 7, we have:  $d\widehat{\pi}^d/d\phi(r) > 0$ . The other terms are positive. Therefore, the vertical differentiation increases the positive impact of the tariff on the Northern firm's profit. It can then be deduced that the difference in profit increases with the tariff as compared to free trade.

- (b) *Impact of the tariff on  $\widehat{\pi}_{\phi t}^d$ .* We show that  $\widehat{\pi}_{t\phi}^d > 0$  and since  $\widehat{\pi}_{\phi t}^d = \widehat{\pi}_{t\phi}^d$ , then  $\widehat{\pi}_{\phi t}^d > 0$ .

From a) and b) and given Assumptions 1 and 2:  $E[\Pi(r, t)]_{rt} > 0$ , therefore:

$$\frac{dr}{dt} > 0$$

### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

The Northern firm's R&D expenditures increase with the implementation of the tariff. The tariff leads to a gain for the Northern firm such as the latter is encouraged to invest more to benefit from a stronger gain. This can be explained by the intensity of competition from the Southern country. Since the tariff reduces imports from the low-cost country, the Northern firm is encouraged to increase its R&D investment in order to increase the probability of vertical differentiation and further reduce its competitor's exports. As a result, the cost of the tariff on the Southern firm's profit is greater in case of a successful R&D, because the effect is all the more negative on its market share.

#### 3.5.2 An Import Quota

Let us study the impact of an import quota implemented by the Northern government. Studying the impact of a quota under Bertrand competition is complex because the levels of domestic sales and exports depend on each price. With a binding quota, a competitive situation is moved to a collusive situation ([Harris, 1985](#); [Krishna, 1989](#); [Karikari, 1991](#); [Boccard and Wauthy, 2006](#)).

Consider a binding quota denoted by  $q$  that corresponds to the maximum level of exports for the Southern firm. Studying the impact of a quota under Bertrand competition is complex owing to demand functions that depend on each level of price. Under free trade, when the R&D is successful, we can express the Southern firm's price of exports as a function of the Northern firm's price of domestic sales and of the Southern firm's exports:  $p_n^{*d} = p_n^{*d}(p_n^d, \phi\eta, y_n^d)$ . Therefore, with a binding quota, the Southern firm's price of exports is a function of the Northern firm's price of domestic sales and of the quota:  $p_n^{*d} = p_n^{*d}(p_n^d, \phi\eta, q)$ .

Such an expression is the Southern firm's best-response to the Northern firm's price of domestic sales ([Krishna, 1989](#)). According to [Karikari \(1991\)](#), when the domestic country implements an import quota, "the output of the foreign firm is fixed" and "an increase in the price of the domestic firm leads to an increase of the foreign price (p. 232)."

As a consequence, the Southern firm no longer maximizes its profit with respect to its price of exports. It only reacts to the levels of  $p_n^d$  and  $q$ .

The demand for the Northern firm's good on the Northern market no longer depends on the level of the Southern firm's price of exports because such a price is a response to the Northern firm's price of domestic sales and to the level of the quota.

The Northern firm benefits from a Stackelberg leadership on its home market ([Harris,](#)

### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

1985) and selects the two optimal price levels. The quota does not influence the outcome on the Southern market. On the Northern market, the Northern firm selects the optimal price of domestic sales:

Krishna (1989) already proves that the domestic firm's profit increases with the implementation of an import quota in a duopoly under Bertrand competition. Therefore, the Northern firm's profit increases with a binding quota as compared to free trade. The Southern firm's profit decreases because it no longer sets the optimal level of price that maximizes its profit. It only sets the best response to  $q$  and  $p_n^d$ .

We consider two cases: a relatively binding quota and a strongly binding quota.

- First case:  $\hat{y}_n^d(\phi, \eta) \leq q < \hat{y}_n^h$ . The quota is relatively binding because it only reduces the Southern firm's exports when the R&D is unsuccessful. The Northern firm's profit only increases compared to free trade under this case:  $\hat{\pi}_n^h(q) > \hat{\pi}_n^h, \hat{\pi}_n^d(q) = \hat{\pi}_n^d$ .
- Second case:  $q < \hat{y}_n^d(\phi, \eta)$ . The quota is strongly binding because it reduces the Southern firm's exports under both cases. The Northern firm's profit increases compared to free trade regardless of the R&D outcome:  $\hat{\pi}_n^h(q) > \hat{\pi}_n^h, \hat{\pi}_n^d(q) > \hat{\pi}_n^d$ .

According to the impact of an import tariff, the first order effect on the R&D investment is that on the difference in profit. Hence, we focus on the impact of the quota on the difference in profit to find the impact on the R&D investment.

**Proposition 2:** The Northern firm's R&D investment decreases with a relatively binding quota and either increases or decreases with a strongly binding quota as compared to free trade. There is a non-null value of quota  $\bar{q}$  such as the R&D investment equals the free trade level. Therefore, the R&D investment decreases as compared to free trade when  $q \in (\bar{q}, \hat{y}_n^d)$ , levels off when  $q = \bar{q}$ , and increases when  $q \in [0, \bar{q})$ .

**Proof:** Let us consider the two cases:

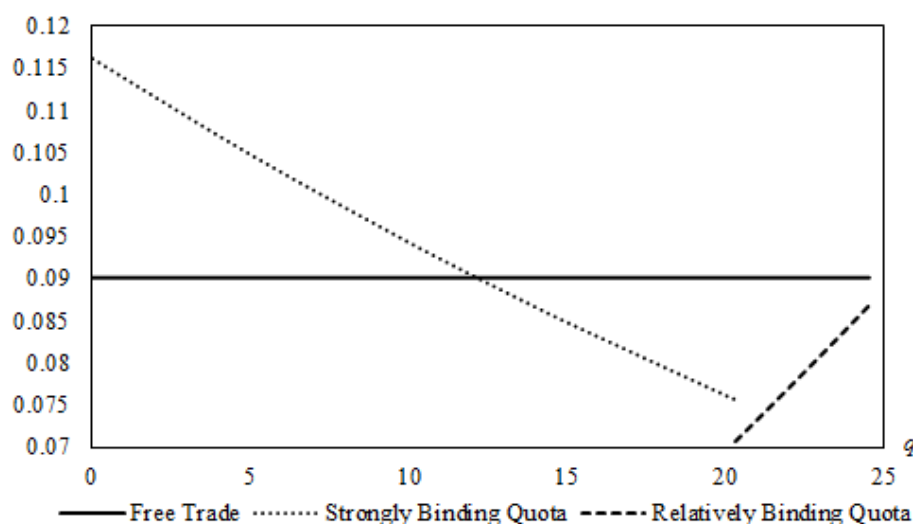
- With a relatively binding quota, the quota is only binding when the R&D is unsuccessful. The Northern firm's profit only increases under this case. The difference in profit decreases as compared to free trade:  $\hat{\pi}_n^d(\phi, \eta, q) - \hat{\pi}_n^h(q) < \hat{\pi}_n^d(\phi, \eta) - \hat{\pi}_n^h$ .
- With a strongly binding quota, the quota is binding under both cases. The Northern firm's profit increases regardless of the R&D outcome. The difference in profit either increases or decreases as compared to free trade. Using the specific linear demand functions, we find that there is a level of quota  $\bar{q}$  such as the difference in profit equals the free trade level. The difference in profit decreases with a strongly binding

### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

quota  $q$  such as  $q \in (\bar{q}, \hat{y}_n^d)$  if  $0 < \bar{q} < \hat{y}_n^d$ . The difference in profit always decreases with a strongly binding quota if  $\bar{q} = 0$ . It always increases, otherwise.

As a result, the Northern firm's R&D investment decreases with a relatively binding quota, and either increases or decreases with a strongly binding quota. Let us use a numerical example. Figure 3.2 illustrates the evolution of the Northern firm's R&D investment when the level of the quota varies. The grey line illustrates the free trade level. Here, we find  $\bar{q} \approx 12.17$ , with  $0 < \bar{q} < \hat{y}_n^d$ . Under such a numerical example, the R&D investment decreases with a strongly binding quota as compared to free trade if  $q \in (\bar{q}, \hat{y}_n^d)$ . It levels off if  $q = \bar{q}$ . It increases if  $q \in [0, \bar{q})$ .

**Figure 3.2 – Evolution of the Northern Firm's R&D Investment When  $q$  Varies**



Source: authors.

Note: We set:  $\phi(r) = \phi_0 + \omega r$ ;  $c^d[\phi(r)] = c^h + \phi(r)$ ;  $\alpha(r) = r^k$ ;  $a_n = 40$ ;  $a_s = 30$ ;  $b_n = b_s = 2$ ;  $c^h = 6$ ;  $c^* = 3$ ;  $g = g^* = 1$ ;  $\phi_0 = 0.2$ ;  $\omega = 0.01$ ;  $\eta = 1$ ;  $\nu = 500$ ;  $k = 0.5$ ;  $F = F^* = 0$ .

This is the first paper that studies the impact of import quotas on product R&D investments. As with the tariff, the negative impact of the relatively binding import quota relates to the negative impact on process R&D mentioned in the theoretical economic literature (Reitzes, 1991; Bouët, 2001). The quota may reduce the incentive to innovate. The results are the same as those of Costa Cabral, Kujal, and Petrakis (1998). They design a theoretical model in which two firms select their optimal cost-reducing R&D investment and then compete in prices. The domestic (foreign) firm's R&D decreases (increases) with the implementation of a quota close to the free trade level. Authors mention that these results differ from the “infant industry” argument. If the European Union removes the four quantitative measures, European R&D investments may increase.

### 3.5. THE IMPLEMENTATION OF TWO TRADITIONAL POLICY INSTRUMENTS

A free trade agreement may increase domestic R&D investments.

The economic literature explains the difference between these instruments by mentioning that a quota changes the strategic relationship between firms while a tariff does not (Bhagwati, 1968; Krishna, 1989). With the quota, the Northern firm benefits from an advantage in terms of information. Since the quota is binding, the Northern firm already knows the level of its competitor's exports before selecting its domestic sales. The Southern firm no longer sets the optimal level of exports. On the Northern market, the Northern firm selects the optimal level of domestic sales without considering the Southern firm's first order condition.

### 3.6 A Quality Standard

The Northern country's government can decide to implement a quality standard on the domestic market regardless of the outcome of the R&D. In that case, the introduction of a quality standard gives the Northern firm a monopoly power on the Northern market if the R&D is successful, since its competitor produces a lower quality good and does not meet the standard. In this case, the demand for the Northern firm's product no longer depends on the Southern firm's price. But if the R&D is unsuccessful, there is no market in the Northern country.

We use the superscripts  $hs$  and  $ds$  for variables with the quality standard. Under the successful case, we set  $y_n^{ds} = 0$  in order to express  $p_n^{*d}$  as a function of  $p_n^d$ . We deduce the following demand function for the Northern firm's product sold on its domestic market:

$$x_n^{ds}(p_n^{ds}, \phi(r)\eta) = \{a_n[b_n(1 + \phi(r)\eta) + 1 - \phi(r)\eta] - (b_n^2 - 1)(1 - \phi(r)\eta)p_n^{ds}\}/b_n \quad (3.17)$$

Prices and demand functions on the Southern market are unchanged. For example,  $x_s^d$  still denotes the Northern firm's exports. The profit expressions are:

$$\pi = \begin{cases} \pi^{hs} = p_s^h x_s^h - (c^h + g)x_s^h, & \text{if } \phi = 0 \\ \pi^{ds} = p_n^{ds} x_n^{ds} + p_s^d x_s^d - c^d(x_n^{ds} + x_s^d) - g x_s^d, & \text{otherwise.} \end{cases} \quad (3.18)$$

$$\pi^* = \begin{cases} \pi^{*dh} = p_s^{*h} y_s^h - c^* y_s^h, & \text{if } \phi = 0 \\ \pi^{*ds} = p_s^d y_s^d - c^* y_s^d, & \text{otherwise.} \end{cases} \quad (3.19)$$

With a successful R&D, the Northern firm's equilibrium price of domestic sales is:

$$\widehat{p}_n^{ds}(\phi(r), \eta) = \frac{a_n(b_n + 1) + (b_n^2 - 1)c^d[\phi(r)] + \phi(r)\eta[a_n(b_n - 1) - (b_n^2 - 1)c^d[\phi(r)]]}{2(b_n^2 - 1)(1 - \phi(r)\eta)} \quad (3.20)$$

Since there is no longer competition from the Southern firm, the Northern firm's price on its domestic market increases as compared to free trade in case of a successful R&D investment. The monopoly situation relates to a case in which the Southern firm sets a level of exports price approaching infinity because the demand for its product would tend toward zero in this case. According to the reaction functions under the initial case without a quality standard, the Northern firm's domestic price increases with the Southern firm's foreign price:  $dp_n^d/dp_n^{*d} = (1 + \phi(r)\eta)/[2b_n(1 - \phi(r)\eta)] > 0$ . This result entails that the Northern firm's domestic price is higher compared to the initial case.



### 3.7. WELFARE ANALYSIS

The Northern firm's domestic sales are:

$$\widehat{x}_n^{ds}(\phi(r), \eta) = \frac{a_n(b_n + 1) - (b_n^2 - 1)c^d[\phi(r)] + \phi(r)\eta[a_n(b_n - 1) + (b_n^2 - 1)c^d[\phi(r)]]}{2b_n} \quad (3.21)$$

The Northern firm's domestic sales also increase when a quality standard is implemented. By the same reasoning as above we have:  $dx_n^d/dp_n^{*d} = (\partial x_n^d/\partial p_n^d)(dp_n^d/dp_n^{*d}) + \partial x_n^d/\partial p_n^{*d} = (1 + \phi(r)\eta)/2 > 0$ . However, total sales on the Northern market decrease because the Southern firm leaves the market and the domestic price increases.

