Doctoral School of Social Sciences

Doctoral programme in Development Economics and Local Systems

Curriculum in Development Economics/Local Systems

South America and Global Value Chains
Productivity and competition in agri-food industry

a dissertation submitted in partial fulfillment of the requirements for the Doctoral degree (Ph.D.) doctoral programme in Development Economics and Local Systems

Sebastien
Payet
Academic year 2018/19

Supervisor/s – Prof. Giorgia Giovannetti

Doctoral Committee

- Prof. Anna Maria Ferragina (University of Salerno)
- Prof. Margherita Velucchi (European University of Rome)
- Prof. Giuseppe De Arcangelis (University of Rome - La Sapienza)

Table of contents

Chapter 1 – Internationalisation and Productivity: Firm level analysis for a panel of South American countries

Chapter 2 – Food Industry and Global Value Chains: The case of Argentina

Chapter 3 - Export Quality in South America: How Argentina and Brazil compete on quality on the soybean market

Introduction

Never before have global value chains (GVC) been so present in the news as at the beginning of 2020. Until then GVCs were mainly object of study by international economists or specialised journalists. Suddenly, when China took drastic containment measures on 23 January 2020, global value chains began to make the headlines. First the city of Wuhan was confined, then the quarantine measures were extended to other cities. Entire regions have been affected, in China and elsewhere in the world. It was only a matter of time before entire countries were put under lockdown, blocking supply chains, thereby blocking the logistics of the world's production systems. The impact of a shortage of intermediate products started to be felt everywhere, prompting the United Nations to ask what the overall impact will be (UNCTAD, 2020).

The coronavirus crisis made the general public understand that the global economy is much more intertwined than they imagined. In the United Kingdom, The Guardian explains "How coronavirus is affecting the global economy"[1]. At the same time, in France, the medical supply chain has been criticized[2], with production having been fragmented and relocated in several countries at the time not reachable. Similar concerns have arisen in other countries. It seems that, suddenly, in the space of a few weeks, the world is becoming aware of the significant fragmentation of GVCs and of the interdependence of the world's different economies.

Today's globalization is, of course, not entirely without precedent, and it shares some features with earlier conditions leading to accelerations in world trade (Cohen, 2007; Baldwin, 2016). The so-called "First Globalization" (1870-1914) in particular was triggered by 19th-century technological advances, such as the telegraph, the railway and the steam engine. Similarly, technological developments such as the internet, computer automation and containerisation, together with trade liberalisation, have considerably reduced the costs of world trade. However, contemporary globalisation has at least one very specific feature: it has led to a fragmentation of production and to the formation of (domestic, regional and global) value chains. The operations of production, design, or logistics - required to manufacture and market a product - find themselves split into a (very) large number of tasks possibly performed in an equally large number of countries.

Antràs (2020) defines the global value chains as follows: "A global value chain or GVC consists of a series of stages involved in producing a product or service that is sold to consumers, with each stage adding value, and with at least two stages being produced in different countries. A firm participates in a GVC if it produces at least one stage in a GVC." This definition underlines the importance of what is at the heart of the analysis: the value added at each production stage. The value created in a country is the difference between what the country imports and what it re-exports after having enriched the product with new attributes. The final value of the finished product is the sum of all the values added by all the countries that took part in the production process. This reality is poorly captured by the usual foreign trade figures that simply add up the export values, as recorded at the borders. The standard methodology artificially inflates the reality of international trade, when goods pass the borders several times. It is therefore important to understand step by step where any component of a product has been created, modified and crafted, in order to reallocate the value added during production to the territory responsible for it. In fact, when a country imports a product, it is importing the result of numerous and varied production processes throughout the world. It is this reality that is captured by the analysis in terms of added value, and more broadly, of GVC.

The number of stages involved in producing, the links of the global value chain, increases as the production fragmentation process grows. This fact clearly suggests an increase in trade (as a matter of

1 The Guardian, *How coronavirus is affecting the global economy*, 5 Feb 2020 – clickable link

2 Radio France Internationale, *Coronavirus: la chaîne d'approvisionnement des médicaments remise en cause*, 06 mar 2020 - clickable link

fact), but more specifically, an increase in intermediates trade. In their article *Accounting for intermediates: Production sharing and trade in value added*, Johnson and Noguera (2012, p.224) estimate that "trade in intermediate inputs accounts for as much as two thirds of international trade."