Finally, the Northern firm's profit earned on its domestic market equals:

$$\widehat{\pi}_n^{ds}(\phi(r), \eta) = \frac{a_n(b_n + 1) - (b_n^2 - 1)c^d[\phi(r)] + \phi(r)\eta[a_n(b_n - 1) + (b_n^2 - 1)c^d[\phi(r)]]}{4b_n(b_n^2 - 1)(1 - \phi(r)\eta)} \quad (3.22)$$

Given the monopoly situation, the Northern firm's optimal level of profit is greater compared to free trade, since the maximization process does not involve taking into account any constraints regarding its rival firm. Moreover, the Northern firm sets a higher price and its marginal profit increases. Its level of output is also stronger.

We now look for the impact of the quality standard on the Northern firm's R&D investment.

**Proposition 3:** The Northern firm's R&D investment increases with the implementation of the quality standard.

**Proof:** The quality standard only increases the Northern firm's profit if the R&D is successful. With an unsuccessful R&D, such a profit decreases because there is no market in the North while the profit earned in the South is the same compared to the initial case. Therefore, the difference in profit increases as compared to the initial case:  $(\widehat{\pi}^{ds} - \widehat{\pi}^{hs}) > (\widehat{\pi}^d - \widehat{\pi}^h)$ . The Northern firm increases its R&D investment in order to increase the probability of R&D success and to benefit from the monopoly in the North with the quality standard.

## 3.7 Welfare Analysis

We have examined the impact of three policy instruments on the Northern firm's R&D investment. Let us study the economic impact of each instrument by analyzing their

impact on expected profits, consumer surplus and public revenues.

### 3.7.1 General Framework under Free Trade

Each expected variable depends on the equilibrium expression of the R&D investment  $\hat{r}$ .

Expected profits are:

$$E[\widehat{\Pi}(\hat{r})] = \alpha(\hat{r})\widehat{\pi}^d[\phi(\hat{r})] + [1 - \alpha(\hat{r})]\widehat{\pi}^h - \nu r, E[\widehat{\Pi}^*(\hat{r})] = \alpha(\hat{r})\widehat{\pi}^{*d}[\phi(\hat{r})] + [1 - \alpha(\hat{r})]\widehat{\pi}^{*h}$$

Let us study each country's expected consumer surplus. We need to express the domestic (foreign) price as a function of the domestic (foreign) sales by turning the domestic (foreign) demand function and considering the foreign (domestic) price as a parameter. We have:

$$\begin{aligned} E[\widehat{CS}(\hat{r})] = & \alpha(\hat{r}) \left[ \int_0^{\widehat{x}_n^d} p_n^d(x_n^d) dx_n^d - p_n^d(\widehat{x}_n^d) \widehat{x}_n^d + \int_0^{\widehat{y}_n^d} p_n^{*d}(y_n^d) dy_n^d - p_n^{*d}(\widehat{y}_n^d) \widehat{y}_n^d \right] \\ & + [1 - \alpha(\hat{r})] \left[ \int_0^{\widehat{x}_n^h} p_n^h(x_n^h) dx_n^h - p_n^h(\widehat{x}_n^h) \widehat{x}_n^h + \int_0^{\widehat{y}_n^h} p_n^{*h}(y_n^h) dy_n^h - p_n^{*h}(\widehat{y}_n^h) \widehat{y}_n^h \right] \end{aligned}$$

$$\begin{aligned} E[\widehat{CS}^*(\hat{r})] = & \alpha(\hat{r}) \left[ \int_0^{\widehat{x}_s^d} p_s^d(x_s^d) dx_s^d - p_s^d(\widehat{x}_s^d) \widehat{x}_s^d + \int_0^{\widehat{y}_s^d} p_s^{*d}(y_s^d) dy_s^d - p_s^{*d}(\widehat{y}_s^d) \widehat{y}_s^d \right] \\ & + [1 - \alpha(\hat{r})] \left[ \int_0^{\widehat{x}_s^h} p_s^h(x_s^h) dx_s^h - p_s^h(\widehat{x}_s^h) \widehat{x}_s^h + \int_0^{\widehat{y}_s^h} p_s^{*h}(y_s^h) dy_s^h - p_s^{*h}(\widehat{y}_s^h) \widehat{y}_s^h \right] \end{aligned}$$

We can now study the impact on the Northern country's consumer surplus. As illustrated in Figure 3.3, the impact is negative for a low sensitivity  $\eta$  of consumers' preference for quality improvement (for example if  $\eta = 0.2$ ). The lower  $\eta$ , the lower the consumers' preference for quality. Since vertical differentiation increases the Northern firm's price, the effect on the consumer surplus is negative. The impact is positive, otherwise.

Under free trade, the Northern country's expected national welfare equals the sum of its expected profit and domestic consumer surplus:  $E[\widehat{W}(\hat{r})] = E[\widehat{\Pi}(\hat{r})] + E[\widehat{CS}(\hat{r})]$ . The same goes for the Southern country's expected welfare:  $E[\widehat{W}^*(\hat{r})] = E[\widehat{\Pi}^*(\hat{r})] + E[\widehat{CS}^*(\hat{r})]$ .

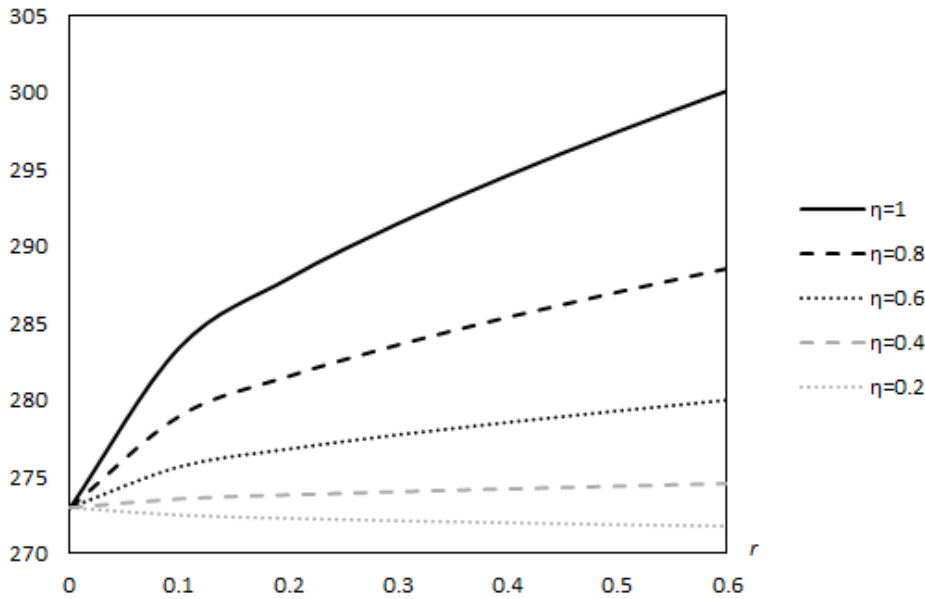
### 3.7.2 Discussion

Table 3.1 illustrates the economic impact of each policy instrument (on expected profits, consumer surpluses and public revenues).

Table 3.2 in the appendix to chapter three, illustrates the impact of the policy instruments on the Northern country's consumer surplus. The import tariff and the quality standard may increase such a consumer surplus if the parameter  $\eta$  (the sensitivity of consumers'

### 3.7. WELFARE ANALYSIS

**Figure 3.3 – Evolution of the Expected Northern Consumer Surplus When the R&D Investment Varies**



Source: authors.

Note: We set:  $\phi(r) = \phi_0 + \omega r$ ;  $c^d[\phi(r)] = c^h + \phi(r)$ ;  $a_n = 40$ ;  $a_s = 30$ ;  $b_n = b_s = 2$ ;  $c^h = 6$ ;  $c^* = 3$ ;  $g = g^* = 1$ ;  $\phi_0 = 0.2$ ;  $\omega = 0.01$ ;  $F = F^* = 0$ .

**Table 3.1 – Economic Impact of Each Policy Instrument**

Instrument	$r$	$E[\Pi]$	$E[\Pi^*]$	$E[CS]$	$E[CS^*]$	$E[PR]$
Import Tariff	+	+	-	+/-	+/-	+
Import Quota	+/-	+/-	+/-	+/-	+/-	0
Quality Standard	+	+/-	-	+/-	+/-	0

Source: Authors.

taste for quality) is high. The indirect positive effect via the increase in the probability of R&D success is higher than the direct negative effect via the increase in prices in this case. Such a result can be offset against traditional results that mention a negative impact of "at-the-border" policy instruments on the consumer surplus.

We also study the impact on the Northern country's expected public revenues.<sup>20</sup> Of course, the import tariff is the only instrument that increases public revenues because we assume that the import quota and the quality standard do not lead to further revenues.

<sup>20</sup>With the import tariff:  $E[\widehat{PR}(\hat{r})] = t\{\alpha(\hat{r})\hat{y}_n^d + [1 - \alpha(\hat{r})]\hat{y}_n^h\} > 0$ .

We have to verify whether or not the Northern country's government is encouraged to implement each policy instrument. Let us study the impact on the Northern country's expected national welfare. We can also compare each instrument. Table 3.3 in the appendix to chapter three illustrates the optimal level of each instrument and the expected national welfare as compared to free trade. The results are obtained under numerical simulations because analytical demonstrations are too complex.

The optimal import tariff is positive. The tariff seems to be the favorite policy instrument because: i) it increases the Northern firm's profit via "profit-shifting"; ii) it also increases its R&D investment; iii) it involves further public revenues for the government; and iv) it may increase the expected consumer surplus when their preference for quality is high - the negative effect is low, otherwise.

The economic impact of the import quota is ambiguous owing to its effect on the R&D investment. According to Table 3.3, the quota increases the Northern country's expected national welfare in seven cases. In these cases, the optimal quota is a prohibitive quota such as the Northern firm benefits from a monopoly on its domestic market. But the quota reduces the expected national welfare under five cases. In these cases, the Northern government is encouraged to remain under free trade.

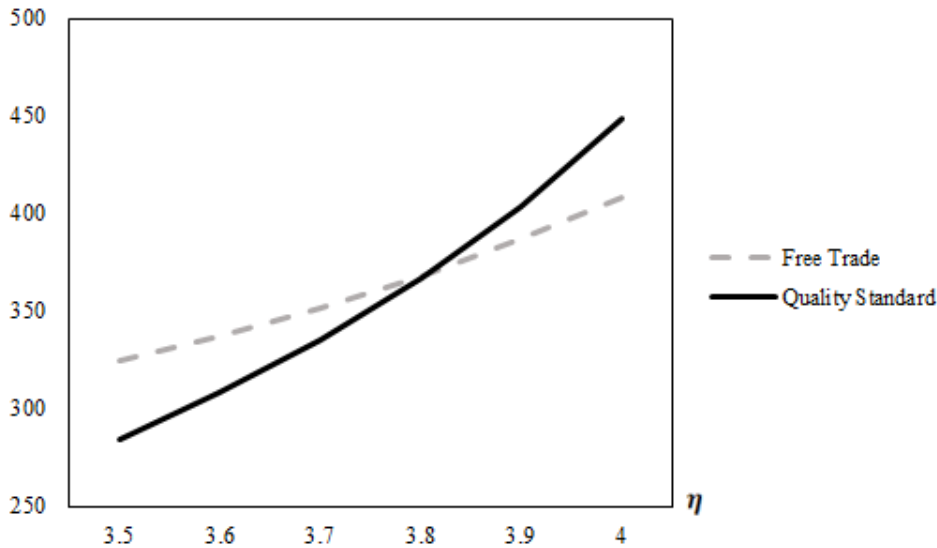
The implementation of a quality standard often reduces the Northern country's national welfare. As a matter of fact, it often reduces the domestic consumer surplus while the effect on the Northern firm's profit is not always positive. Nevertheless, the Northern country's expected national welfare may increase if the level of  $\eta$  is really high. The figure below illustrates the Northern country's expected national welfare under free trade and quality standard when  $\eta$  varies. The national welfare is higher with the implementation of the quality standard for  $\eta \geq 3.8$  (see Figure 3.4).

The implementation of the import tariff and the quality standards increases the domestic R&D investment while the implementation of the import quota either increases or reduces it. The positive impact of the quality standard is higher than that of the import tariff. The reason is that the Southern firm leaves the Northern market with both a prohibitive tariff and a quality standard. But the Northern firm also leaves such a market if the R&D is unsuccessful with the quality standard. The quality standard is the best instrument in terms of innovation improvement. The ranking is as follows: quality standard  $>$  import tariff  $>$  import quota, where  $>$  denotes an operator for the preference in terms of the R&D investment for the Northern country.

The implementation of the import tariff and the import quota increases the Northern country's expected national welfare. The quality standard often reduces it. Nevertheless,

### 3.8. A NON-PROHIBITIVE QUALITY STANDARD

**Figure 3.4 – Evolution of the Northern Country’s Expected National Welfare under Free Trade and Quality Standard When the Parameter  $\eta$  Varies**



Source: authors.

Note: We set:  $\phi(r) = \phi_0 + \omega r$ ;  $c^d[\phi(r)] = c^h + \phi(r)$ ;  $a_n = 40$ ;  $a_s = 30$ ;  $b_n = b_s = 3$ ;  $c^h = 6$ ;  $c^* = 3$ ;  $g = g^* = 1$ ;  $\phi_0 = 0.1$ ;  $\omega = 0.01$ ;  $F = F^* = 0$ .

we have identified cases in which the effect becomes positive. But such an instrument is always the worst instrument. The optimal import quota is often prohibitive. But the positive effect on the Northern country’s national welfare is always lower than that of the optimal import tariff. Both instruments increase (reduce) the Northern (Southern) firm’s profit and often reduce the Northern country’s expected consumer surplus (even if the import tariff may increase it with a high value for  $\eta$ ). But the import tariff leads to further public revenues. We have the following ranking: import tariff  $>$  import quota  $>$  quality standard, where  $>$  denotes here an operator for the preference in terms of expected national welfare for the Northern country.

As a consequence, the choice of the best policy instrument depends on the objective of the Northern government. If the government only aims at promoting domestic innovations, quality standards are the best instrument. But if it aims to increase national welfare, import tariffs seem better.

## 3.8 A Non-Prohibitive Quality Standard

We have studied the impact of a prohibitive quality standard. Our results show that the implementation of such a policy instrument is not optimal in terms of national welfare.

### 3.8. A NON-PROHIBITIVE QUALITY STANDARD

It is too binding. However, there has been a growing interest in the implementation of policy standards such as ISO International Standards in order to ensure product safety for consumers. Our aim is to provide some evidence on the effects of such a modern instrument, in particular on the Northern country's national welfare.

We could have considered a less binding quality standard (Crampes and Hollander, 1995). In that case, the Northern government only sets a maximum level of low-quality sales for each firm on the Northern market. For example, we denote by  $qs$  the maximum level of low-quality sales for each firm on the Northern market. Such a quality standard is still binding, i.e. the maximum level  $qs$  is lower than the free trade low-quality sales:  $0 < qs < \{\hat{x}_n^h, \hat{y}_n^h, \hat{y}_n^d\}$ .

The sign of the impact on the Northern firm's R&D investment would be the same because its profit increases (decreases) if the R&D is successful (unsuccessful) with the implementation of such a maximum level. Crampes and Hollander (1995) proved that the low-quality firm's profit might increase with the implementation of a quality standard while the high-quality firm's profit could decrease. But in their framework, firms select a level of quality. Our framework differs. There are two levels of quality. With the implementation of a prohibitive quality standard, we did not find any case in which the Southern firm's expected profit increases because it no longer exports to the Northern market.

With a non-prohibitive quality standard, we do find cases in which the Southern firm's expected profit increases as compared to free trade (especially when  $\phi$  and  $\eta$  are low). Under these cases, the Northern firm's expected profit also increases but the effect is lower than that on the Southern firm's expected profit.

An important result of our simulations is that the effect of the non-prohibitive quality standard on the expected national welfare is negative (see Table 3.4 in the appendix to chapter three). We do however find evidence to the opposite effect when  $b_n = b_s = 3$  and if the preference for quality is high ( $\eta = 2.5$ ).<sup>21</sup> There is nevertheless no case when the Northern country's national welfare is higher as a result of the implementation of a non-prohibitive quota compared to the optimal tariff.

Note that we find cases in which the Southern country's national welfare increases with the implementation of the optimal non-prohibitive when  $\eta$  is low.

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<sup>21</sup>If we consider the quality level to be exogenous to the model, the non-prohibitive quality standard may become the Northern government's favorite policy instrument if  $\eta$  is high. In this case, the level of the Northern country's national welfare is higher than that with the optimal tariff.

## 3.9 Concluding Remarks

In this chapter, we establish a theoretical model of international trade in a two-country duopoly with a Northern and Southern firm to examine the impact of several trade policy instruments on product R&D investment and welfare. The Southern firm is considered to have a competitive advantage due to lower production costs, encouraging the Northern competitor to invest in quality improvement. Unlike related studies, we suppose that the outcome of this investment is uncertain: there is a given probability for the Northern firm's product R&D to be successful. The Northern country's government is the only one to be policy active, having the choice between several policy instruments: an import tariff, an import quota and a quality standard. Firms compete in prices on both markets.

Through our three-stage game, we show that the implementation of an import tariff and a quality standard increases the Northern firm's R&D. Therefore, if the Northern government's only aim is to enhance non-price competitiveness by encouraging product R&D investment, we provide evidence in favor of implementing these policy instruments. But the effect of an import quota is ambiguous. A relatively binding quota reduces the R&D investment while a strongly binding quota either increases or reduces it. However, it is also argued that the effect of these instruments may hinder profits, consumer surplus, public revenues and welfare.

Based on numerical simulations and comparisons of the impact of these instruments, it appears that the Northern country's government would favor the implementation of an import tariff. By this means, the domestic expected profit, consumer surplus and public revenues could increase. Nevertheless, the real implications of this result are limited, as the ongoing trend in the international arena is towards the reduction of this trade barrier.

We consider an extension with the study of the implementation of a non-prohibitive quality standard (section 3.8). Under the assumption that the quality level is endogenous to the model we do not find cases in which the Northern government favors the implementation of such an instrument instead of the import tariff.

The analysis we conducted is relevant to international trade between developed and developing countries, high and low cost firms, in which the latter do not necessarily have the capacities to undergo quality improvement and finance product R&D activities. We believe to have contributed to the existing literature by building such a framework, including uncertainty in it and analyzing the impact of a relatively wide panel of instruments.

An extension to our study would be to consider competition in quantities instead of prices and see how the mode of competition changes our results. Changing the setting of

### 3.9. CONCLUDING REMARKS

the model by analyzing trade between identical firms in a North-North or South-South duopoly might also have important implications and constitute future research topics. Another possible extension would be to consider individual preferences for quality for each consumer. Finally, we could consider the case of the Southern government becoming policy active by implementing retaliations.





# Appendix to Chapter 3

## 3.A Impact of “At-the-Border” Policy Instruments on Expected Consumer Surplus

Table 3.2 – Evolution of the Northern Country’s Expected Consumer Surplus with an Import Tariff, an Import Quota and a Quality Standard

$\eta$	Import Tariff such as $t = 1$		Prohibitive Import Quota $q = 0$		Quality Standard	
	$b_i = 2$	$b_i = 3$	$b_i = 2$	$b_i = 3$	$b_i = 2$	$b_i = 3$
0.25	-7.4571	-7.79463	-111.22727	-50.64387	-207.93847	-97.181674
0.5	-8.0033	-7.70629	-105.72333	-49.700568	-186.05601	-91.925472
0.75	-7.5564	-7.51709	-99.480279	-48.045127	-160.90968	-85.04123
1	-6.7487	-7.1814	-90.304934	-45.647438	-128.73748	-76.214956
1.25	-5.3633	-6.63139	-77.521747	-42.473391	-84.848596	-74.158622
1.5	-2.9335	-5.75858	-59.239585	-38.479008	(b)	-50.512691
1.75	(a)	-4.36916	(a)	-33.590742	(a)	-31.332811
2	(a)	-2.04669	(a)	-27.633189	(a)	-3.8781074
2.25	(a)	2.50015	(a)	-19.961088	(a)	44.7286098
2.5	(a)	(a)	(a)	(a) (b)	(a)	(a)

Source: authors.

Note: We set:  $\phi(r) = \phi_0 + \omega r$ ;  $c^d[\phi(r)] = c^h + \phi(r)$ ;  $a_n = 40$ ;  $a_s = 30$ ;  $c^h = 6$ ;  $c^* = 3$ ;  $g = g^* = 1$ ;  $\phi_0 = 0.2$ ;  $\nu = 500$ ;  $k = 0.5$ ;  $\omega = 0.01$ ;  $F = F^* = 0$ .

## 3.B Welfare Analysis

**Table 3.3 – Optimal Policy Instruments and Evolution of the Northern Country's Expected National Welfare**

			Policy Instrument	Optimal Instrument	$\Delta E(W)$
$\phi(r) = 0.2 + 0.01r$	$b_n = b_s = 2$	$\eta = 0.5$	Import Tariff	16.55	183.8335
			Quality Stand.	-	-272.410833
			Import Quota	0	85.1860574
		$\eta = 1$	Import Tariff	16.98	201.5681
			Quality Stand.	-	-112.950839
			Import Quota	0	110.640039
	$\eta = 1.5$	Import Tariff	19.76	286.4359	
		Quality Stand.	(a)	(a)	
		Import Quota	0	167.597932	
	$b_n = b_s = 3$	$\eta = 0.5$	Import Tariff	6.66	47.83412
			Quality Stand.	-	-163.24297
			Import Quota	19.7142	-7.18761905
$\eta = 1$		Import Tariff	6.62	48.42911	
		Quality Stand.	-	-133.890667	
		Import Quota	0	-2.10727554	
$\eta = 1.5$	Import Tariff	6.74	52.87281		
	Quality Stand.	-	-87.7535248		
	Import Quota	0	7.13606233		
$\phi(r) = 0.1 + 0.01r$	$b_n = b_s = 2$	$\eta = 0.5$	Import Tariff	16.55	182.013
			Quality Stand.	-	-325.861648
			Import Quota	0	79.8645211
		$\eta = 1$	Import Tariff	16.56	184.0115
			Quality Stand.	-	-265.966798
			Import Quota	0	85.5216811
	$\eta = 1.5$	Import Tariff	16.66	189.7378	
		Quality Stand.	-	-188.670793	
		Import Quota	0	95.865176	
	$b_n = b_s = 3$	$\eta = 0.5$	Import Tariff	6.68	47.90207
			Quality Stand.	-	-172.809276
			Import Quota	-	-8.29095048
$\eta = 1$		Import Tariff	6.66	47.84878	
		Quality Stand.	-	-162.297654	
		Import Quota	19.7142	-7.08726889	
$\eta = 1.5$	Import Tariff	6.63	47.95578		
	Quality Stand.	-	-148.957236		
	Import Quota	19.7142	-4.97213351		

Source: authors.

Note: We set:  $c^d[\phi(r)] = c^h + \phi(r)$ ;  $a_n = 40$ ;  $a_s = 30$ ;  $b_n = b_s = 2$ ;  $c^h = 6$ ;  $c^* = 3$ ;  $g = g^* = 1$ ;  $F = F^* = 0$ . The level of R&D is greater than one.

### 3.C Welfare Analysis with the Non-Prohibitive Quality Standard

Table 3.4 – Optimal Non-Prohibitive Quality Standard and Evolution of the Northern Country's National Welfare

			Optimal Quality Standard	$\Delta E(W)$
$\phi(r) = 0.2 + 0.01r$	$b_n = b_s = 2$	$\eta = 0.5$	22.1333	-12.7581
		$\eta = 1$	20.2902	-37.3714
		$\eta = 1.5$	18.067	-66.1516
	$b_n = b_s = 3$	$\eta = 0.5$	16.2857	-13.3031
		$\eta = 1$	14.847	-24.1006
		$\eta = 1.5$	12.3661	-40.2886
$\phi(r) = 0.1 + 0.01r$	$b_n = b_s = 2$	$\eta = 0.5$	22.1333	-11.2974
		$\eta = 1$	22.1333	-12.8783
		$\eta = 1.5$	21.342	-23.6773
	$b_n = b_s = 3$	$\eta = 0.5$	16.2857	-13.5177
		$\eta = 1$	16.2857	-13.2924
		$\eta = 1.5$	16.055	-14.9339

Source: authors.

Note: We set:  $c^d[\phi(r)] = c^h + \phi(r)$ ;  $a_n = 40$ ;  $a_s = 30$ ;  $b_n = b_s = 2$ ;  $c^h = 6$ ;  $c^* = 3$ ;  $g = g^* = 1$ ;  $F = F^* = 0$ .



# General Conclusion

The objective of this dissertation was to examine the relationship between quality and trade costs. Our approach, both theoretical and empirical, aimed to shed light on three aspects that have been the object of limited documentation. First, we focused on the effects of natural and policy-related trade costs on the export flows of a luxury product by evaluating empirically the impact of distance and customs protection on Cognac's foreign shipments. Second, we investigated empirically the role of these trade costs on the quality structure of trade flows based on a time-invariant and objective measure of quality, rather than indirect or subjective measure. We quantified the impact on Cognac's quality mix of: i) cross-country variations in trade costs through distance, ad valorem and specific duties; and ii) the impact of time variations in trade costs through containerization. Third, we developed a theoretical framework in which quality is the result of product R&D and analyzed the impact of policy-related trade costs (a tariff, an import quota and a quality standard) on product R&D. In the first two chapters a lot of effort was put into data assembling. We built two unique databases of Cognac shipments and customs protection. Meanwhile, the main challenge of the third chapter was to calculate and deduce the effects of several policy instruments on product R&D, in a model with an endogenous investment level that depends on the degree of vertical differentiation.

The results and contributions of this research are of both academic and private interest.

First, the econometric model analyzing the determinants of Cognac foreign shipments can be used as a means to predict Cognac's export flows. This is an important issue for Cognac's inter-profession. Indeed, after the 2008-2009 economic crisis, the BNIC decided to implement an elaborate "Cognac Business Plan" in order to "develop Cognac and represent and defend the collective interests of professionals" ([High Council for Food, Agriculture and Rural Areas-CGAAER report on viticulture, 2017](#)). The objective of this plan is to favor the long-run development of the Cognac sector and assure that the Cognac production and stocks satisfy markets needs. It includes a tool for calculating stocks over the following fifteen years. The report also emphasizes the importance of export markets in strengthening the Cognac sector. Our econometric model would therefore be an additional tool to help draw projections of Cognac's export performance. It would

## GENERAL CONCLUSION

also be of use in debates that sometimes oppose actors from trading and viticulture. The first usually demand an increase in Cognac production because they foresee a booming market while the second are more reluctant because they fear a decrease in demand, an increase in stocks and a fall in prices.

Second, this dissertation gives new insight into the impact of transport costs and their variation on the quality structure of trade flows. Our results show that Alchian and Allen's original conjecture holds in the case of Cognac. We are thus among the few to validate empirically this conjecture and among even fewer to do so by examining the quality mix of a luxury product (with a notable exception by [Crozet, Head, and Mayer, 2012](#) who study Champagne). We also provide unprecedented empirical evidence of the effects of the technological change brought by containerization on a product's quality mix. Recent papers like [Rua \(2014\)](#) and [Bernhofen et al. \(2016\)](#) have examined respectively the determinants of the diffusion of containerization and its impact on world trade. However, there has been no evidence - until now - showing how entering the age of containerization shaped the quality structure of export flows. The use of containers revolutionized ocean shipping in the twentieth century ([Hummels, 2007](#)) and we show empirically how it impacted Cognac's quality mix. Technological advances in transportation such as containerization or the use of jet engines in air shipments, have considerably changed the way goods move. As a result, transport costs have been declining, but they still matter ([Hummels, 2007](#)). Other improvements in transportation modes are therefore yet to come, with the potential to further transform the cross-border movement and trade of goods.

Third, we build a theoretical framework that relates to the debate over the effects of protectionist policies and whether countries should resort to these measures especially after the 2008-2009 crisis. Recent changes in governments' stances as in the United States for instance, with respect to the increase of taxation of imports from low-cost firms and countries (e.g. Mexico) have further sparked the debate over the necessity of implementing trade-restrictive policy instruments. Based on results and numerical simulations from our theoretical model, we argue that a country could have reasons to implement an import tariff because such an instrument could increase the product R&D investment level of its firms, the consumer surplus and public revenues. This should not be viewed as a statement in favor of the implementation of protectionist policies but rather as a means to induce reflection on different aspects associated with such trade-restrictive policy measures especially when a country's priority is promoting product R&D investment. On a more general level, countries continuously seek ways to encourage innovation, which is a key determinant of economic growth and competitiveness. In this context, our analysis provides some insight into the effects of policy-related measures on product innovation. This theoretical research is particularly relevant for firms in developed countries that can

afford to invest in product R&D as a result of increasing competition from cost-advantaged firms in developing countries that do not possess the capacities to undergo product quality improvement.

This dissertation could benefit from several extensions. For instance, we rely on distance as a proxy for transport costs when we analyze the determinants of Cognac's trade flows and the impact of trade costs on Cognac's quality mix. The use of distance is common especially in gravity-like frameworks, but it presents a few drawbacks: i) it captures other aspects like information costs for example; and ii) it reflects poorly the quality of roads and ports infrastructure. Furthermore, transport costs do not depend exclusively on distance, but also on the quality of transport services offered (Hummels, 2007). Data on transport costs would allow us to obtain more precise estimates of their impact on the volume and probability of Cognac trade. Following Hummels and Skiba's (2004) work, it would also be possible to estimate the elasticity of transport costs with respect to Cognac prices and determine if they indeed have a per-unit rather than a per-value (iceberg) form, which is a key assumption for Alchian and Allen's conjecture to hold. Our empirical analysis of this conjecture would also benefit from a deeper understanding of cost-related issues surrounding containerization. Available data at our disposal only reflect the year of adoption of this technology by country. In the present analysis we presented several arguments showing that entering the age of containerization is highly likely to have led to a reduction of per-unit transport costs, but there is no precise evidence on the matter. With appropriate data we would be able on the one hand, to estimate more precisely the impact of containerization on Cognac's quality mix. On the other hand, in the spirit of Donaldson (2012) and his examination of the effects of India's railroad system, it would also be possible to conduct a study of a larger scale and quantify the impact of containerization on trade costs, international trade and welfare.

Another dimension we would like to explore is related to the impact of income distribution on Cognac export flows. We already tried to incorporate this element into our analyses, but the lack of sufficient observations compromised our estimations (see section 1.A of the appendix to chapter one for example). This issue could be circumvented if better data were made available. In that case, we would be able to conduct estimations and compare our findings with Ray and Vatan's (2013) results for example, who show that the demand for luxury products increases with the income gap in importing countries. Nonhomothetic preferences are also closely related to international trade flows by qualities (Fajgelbaum, Grossman, and Helpman, 2011), therefore we would like to control for income distribution when examining Cognac's quality mix and test if the share of high-quality Cognac increases with the income gap in importing countries.



## GENERAL CONCLUSION

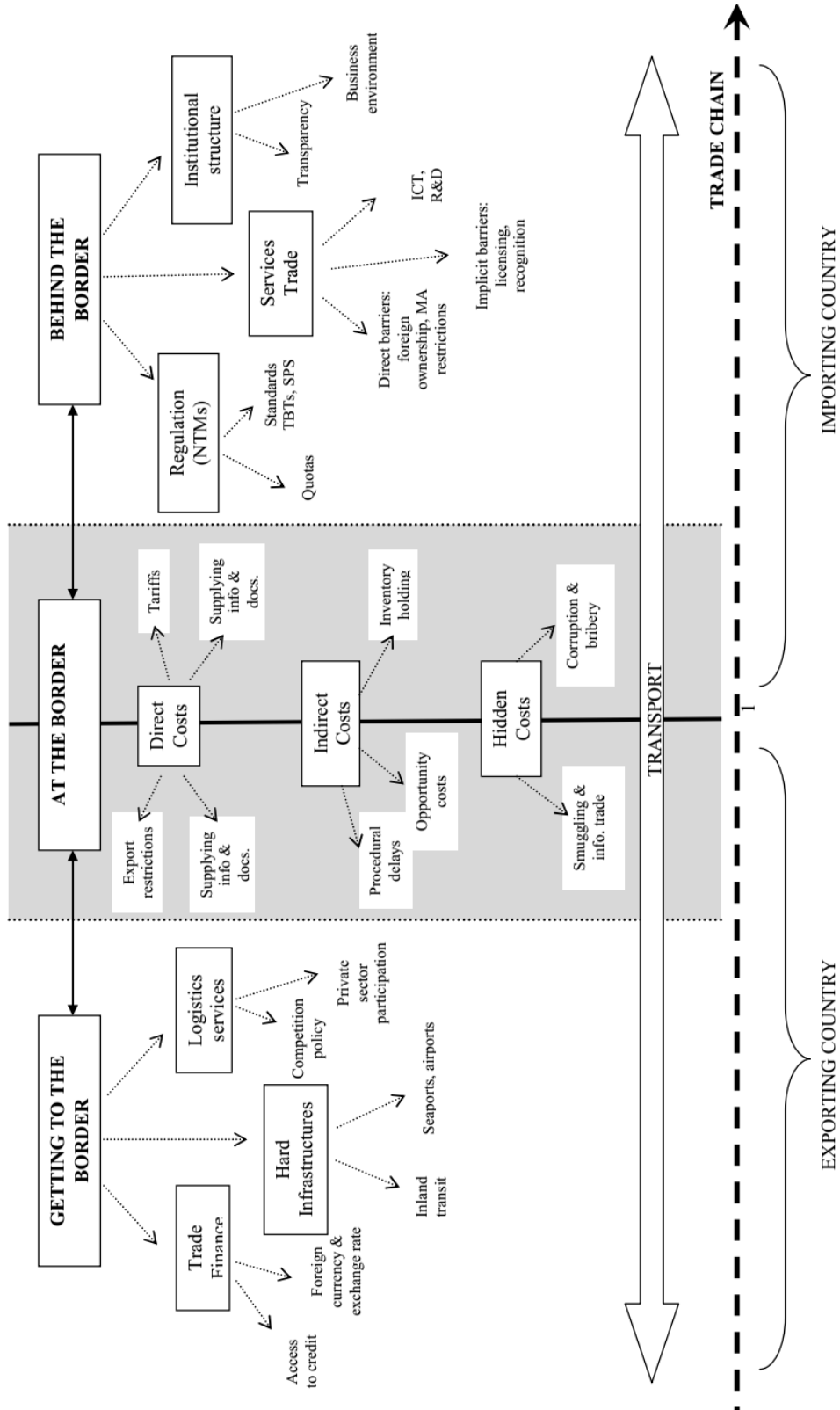
Finally, we would like to investigate the firm-level determinants of product quality. In the case of Cognac, the question we raise is whether the Alchian and Allen effect is due to cross-firm selection (only firms that produce higher-quality goods export to more distant markets) or within-firm selection (firms choose higher-quality and more expensive goods when they decide to export to more distant markets). The strategies of Cognac's firms in terms of Cognac exports by quality designations are highly likely to differ from one firm to another. More than 300 hundred *Maisons de Cognac* commercialize Cognac according to the BNIC, including the four leading actors of the sector: Hennessy, Martell, Rémi Martin and Courvoisier. The decision-making process and export performance may be highly variable within Cognac Houses and we would like to investigate these issues in further detail which is why our future endeavors will focus on obtaining data on Cognac flows at the firm level. In the case of product R&D, we could extend the present framework to multiple firms in the Northern country and introduce firm heterogeneity. The goal would be to analyze how trade with a cost-advantaged firm would affect the Northern firms' decisions to invest in product R&D and quality improvement in presence of policy instruments.

# Appendix A

## Global Appendix

# A.1 Categorizing Trade Costs

Figure A.1 – Trade Costs: An Alternative Classification



Source: Moïse and Le Bris (2013).

## A.2 Quality: A Multidimensional Concept

The academic literature in several disciplines - economics, management, marketing, philosophy - has focused extensively on the concept of quality. In an attempt to summarize the multidimensional aspects related to this concept, [Garvin \(1984\)](#) identifies five approaches to defining quality: (i) transcendent (associated to philosophy), (ii) product-based (associated to economics), (iii) user-based (associated to economics, marketing and management), (iv) manufacturing-based and (v) value-based (associated to management). From the philosophical point of view (first approach) it is difficult to precisely define quality which is rather recognizable through experience. Proponents of the product-based approach on the other hand ([Leffler, 1982](#), for example), consider quality to be an inherent measurable characteristic of goods that can be assessed objectively. Goods can be vertically ranked based on the amount of the preferred attribute they possess. Production costs are proportional to a good's quality meaning that higher quality goods are more costly to manufacture and therefore more expensive. The user-based approach sees quality as highly subjective, depending on consumers' preferences. A (high) quality good best satisfies (a) consumer(s)' needs. In the economic literature this would translate into shifts in a product's demand curve. The fourth approach is related to engineering and manufacturing practices: it simplifies them. Quality is defined as "conformance to requirements". In the final approach, quality's definition is related to cost and prices, providing "performance at an acceptable price or conformance at an acceptable cost". Garvin himself introduces eight dimensions in order to identify quality:

- performance, referring to primary operating characteristics of goods
- features: additional, secondary characteristics of goods that add on the primary attributes
- reliability: probability and frequency of failure
- conformance: whether or not goods meet standards
- durability referring to product's life
- serviceability: whether or not goods are quick to be repaired
- aesthetics referring to subjective attributes such as: color, smell, taste etc.
- perceived quality related to consumers' perception of quality that can be influenced by reputation, brand names, advertising.

According to the author, the product-based approach focuses on the first two dimensions and durability, while the user-based approach focuses on the most subjective dimensions: aesthetics and perceived quality.

## A.2. QUALITY: A MULTIDIMENSIONAL CONCEPT

Evidently, a product's objective quality and how it is perceived by consumers may not necessarily go hand in hand together. In order to somehow remedy for this issue, the European Union for example has implemented a legal framework for *quality logos* in the case of food, agricultural products, wine and spirits to attest and better inform consumers on "the specific traditions and qualities" of these products (European Commission). These logos include: the Protected Designation of Origin (PDO), the Protected Geographical Indication (PGI) and the Traditional Speciality Guaranteed (TSG). The first two are related to the region where the product comes from, while the third one emphasizes a traditional production process. In the same spirit but subject to different regulations and labeling rules is organic farming. On an international level, there is the ISO 9000 certification which consists of a group of standards whose aim is to "provide guidance and tools for companies and organizations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved" (International Organization for Standardization).

## A.3 Compiling the Database on Cognac Exports from 1967 to 2013

### A.3.1 Collecting the Data

Our database covers a large period of time, forty-seven years of Cognac exports were accounted for. Information on the volume and value of shipments by quality designations to more than a hundred destinations goes from September 1, 1967 to December 31, 2013. Between 1967 and 1987 data were paper-based and available on the time dimension of a campaign, from September 1 to August 31 of the following year. Starting from 1988 until now, information was available on a digital and calendar basis.

Different issues were encountered when compiling these data, mainly due to the length of the time-series. We discuss them in the following subsections.

### A.3.2 The Geographic Coverage of the Database

One of the problems arising when dealing with a large panel of countries over a long time-span is related to geopolitics. As countries can be created, united or separated over time, our database had to account for such movements in the international arena<sup>1</sup>. For example, countries that were once part of the Union of Soviet Socialist Republics are not represented individually in our database. They were regrouped after 1991 to recreate the former entity, called FSU (Former Soviet Union). This was done in the spirit of preserving the cohesion of the whole dataset, our goal being that of tracing the evolution of shipments to the same countries from 1967/1968 onward. Other groups of countries similar to the FSU, are Ex-Czechoslovakia, Ex-Yugoslavia, Netherlands Antilles, and West Indies.

Moreover, countries that for geographical, economical or political reasons appeared as subdivisions of each other were also considered as one entity: Malaysia and Sri Lanka, United Arab Emirates and Oman, Belgium and Luxembourg, etc. For similar reasons, Guadeloupe, French Guiana, Martinique, Mayotte, Réunion and Saint Barthélemy were regrouped with France for the whole period of study. Even though no subdivisions were reported, San Marino was included under Italy, Liechtenstein under Switzerland etc.

To each country, wherever possible, we attached codes<sup>2</sup> from the *International Standard for country codes and codes for their subdivisions* (ISO 3166). Our purpose in doing so, same as the reason for establishing ISO 3166, was to “save time and avoid errors as in-

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<sup>1</sup>Data concerning exports to the “Allied Forces” (1967/1968-1987/1988) were dropped.

<sup>2</sup>These codes include: a two letter code (Alpha-2), a three letter code (Alpha-3) and a numeric code (numeric-3).

### A.3. COMPILING THE DATABASE ON COGNAC EXPORTS FROM 1967 TO 2013

stead of using a country’s name, which will change depending on the language being used”.

The countries’ names in our dataset, were defined according to the English short name version in capital letters of ISO 3166, available on the *Online Browsing Platform*. The source of this information is the United Nations Statistics Division.

#### A.3.3 From the French Franc to the Euro

Before 1988, the reference unit of Cognac exports was the French franc (FRF). From 1988 to 1999, the values had been converted to fixed euros by dividing them by 6.55956. The euro succeeded in 1999 the ECU (European Currency Unit), a currency basket, containing fixed amounts of most of the EU currencies, with a conversion rate between the two of 1:1. Since that date, irrevocably fixed rates of conversion were established between the euro and the currencies of the euro-area, whereas prior to 1999, exchange rates between the euro and national currencies varied over time.

Therefore, using a fixed exchange rate before 1999, causes a minor loss of precision. This is why we re-converted the value of shipments from 1988 to 1999 to French francs. Based on data provided by Eurostat, we then proceeded to establish an exchange rate between the French franc and the fixed euro using the following formula:

$$S_{XEU/FRF} = \frac{S_{ECU/FRF}}{CF_{XECU/EU}}$$

with  $S_{XEU/FRF}$  the exchange rate Euro/FRF,  $S_{ECU/FRF}$  the historical exchange rate of former FRF vs. Euro/ECU and  $CF_{XECU/EU}$  the conversion factor for euro fixed series into Euro/ECU<sup>3</sup>. The Eurostat data for the exchange rate between the French franc and the fixed Euro was only available from 1971, therefore we turned to the 1971 official fixed exchange rate for the Cognac campaigns: 1967/1968 to 1969/1970.

#### A.3.4 From 6 to 3 Qualities of Cognac

Last but not least, there was the issue of Cognac *qualities*. Aggregated and more detailed ageing designations (VS, VSOP, NAPOLEON, EXTRA...) were assigned by the BNIC from 1988 onward. Consistent with our purpose of analysis and further investigation, we deemed sufficient to retain only the aggregated ageing designations: VS (Very Special), VSOP (Very Superior Old Pale) and XO (Extra Old)<sup>4</sup>.

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<sup>3</sup>We use monthly average series of the Eurostat Exchange rates database. The historical exchange rates and the conversion factors are averages of the monthly data from September to August of the following year concerning Cognac campaigns; from January to December for the calendar years.

<sup>4</sup>Observations with an *ageing account* equal to 77 were deleted, while observations belonging to *ageing account*=“S” were included under VS.

Before 1988 and whenever the designations were missing, we assigned the above mentioned quality designations based on the minimum time in oak legally required by the youngest eau-de-vie used in creating a blend. This information was provided by the “compte de vieillissement” (literally translates to *ageing account*). Thus we had: 2 to 3 years: VS (00, 0 and 1 were exceptionally included in this quality category); 4 to 5 years: VSOP and finally for more than 6 years: XO. In reality Cognac growers and houses often exceed these minimum requirements in their blends, but we do not believe this to constitute a problem for our statistical and empirical analysis.

## A.4 Cognac Shipments from 1967 to 2013: Stylized Facts

Figure A.2 presents the evolution of total exports, in volume, of Cognac from 1967 to 2013. Over these forty-seven years, the volume of foreign shipments has more than doubled, reaching as high as 440,981 HL PA in 2013. However, as shown by Figure A.2, there have been significant ups and downs: the oil crisis in 1973, the oil crisis in 1979, the global economic recession in the early 1990’s, financial crisis in 2007-08 all apparently significantly hurt global Cognac sales.

Meanwhile, the French market has registered a slow and long decline since the beginning of the seventies. In 1971, the sales in volume on the domestic market were equal to 52,020 HL PA, while in 2013, they had decreased to 10,829 HL PA, a decrease of nearly 80 percent in 42 years. the rate of foreign exports compared to the overall shipments (exports coefficient) of Cognac has gone beyond the 95 percent threshold (see Figure A.3).

During discussions with the BNIC, at least two reasons have been pointed out for the long term decrease of Cognac sales in France. First, brandy is the object of excessive indirect taxation in France. Second, Cognac was traditionally consumed as a *digestif* in France, that is to say drunk after dinner. Abroad it has been for a long time drunk alone or mixed in cocktails (with sparkling water or soda) as an *aperitif* (before dinner), a custom that is not widespread in France where aperitifs prioritize rum (mojito, punch, piña colada).<sup>5</sup>

In 1967, Cognac was shipped to 148 countries. As shown by Figure A.4, there seems to be a concentration of destinations, as the number of importing countries has decreased to

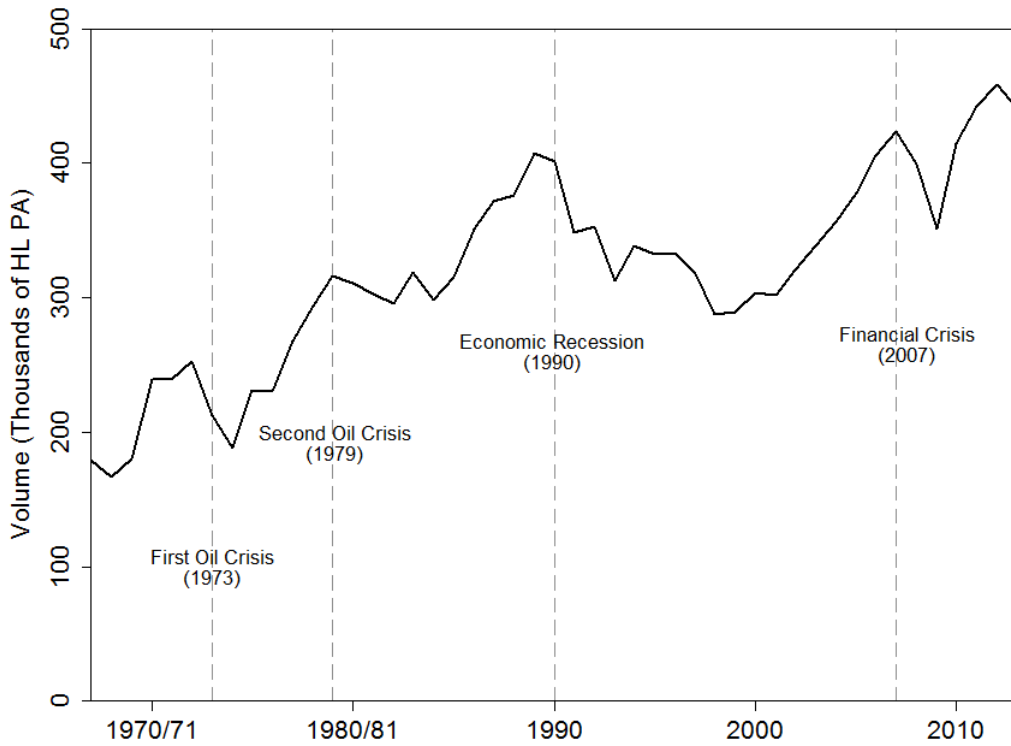
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<sup>5</sup>See also Coussié, 1996. Both explanations have also been cited by newspapers like Le Figaro (11/18/2011), la Charente Libre (11/9/2011), La Vigne-Mag (11/9/2011) or by websites focusing on Cognac (www.cognacforgeron.com).



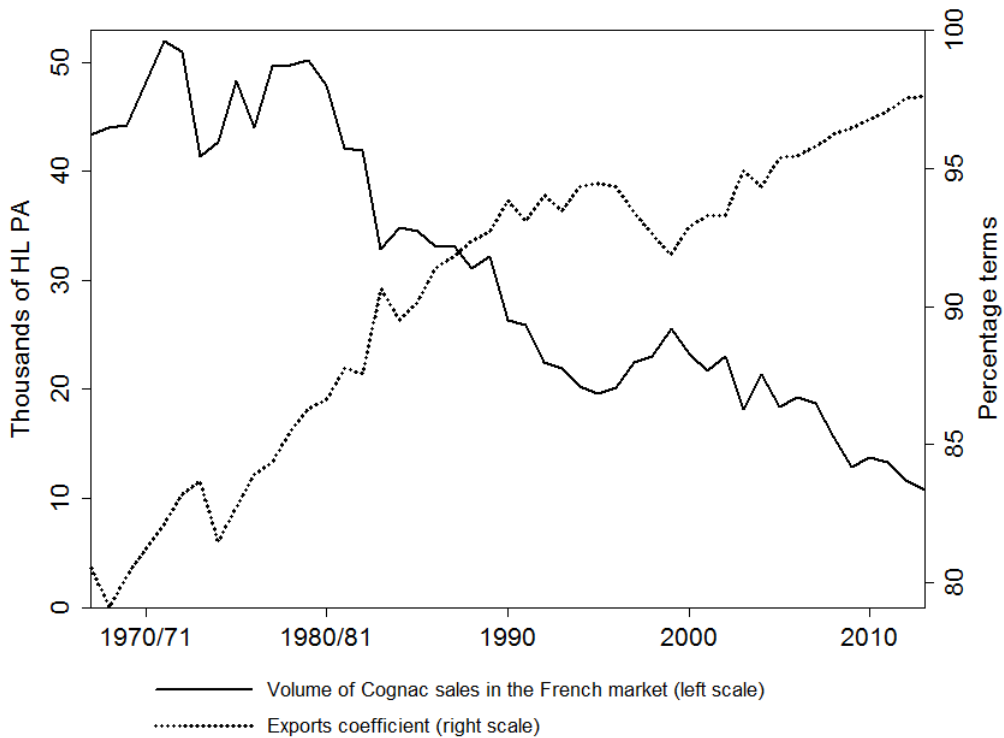
A.4. COGNAC SHIPMENTS FROM 1967 TO 2013: STYLIZED FACTS

Figure A.2 – Evolution of Total Cognac Shipments from 1967 to 2013



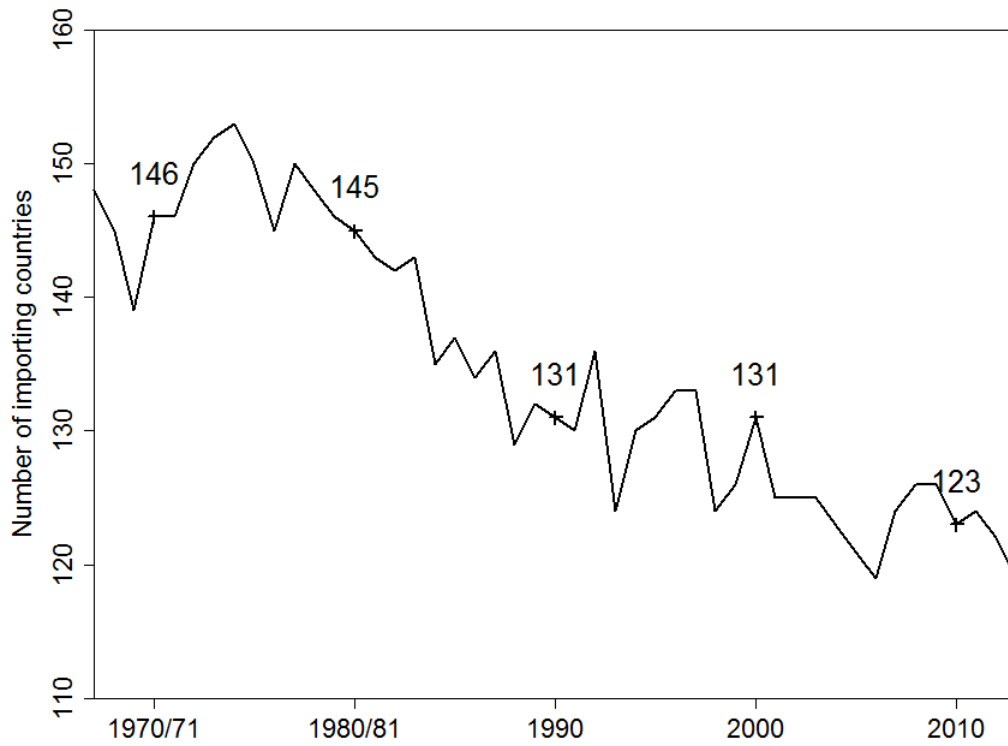
Source: authors; raw data from BNIC.

Figure A.3 – Evolution of Cognac Domestic Sales and Exports Coefficient from 1967 to 2013



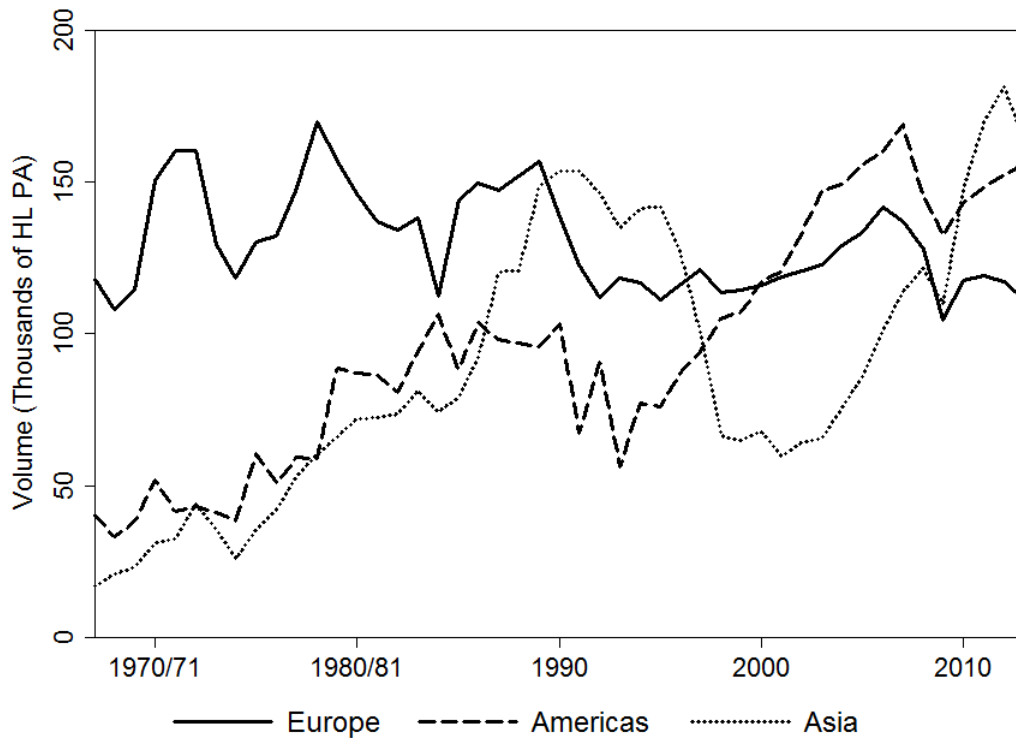
Source: authors; raw data from BNIC.

Figure A.4 – Number of Destinations of Cognac Exports from 1967 to 2013



Source: authors; raw data from BNIC.

Figure A.5 – Cognac Exports by Continent from 1967 to 2013



Source: authors; raw data from BNIC.

#### A.4. COGNAC SHIPMENTS FROM 1967 TO 2013: STYLIZED FACTS

119 in 2013<sup>6</sup>. This is an important feature of the Cognac sector: total exports in volume and in value are increasing in the long term while the number of importing countries is decreasing. Several facts explain most of this phenomenon. First, a certain number of countries (15) prohibited brandy sales between 1979 and 2015 (most of these prohibitions are in application of Islamic law). Second, some countries, particularly in Africa, have experienced civil war between 1990 and 2005 (examples include Burundi, Chad, Comoros, Rwanda...) and consecutively interrupted their imports of Cognac. The remaining ones that ceased to import Cognac have recorded economic stagnation or even recession<sup>7</sup>.

Europe has long been the center of Cognac consumption. In the eighteenth century, the first exports of Cognac were to England and Northern Europe. After the Second World War, Europe was still the first continent in terms of destination of Cognac exports: in 1967, European imports were equal to 118,140 HL PA. The creation of the customs union in 1968 may have played an important role in expanding the trade of goods across the European community members. In 1980, shipments to Europe were still more important both in terms of volume and value, than shipments to the Americas and Asia. Nevertheless, since the mid-eighties, the American and especially the Asian markets have become the most dynamic destinations for Cognac sales (see Figure A.5).

Figure A.6 shows the evolution of Cognac exports to the Americas between 1967 and 2013. The United States has always been by far the main destination on this continent; Cognac exports to Canada and Latin America have been quite marginal. The US has been since 1979, the first destination of Cognac exports in volume with the exception of 1991 and 1993 when it was outpaced by Japan.

It is however necessary to pinpoint that Cognac consumption in the United States, greatest importer of the region, is irregular. On one hand, Cognac is a usual target of US retaliation exerted under the aegis of the multilateral trading system and its dispute settlement mechanism<sup>8</sup>. On the other hand, Cognac became a fashion consumption good when Cognac was referenced in rap lyrics and the African-American culture: in 2001 after Busta Rhymes, Puff Daddy and Pharell Williams sang '*Pass the Courvoisier*'.

At the beginning of the 1990, slowing sales to Europe and America places Asia at the forefront of Cognac exports. In 2010, Asia became the top Cognac-importing continent. It is worth noting that Cognac exports to Japan were booming until 1990 but have

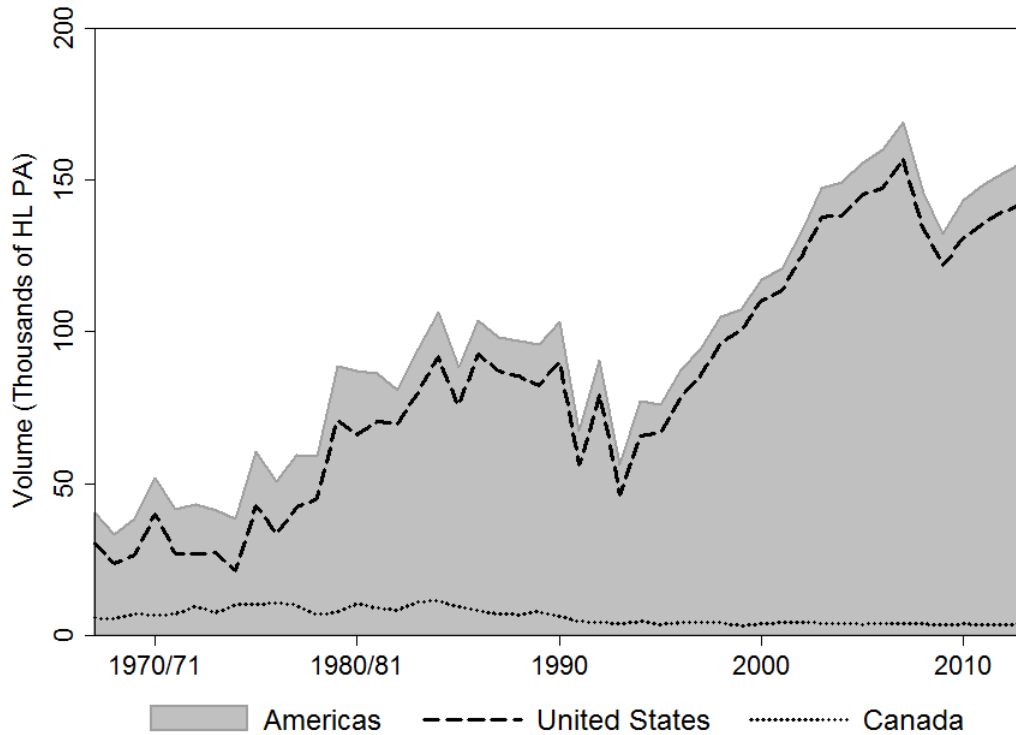
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<sup>6</sup>For a harmonized definition of countries throughout the period from 1967 to 2013.

<sup>7</sup>These are all African countries. Let us remind that the 1980's and the 1990's decades are often referenced as the lost decades in Africa.

<sup>8</sup>See the chicken war, in 1962-63, and more recently the maize war in 1986 when Spain and Portugal acceded the European Union. Each time the US government exerted retaliation on exports of Cognac.

Figure A.6 – Evolution of Cognac Exports to the Americas from 1967 to 2013

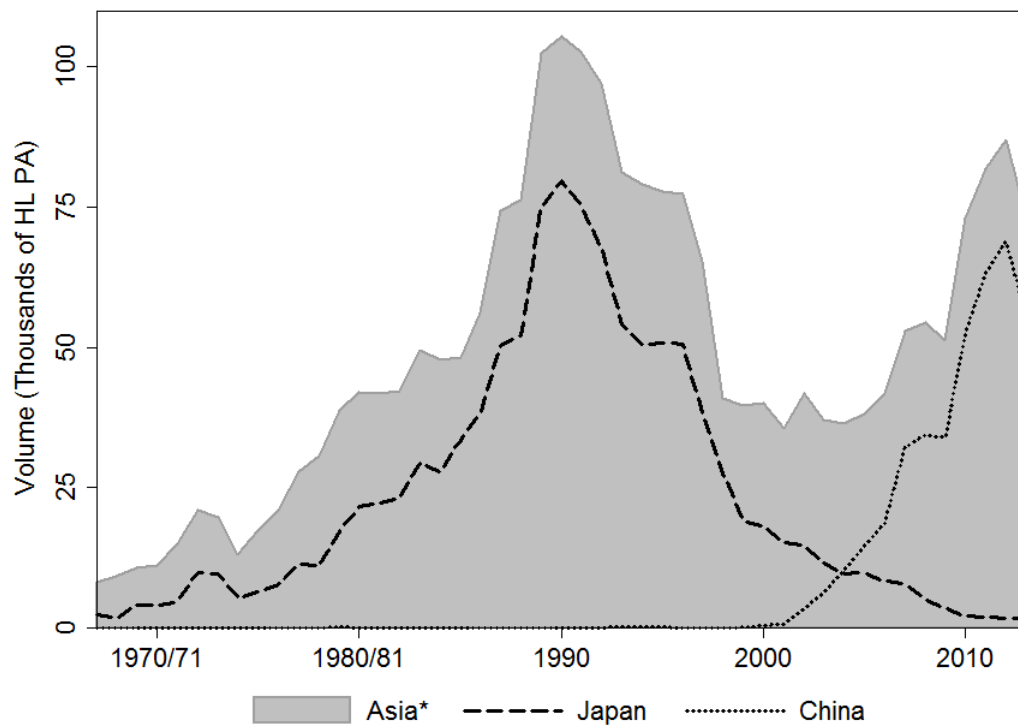


Source: authors; raw data from BNIC.

continuously declined since then (see Figure A.7). Exports to China, on the other hand, have substantially increased, and this destination is now a priority for Cognac houses. Meanwhile, Africa and Oceania are only marginal destinations for Cognac exports, with less than 10,000 HL PA (around 3.5 million bottles) each.

A.4. COGNAC SHIPMENTS FROM 1967 TO 2013: STYLIZED FACTS

Figure A.7 – Evolution of Cognac Exports to Asia\* (Singapore and Hong Kong excluded) from 1967 to 2013



Source: authors; raw data from BNIC.

# Résumé en Français

## Contexte

L'internationalisation croissante des économies nationales, autrement dit la mondialisation, est un processus multidimensionnel qui a été beaucoup étudié dans la littérature économique. La réduction des barrières au commerce liées aux politiques commerciales (droits de douane, quotas etc.) et/ou aux barrières naturelles (coûts de transport par exemple) est une composante essentielle de ce processus à l'origine d'un accroissement des flux de biens et services échangés entre les pays. Ainsi, selon les estimations de [Jacks, Meissner, et Novy \(2010\)](#), environ 44 pourcent de l'augmentation des échanges commerciaux observée pendant la première vague de mondialisation (1870-1913) est dû à la réduction des barrières au commerce, elle-même estimée entre 10 et 16 pourcent. Entre 1950 et 2000, ces barrières ont diminué en moyenne de 16 pourcent, ce qui expliquerait 31 pourcent de la croissance économique pendant cette période ([Jacks, Meissner, et Novy, 2011](#)).

Malgré leur tendance à la baisse sur les cinq à six dernières décennies, les barrières au commerce, ou *coûts à l'échange*, continuent à jouer un rôle important. Selon les estimations d'[Anderson et van Wincoop \(2004\)](#), l'équivalent ad valorem des barrières au commerce pour les pays industrialisés est de l'ordre de 170 pourcent. Toujours d'après ces auteurs, les barrières au commerce international sont de l'ordre de 74 pourcent en équivalent ad valorem, alors que les barrières au commerce intranational (liées à la distribution des biens par exemple) sont de l'ordre de 55 pourcent.

La problématique de ces coûts à l'échange est importante du point de vue macroéconomique ([Obstfeld et Rogoff, 2000](#)) et politique. Suite à la crise de 2008-2009 et au ralentissement de la croissance économique globale de ces dernières années, le nombre de mesures commerciales restrictives mises en place par les pays membres du G20 a augmenté. Plusieurs gouvernements ont remis en question les bienfaits de la libéralisation commerciale. Il pourrait s'agir d'une tendance inquiétante selon l'Organisation Mondiale du Commerce (l'OMC) qui a recensé la mise en place de 145 nouvelles mesures commerciales restrictives par les économies du G20 entre mi-octobre 2015 et mi-mai 2016.

Pour ces raisons, les coûts à l'échange continuent de faire l'objet de beaucoup d'études empiriques et théoriques qui s'interrogent sur leurs définitions, leurs mesures, leurs effets, etc. L'objectif de cette thèse est d'étudier les effets des coûts à l'échange sur la *qualité* des produits échangés, qui constitue un déterminant clé des flux commerciaux.

Les échanges de produits de différentes qualités influencent à la fois la croissance et le développement (Grossman et Helpman, 1991), la performance des firmes à l'export (Verhoogen, 2008) ou l'emploi et les salaires (Verhoogen, 2008; Khandelwal, 2010). La littérature théorique qui étudie la relation entre la qualité et le commerce est abondante (voir par exemple les contributions pionnières de Krugman, 1979 et Lancaster, 1980). Néanmoins, à l'exception de Linder (1961), les études empiriques sur le rôle de la qualité dans les exportations n'ont été réalisées que récemment. La mesure de la qualité est le principal défi de ces études que nous relevons dans les deux premiers chapitres de cette thèse en étudiant le commerce de *Cognac*, un produit dont la mesure de la qualité est objective et ne varie pas dans le temps.

Dans le troisième chapitre nous considérons que la qualité d'un bien produit par une firme dépend de l'investissement en Recherche et Développement de produit (R&D de produit). Cet investissement peut entraîner la création d'un nouveau produit ou l'amélioration de la qualité des produits existants. L'objectif des firmes qui investissent en R&D de produit est ainsi de différencier verticalement les produits (différenciation par la qualité) afin de faire face à la concurrence. L'investissement en R&D de produit et plus généralement l'innovation sont des éléments moteurs de la compétitivité et la croissance (Global Competitiveness Report, 2014-2015).

**Dans le premier et deuxième chapitre de cette thèse, nous adoptons une approche empirique et nous travaillons sur le commerce de Cognac. D'abord nous étudions les déterminants des exportations de Cognac, en mettant en avant les effets des coûts à l'échange (distance et barrières douanières). Ensuite, nous analysons l'impact de ces coûts à l'échange sur la structure par qualité des exportations de ce produit. Dans le troisième chapitre, nous adoptons une approche théorique et évaluons l'impact de plusieurs instruments de politique commerciale (un droit de douane, un quota d'importation et un standard de qualité) sur l'investissement en R&D de produit.**

## Coûts à l'Échange et Qualité : Des Relations Théoriques et Empiriques à Vérifier

Les coûts à l'échange constituent des obstacles aux échanges. Ils varient dans le temps, par pays, secteurs d'économie et produits. Ils sont également de nature différente et ont des effets différents sur l'économie ([Anderson et van Wincoop, 2004](#)).

Nous distinguons les coûts à l'échange liés à l'environnement (ou naturels) des coûts à l'échange liés aux politiques commerciales. Dans la première catégorie se trouvent les coûts de transport, le temps, ainsi que d'autres barrières (e.g. contiguïté, être enclavé...). La deuxième catégorie regroupe des barrières qui peuvent être subdivisées en droits de douane (tarifs douaniers) et barrières non-tarifaires. Les droits de douane sont des taxes levées sur les produits importés. Les barrières non-tarifaires sont des obstacles aux échanges, autre que les droits de douane, comme les quotas d'importation, les mesures sanitaires et phytosanitaires, les obstacles techniques au commerce, etc. Selon les estimations d'[Anderson et van Wincoop \(2004\)](#) pour les pays industrialisés, les coûts de transport représentent des barrières au commerce de l'ordre de 21 pourcent en équivalent ad valorem, alors que les droits de douane et les barrières non-tarifaires sont de l'ordre de 8 pourcent.

La qualité est une notion complexe. De manière générale, elle fait référence à une combinaison d'attributs ou de caractéristiques tangibles et intangibles qui accroissent la disposition des consommateurs à payer pour un produit donné ([Crinò et Ogliari, 2015](#)). Ces attributs peuvent être objectifs (comme la performance, la durabilité, etc.) ou perçus. Les attributs objectifs peuvent être mesurés et classés selon un ordre. Les attributs perçus sont subjectifs et dépendent de la perception des consommateurs. Les produits de luxe par exemple, font partie des produits dont la qualité est perçue.

La relation entre les coûts à l'échange et la qualité des produits échangés a fait l'objet d'une littérature abondante à la fois théorique et empirique. À notre connaissance, [Alchian et Allen \(1964\)](#) sont les premiers à avoir contribué dans cette littérature. Ils montrent qu'une charge unitaire (un coût de transport unitaire par exemple) qui s'applique à la fois à des produits de haute et faible qualité, augmente le prix relatif du bien de faible qualité par rapport au bien de haute qualité. Ainsi, si l'État de la Californie exporte par exemple des raisins de haute et faible qualité vers l'État de New York, les raisins de haute qualité seront relativement moins chers que les raisins de faible qualité à New York comparés à la Californie. Par conséquent, les consommateurs à New York achèteront davantage de raisins de haute qualité que des raisins de faible qualité comparés aux consommateurs en Californie. Cet effet, connu sous le terme d'effet Alchian-Allen, peut être résumé ainsi : les coûts de transport unitaires augmentent la demande relative des biens de haute qualité.



Plusieurs extensions du cadre théorique original d'Alchian et Allen ont été développées ces dernières décennies. [Borcherding et Silberberg \(1978\)](#) et par la suite [Bauman \(2004\)](#) ont généralisé l'effet Alchian-Allen à un monde à 3 et  $n$  biens, respectivement. Par ailleurs, [Falvey \(1979\)](#) examine l'effet d'autres barrières au commerce (des restrictions quantitatives et ad valorem) sur la demande relative des biens de haute et faible qualité. [Razzolini, Shughart II et Tollison \(2003\)](#) cherchent à voir si l'effet Alchian-Allen est valide dans le cas d'une industrie à coûts croissants et/ou une structure de marché monopolistique. [Saito \(2006\)](#) et [Liu \(2010\)](#) analysent l'effet Alchian-Allen pour plusieurs qualités.

De manière générale, la recherche théorique sur la relation entre les coûts à l'échange et la qualité des biens exportés a montré que, toutes choses égales par ailleurs, la mise en place de restrictions quantitatives entraîne l'augmentation de la qualité des produits exportés. En revanche, les restrictions ad valorem (définies par rapport à la valeur des produits) n'ont pas d'impact sur les prix relatifs et la qualité, toutes choses égales par ailleurs.

Les vérifications empiriques de l'effet Alchian-Allen et plus globalement de l'impact des coûts à l'échange sur la qualité des produits échangés sont relativement récentes en raison des difficultés liées à la mesure de la qualité des produits. La plupart des études empiriques utilisent soit des *proxies* tels que les valeurs unitaires définies comme le ratio entre la valeur et le volume des échanges ([Hummels et Skiba, 2004](#)), soit des mesures paramétriques ([Curzi et Olper, 2012](#); [Curzi, Raimondi, et Olper, 2015](#)) afin d'examiner l'impact des coûts à l'échange sur la structure du commerce par qualité. Il y a quelques exceptions : [Crozet, Head, et Mayer \(2012\)](#) utilisent une mesure directe de la qualité du Champagne basée sur des notations d'experts; [Fontagné et Hatte \(2013\)](#) et [Martin et Mayneris \(2015\)](#) utilisent une mesure "mixte" qui combine des valeurs unitaires et une liste d'exportateurs de produits de haute qualité sur la base de la liste du Comité Colbert. Contrairement à ces études, nous analysons empiriquement les déterminants des flux d'exportations et de la structure par qualité des exportations de Cognac (chapitres 1 et 2) sur la base d'une mesure de la qualité objective et qui ne varie pas dans le temps. L'âge de l'eau de vie la plus jeune utilisée dans l'assemblage détermine la qualité du Cognac : VS (Very Special), pour du Cognac âgé d'au moins deux ans; VSOP (Very Superior Old Pale) pour du Cognac âgé d'au moins quatre ans; XO (Extra Old) pour du Cognac âgé d'au moins six ans.

Un déterminant clé de la qualité d'un produit est l'investissement en R&D de produit. Une grande partie de la littérature théorique se concentre sur l'impact des instruments de politique commerciale sur l'investissement en R&D de procédés ([Bhagwati, 1986](#); [Krishna, 1989](#); [Reitzes, 1991](#)). La plupart des études théoriques sur la R&D de produit se concentrent sur l'identification des politiques stratégiques en R&D ([Park, 2001](#); [Zhou,](#)

Spencer, et Vertinski, 2002 ; Jinji, 2003 ; Jinji et Toshimitsu, 2006 ; Jinji et Toshimitsu, 2013 ; Ishii, 2014). Notre objectif dans le troisième chapitre consiste à développer un modèle théorique qui analyse l'impact de plusieurs instruments sur la R&D de produit qui est directement liée à la qualité du produit.

## Résumé Détaillé des Chapitres

Dans le **premier chapitre** de cette thèse, nous adoptons une approche empirique afin de répondre à la question suivante : *“Qu'est-ce qui détermine les exportations de produits de luxe ?”*. Nous examinons cette problématique relativement large en nous concentrant sur le Cognac. Nous utilisons une base de données originale des exportations de Cognac sur plus de 140 destinations entre 1996 et 2013. Nous construisons à partir de cette base des statistiques descriptives sur l'évolution des exportations de Cognac pendant cette période. Nous montrons que plus de 95 pourcent de la production totale de Cognac est exportée chaque année. Il s'agit d'un produit de luxe et d'un secteur de l'économie française en plein essor. En effet, les exportations de Cognac en valeur représentaient plus de 2 milliards d'euros en 2013. Nous construisons également une base de données des mesures protectionnistes (tarifs ad valorem et spécifiques) qui affectent les flux d'exportations de Cognac dans le monde entier.

Nous analysons les déterminants des exportations de Cognac et nous nous concentrons sur l'effet des coûts à l'échange (distance et tarifs) en utilisant la procédure d'[Heckman \(1979\)](#). Nous estimons successivement l'impact des facteurs géographiques, de demande et ceux liés aux politiques commerciales sur la marge extensive (le volume du commerce) et la marge intensive (la probabilité d'exporter). Nous contrôlons également pour la possibilité d'un biais d'endogénéité sur la probabilité d'exporter. Nous montrons que dans le cas du Cognac, comme pour d'autres produits de luxe, l'élasticité des exportations de Cognac par rapport à la distance est négative, significative et relativement faible. L'élasticité par rapport au PIB est par ailleurs positive, significative et relativement élevée. Nous trouvons également que les droits de douane n'ont pas d'effet sur la marge intensive. Par contre, ils ont un effet significatif et négatif sur la probabilité d'exporter. Ce résultat est obtenu après correction d'un biais d'endogénéité, en utilisant les revenus des taxes des pays de destination (en pourcentage du PIB) comme instrument. Nous contribuons ainsi à la littérature existante en mettant en évidence empiriquement l'impact des coûts à l'échange sur les exportations des produits de luxe.

Dans le **deuxième chapitre**, nous cherchons à savoir : *“Comment les coûts à l'échange influencent-ils la qualité des produits exportés ? L'effet Alchian-Allen est-il vérifié empiri-*

## RESUMÉ EN FRANÇAIS

*quement ?*". Nous estimons l'impact des coûts à l'échange sur la part et le prix relatif du Cognac de haute qualité à partir de notre base de données des exportations de Cognac. La définition et la mesure de la qualité du Cognac est basée sur l'âge de l'eau de vie la plus jeune utilisée dans l'assemblage. Cette mesure est objective et ne varie pas dans le temps.

Nous procédons en deux temps. Dans un premier temps, nous analysons dans quelle mesure la distance et les barrières douanières influencent la structure par qualité des exportations de Cognac pendant la période 1996-2013. Dans un deuxième temps, nous évaluons l'impact d'une variation des coûts à l'échange à travers l'adoption de la conteneurisation sur les exportations de Cognac par qualité entre 1969 et 2013. Il s'agit de la première étude visant à quantifier l'impact de la conteneurisation sur le commerce par qualité. Nos résultats confirment l'effet Alchian-Allen : les coûts à l'échange unitaires augmentent la part des exportations de Cognac de haute qualité et ont l'effet inverse sur son prix relatif. Nos contributions à la littérature sont les suivantes : i) nous validons empiriquement l'effet Alchian-Allen en nous basant sur une définition directe et non pas perçue de la qualité ; ii) nous évaluons empiriquement l'impact des barrières tarifaires sur les flux de commerce par qualité, en distinguant entre tarifs spécifiques et ad valorem ; iii) nous évaluons empiriquement l'impact d'une variation dans le temps des coûts à l'échange suite à l'adoption de la conteneurisation, sur la structure des exportations de Cognac par qualité.

Dans le **troisième chapitre** nous développons un cadre théorique afin d'examiner "*Quel est l'impact de la mise en place d'instruments de politique commerciale sur l'investissement en R&D de produit ?*". Nous traitons cette question à travers un modèle en duopole Nord-Sud où la firme du Nord est en concurrence par les prix avec la firme du Sud sur les deux marchés. La firme du Nord investit en R&D de produit en raison d'un désavantage compétitif en comparaison avec la firme du Sud qui a des coûts moins élevés. Le résultat de l'investissement en R&D de produit est incertain. Si l'investissement a du succès, il y a de la différenciation verticale sur les deux marchés. Notre cadre fait référence à un exemple empirique dans l'industrie téléphonique, où l'investissement en R&D de produit est élevé surtout au début du cycle de vie d'un produit. Les firmes "du Nord" qui produisent des smartphones comme Apple par exemple, font face à une concurrence accrue sur leurs marchés domestiques et étrangers, de la part des firmes "du Sud" comme Huawei, OPPO, et vivo. Un autre exemple provient de l'industrie automobile où la concurrence de la part des firmes comme Tata et Maruti Suzuki (en Inde) continue à augmenter.

Dans notre modèle, nous faisons l'hypothèse que le gouvernement du pays du Nord est le seul à mettre en place les mesures protectionnistes suivantes : un droit de douane, un quota d'importation et un standard de qualité. Les résultats montrent que les dépenses

en R&D de produit de la firme du Nord augmentent avec chacun de ces instruments à l'exception du quota d'importation. Nous menons également une analyse de bien-être sur la base de simulations numériques, afin de vérifier si le gouvernement du Nord est incité à adopter ces mesures. Nos résultats suggèrent que le gouvernement du Nord est incité à mettre en place un droit de douane, car il est probable que le profit domestique, le surplus des consommateurs et les revenus publics augmentent. Nous contribuons à la littérature existante en développant un cadre théorique avec des coûts asymétriques et en étudiant une problématique qui n'a pas été traitée auparavant : l'impact de plusieurs instruments de politique commerciale sur l'investissement en R&D de produit. Une autre contribution consiste à introduire de l'incertitude par rapport au résultat de l'investissement en R&D de produit.

## Principales Contributions et Extensions Possibles

Premièrement, le modèle économétrique que nous utilisons pour analyser les déterminants des exportations de Cognac peut être utilisé pour faire des prévisions sur les exportations de Cognac. Cette problématique est très importante pour l'interprofession du Cognac. En effet, après la crise économique de 2008-2009, le Bureau National Interprofessionnel du Cognac (BNIC) a décidé de mettre en place un plan élaboré "Business Plan Cognac", afin de "développer le Cognac, représenter et défendre les intérêts collectifs des professionnels" ([Rapport du CGAAER N.16054-5](#), p. 8). L'objectif de ce plan est de favoriser le développement du secteur de Cognac dans le long terme et de s'assurer que la production et les stocks sont suffisants pour satisfaire la demande et les exigences des marchés. Ce plan comprend un outil qui permet de calculer la quantité des stocks sur les 15 prochaines années. Le rapport met également en évidence l'importance des marchés à l'export pour renforcer la solidité du secteur de Cognac. Notre modèle économétrique est donc un outil complémentaire qui permettrait de faire des projections sur la performance du Cognac dans le futur. Il serait également utile pour éclairer les débats qui opposent parfois les viticulteurs et les négociants. Les premiers demandent généralement un accroissement de la production du Cognac, car ils prévoient l'expansion du marché, alors que les derniers sont plus réticents car ils craignent une baisse de la demande, une augmentation des stocks et une baisse des prix.

Deuxièmement, cette thèse illustre l'impact des coûts de transport et de leur variation dans le temps sur la structure du commerce par qualité. Nos résultats montrent que la proposition originale d'Alchian et Allen est vérifiée dans le cas du Cognac. Il y a relativement peu d'études qui ont pu valider empiriquement cette proposition et encore moins d'études qui examinent la structure par qualité d'un produit de luxe (à l'exception

de [Crozet, Head, et Mayer, 2012](#) sur le Champagne). Nous sommes également les premiers à quantifier les effets du changement technologique induits par la conteneurisation sur le quality mix (i.e. structure par qualité) du Cognac. Des études récentes telles que [Rua \(2014\)](#) et [Bernhofen et al. \(2016\)](#) ont examiné respectivement les déterminants de la diffusion de la conteneurisation et ses effets sur le commerce mondial. Néanmoins, il n’y a pas eu jusqu’à présent de preuves empiriques montrant comment l’adoption de la conteneurisation a modifié la structure du commerce par qualité. L’utilisation des conteneurs a révolutionné le transport océanique au vingtième siècle ([Hummels, 2007](#)) et nous montrons empiriquement dans quelle mesure le quality mix du Cognac a été affecté. Les progrès technologiques dans le transport, comme la conteneurisation ou l’introduction des moteurs à réaction dans le transport aérien, ont considérablement changé la circulation des biens. Par conséquent, les coûts de transport ont diminué, mais ils sont toujours importants ([Hummels, 2007](#)). D’autres avancées technologiques, qui pourraient transformer le commerce international, sont ainsi à prévoir.

Troisièmement, nous développons un cadre théorique en lien avec le débat sur les effets des politiques protectionnistes. Des changements récents dans l’attitude des gouvernements comme les Etats-Unis sur le libre-échange ; pouvant potentiellement mener à une augmentation des droits de douane par rapport aux produits importés en provenance des pays à faible coûts comme le Mexique, ont alimenté davantage le débat sur les mesures restrictives sur le commerce. Sur la base des résultats et des simulations numériques de notre modèle théorique, nous affirmons qu’un pays aurait des raisons de mettre en place un droit de douane parce qu’un tel instrument augmente l’investissement en R&D de produit, le surplus des consommateurs et les revenus publics. Ceci ne doit pas être interprété comme une prise de position en faveur du protectionnisme, mais devrait plutôt mener à une réflexion sur les différents effets des mesures protectionnistes, surtout lorsque la priorité d’un pays est la promotion de la recherche et développement. De manière générale, les pays cherchent des moyens pour encourager l’innovation, qui est un déterminant clé de la croissance et la compétitivité. Dans ce contexte, notre analyse éclaire les effets des mesures de politique commerciale sur l’innovation de produit. Cette recherche théorique est particulièrement pertinente pour les firmes des pays développés, qui peuvent investir en R&D de produit pour faire face à la concurrence accrue de la part des firmes des pays en développement qui n’ont pas forcément les moyens d’entreprendre un tel investissement.

Plusieurs extensions de notre recherche sont envisageables. Nous utilisons par exemple la distance comme *proxy* des coûts de transport lorsque nous analysons les déterminants des flux d’exportation du Cognac et l’impact des coûts à l’échange sur le quality mix du Cognac. L’utilisation de la distance est courante surtout dans les modèles de gravité. Cependant, elle présente certains désavantages : i) elle capture d’autres aspects comme

les coûts d'information; et ii) elle ne reflète pas la qualité des infrastructures routières et portières. En outre, les coûts de transport ne dépendent pas exclusivement de la distance mais également de la qualité du service de transport (Hummels, 2007). Des données plus précises sur les coûts de transport nous permettraient d'obtenir des estimations de meilleure précision concernant leur impact sur les volumes exportés et la probabilité d'exporter du Cognac. En nous appuyant sur Hummels et Skiba (2004), il serait également possible d'estimer l'élasticité des coûts de transport par rapport au prix du Cognac et de déterminer s'ils s'agit vraiment de coûts unitaires ou plutôt ad valorem (iceberg), ce qui est une hypothèse clé pour que l'effet Alchian-Allen soit valide. Notre analyse de cet effet pourrait également être enrichie, si nous pouvions mieux rendre compte de la structure des coûts liée à la conteneurisation. Les données à notre disposition reflètent uniquement l'année d'adoption de cette technologie par pays. Nous mettons en avant plusieurs arguments montrant que l'adoption de la conteneurisation a très probablement entraîné une réduction des coûts, mais il n'y a pas de véritables preuves empiriques à ce propos. En disposant des données appropriées, nous pourrions, d'une part, estimer plus précisément l'impact de la conteneurisation sur le quality-mix du Cognac. D'autre part, comme Donaldson (2012) qui étudie les effets de la mise en place du système ferroviaire en Inde, nous pourrions essayer de quantifier l'impact de la conteneurisation sur les coûts à l'échange, le commerce international et le bien-être.

Une autre dimension que nous voulons explorer concerne l'impact de la distribution du revenu sur les importations du Cognac. Nous avons déjà essayé d'incorporer cet élément dans nos analyses, mais nos estimations ont été compromises faute d'un nombre suffisant d'observations. Ce problème pourrait être résolu si nous avions de meilleures données. Nous pourrions dans ce cas faire des estimations et comparer nos résultats avec ceux de Ray et Vatan (2013) par exemple, qui montrent que la demande des produits de luxe augmente avec l'écart de revenu dans les pays de destination. Les préférences non-homothétiques sont également liées aux flux de commerce par qualité (Faigelbaum, Grossman, et Helpman, 2011). Pour cette raison, nous voudrions contrôler l'effet de la distribution du revenu lorsque nous examinons le quality mix du Cognac et tester si la part du Cognac de haute qualité augmente avec l'écart du revenu dans les pays importateurs.

Enfin, nous voudrions estimer les déterminants de la qualité d'un produit au niveau de la firme. Dans le cas du Cognac, la question est de savoir si l'effet Alchian-Allen est dû à une sélection entre firmes (autrement dit, seules les firmes qui produisent des biens de haute qualité exportent vers des destinations lointaines) ou à une sélection intra-firme (les firmes choisissent d'exporter des produits de haute qualité et plus chers vers des destinations lointaines). Les stratégies des Maisons de Cognac par rapport à la structure de leurs exportations par qualité sont susceptibles d'être très différentes d'une firme à l'autre.

## RESUMÉ EN FRANÇAIS

Selon le BNIC, il y a aujourd'hui plus de 300 Maisons de Cognac qui commercialisent le produit, y compris les plus grands acteurs du secteur : Hennessy, Martell, Rémi Martin et Courvoisier. Le processus de prise de décisions et la performance à l'export peuvent varier entre les Maisons de Cognac. Pour pouvoir étudier ces problématiques dans le détail, il est nécessaire d'obtenir des données au niveau des firmes. Dans le cas de la R&D de produit, nous pourrions étendre le cadre principal à plusieurs firmes dans le pays du Nord et introduire de l'hétérogénéité des firmes. L'objectif serait alors d'analyser comment, en présence de mesures de politique commerciale, la décision de la firme du Nord d'investir en R&D de produit serait affectée par le commerce avec une firme du Sud à faible coûts.

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## International Trade, Trade Costs and Quality of Traded Commodities

**Abstract:** The objective of this dissertation is to identify the effects of trade costs on the quality structure of international trade flows. In chapter one we empirically analyze the determinants of Cognac export flows and emphasize the role of trade costs. We show that, as with other luxury products, the elasticity of Cognac exports to distance is negative and relatively small. Meanwhile, average customs duties do not have a significant impact on the intensive margin, but we find that they negatively affect the probability of trade, after correcting for an endogeneity bias. In chapter two we empirically test the validity of the Alchian and Allen effect that states that per-unit charges increase the relative demand of higher quality goods. We use data on Cognac exports by quality designations. The measure of Cognac quality is objective and invariant over time. Our results show that distance and specific duties increase the share of exports of higher quality Cognac. We also examine the impact of containerization on Cognac's quality mix from 1967 to 2013. In chapter three we build a theoretical model of a North-South duopoly where firms compete in prices on both markets. We use this framework to study the impact of several trade policy instruments (import tariff, quota and quality standard) on the product R&D investment of the Northern firm. Our results show that the Northern firm's R&D expenditures increase with each policy instrument except for the import quota.

JEL Classifications: F10; F13; F14; O30

Keywords: luxury products, quality mix, trade costs, Cognac, product Research and Development (R&D).

## Commerce International, Coûts à l'Échange et Qualité des Produits Échangés

**Résumé :** L'objectif de cette thèse est d'identifier les effets des coûts à l'échange sur la structure du commerce par qualité. Dans le premier chapitre, nous analysons empiriquement les déterminants des exportations de Cognac et nous nous focalisons sur l'impact des coûts à l'échange. Nous montrons que, comme pour d'autres produits de luxe, l'élasticité des exportations de Cognac à la distance est négative et relativement faible. Les droits de douane n'ont par ailleurs pas d'impact significatif sur la marge intensive, mais nous trouvons un impact négatif sur la marge extensive, une fois corrigé d'un biais d'endogénéité. Dans le deuxième chapitre, nous testons empiriquement la validité de l'effet Alchian-Allen qui stipule que les coûts unitaires augmentent la demande relative des biens de haute qualité. Nous exploitons la dimension "qualité" de nos données sur les exportations de Cognac. La mesure de la qualité du Cognac est objective et ne varie pas dans le temps. Nos résultats montrent que la distance et les droits de douane spécifiques augmentent la part relative des exportations de Cognac de haute qualité. Nous examinons également l'impact de la conteneurisation sur la structure par qualité des exportations de Cognac entre 1967 et 2013. Dans le troisième chapitre, nous construisons un modèle théorique de duopole Nord-Sud en concurrence à la Bertrand sur les deux marchés. Nous étudions l'impact de plusieurs instruments (droit de douane, quota et standard de qualité) sur l'investissement en R&D de produit de la firme du Nord. Nous montrons que cet investissement augmente avec chaque instrument de politique commerciale à l'exception du quota d'importation.

Mots-clés: produits de luxe, structure du commerce par qualité, coûts à l'échange, Cognac, Recherche et Développement (R&D) de produit.