It has been known since the seminal article by Melitz (2003, p.1695) that "the exposure to trade will induce only the more productive firms to enter the export market (while some less productive firms continue to produce only for the domestic market) and will simultaneously force the least productive firms to exit". This article is rooted in empirical research focusing on very different countries, such as, the United States (Bernard and Jensen, 1999), Colombia, Mexico and Morocco (Clerides et al., 1998), or Korea and Taiwan (Aw et al., 2000). Firms engaged in international trade (no matter which mode of internationalization is concerned) are a minority. Bernard et al. (2007) estimate that only 4% of US companies were exporters in 2000. In addition, a small number of firms are responsible for most of exports. Mayer and Ottaviano (2008) estimate for a panel of European countries that the top 1% of exporters account for more than 45% of aggregate exports[3].

Starting from these (and similar) stylized facts, chapter 1 addresses the issue of the productivity of heterogeneous firms (where heterogeneity is measured along different modes of internationalization) over the period 2006 – 2017 in South America. More specifically, the chapter explores the relationship between firms' productivity and the participation in GVCs of a panel of South American countries, using a "firm-level survey of a representative sample of an economy's private sector" (World Bank Enterprise Survey, WB-ES). I compare the productivity of firms, grouped according to their internationalization mode. To do so, I compute different productivity measures. I divide the firms into five different groups according to their international trading status. I define first a group called "domestic" composed of firms not engaged in international trade. This group only includes firms producing and selling on the domestic market. I then define an importers group which gathers firms engaged in import activities only. The third group includes exporters only, i.e. firms engaged in export activities. The two-way traders group regroups firms engaged in both import and export activities. The so-called traders group is composed of firms engaged, indifferently, in import or export activities, or both at the same time. Finally, I single out a GVC group composed of certified traders (see for a similar classification, Taglioni and Winkler, 2016).

In this chapter, I focus on firms that enter GVCs. I carry out two analyses of productivity. First, with an *ex-ante* analysis, I analyse the productivity evolution of firms before their entry into GVCs. Then, I analyse the productivity evolution after firms enter GVCs. In both cases, the productivity is compared to the productivity of firms that are GVC members (or not) over the whole period (i.e. firms that do not change status). I perform this analysis to better understand the productivity evolution during the self-selection process, and the process of "learning by supplying". From a theoretical perspective, it is well established that only firms enjoying higher productivity should self-select in international trade (Melitz, 2003; Merino, 2012). Once they have become internationalised, other studies, such as Alcacer and Oxley (2012), suggest that firms can see a growth of technical (and potentially other) capabilities directly attributable to their experience as international suppliers. I show, for the whole panel of South American countries, that most productive firms self-select for international trade. Firms that remain GVC members over the period enjoy a significant productivity premium compared to the other firms. I also show that the productivity of firms that become GVC members during the period of the analysis is already significantly higher than that of non-GVC members and this seems to be true even before entry. Finally, despite a high productivity level compared to non-GVC members, this level is still low when compared to that of firms that remain GVC members over the period considered. These points lead to two important conclusions. First, firms choose to engage in international trade because they already enjoy a higher productivity level than that of firms that remain domestic. Self-selection is then observed, also for the panel of South American countries. Second, productivity continues to grow after their entry

[3] the top 10% of exporters accounting for more than 80% of aggregate exports.

and tends to reach the productivity level of firms that have always engaged in international trading activities. In addition, I find that the productivity does not grow faster for traders, therefore contributing to the growing literature on the discussion of whether international firms become more productive because exposed to international competition or are already more productive to start with and this is why they become traders.

The analysis at the aggregate level is accompanied by productivity computation at the industry level. There are several differences, as expected, in the different sectors, due to their different exposure to international trade, to sector specific characteristics, etc. In particular, the productivity of food industry has a peculiar distribution compared to the other industries. The recent literature on international trade and GVCs addresses to a very limited extent the issue of global agri-food trade flows (Greenville et al., 2017). Chapter 2 of this thesis tries to fill this gap by focusing on the food industry and identifying the opportunities for developing and emerging countries to participate (and possibly upgrade) in GVCs. GVCs are particularly important for agricultural trade and food processing industries but their extension and complexity vary considerably depending on what level of processing the individual products need (for instance some products, e.g dried fruits, undergo minimum levels of processing, while others, e.g. packed frozen food, need more sophisticated technologies and skills). Actors of this industry are so dispersed worldwide that the Food Trust consortium, run by IBM, has focused on using blockchain technologies to improve food traceability (World Bank, 2019, box 6.1 p.139). Looking at the 1995-2011 period, we can notice an increase in GVC participation (World Bank, 2019, Ch1 p.27:29); furthermore, the increase tends to be at the global rather than at the regional level despite the fact that part of the literature highlighted the development of regional value chains, especially in Asia.

The agri-food industry is an interesting and peculiar sector. Unlike other industrial sectors, agri-food is present worldwide. Indeed, a country can actually do without a specific industrial sector, and many do, with the exception of agri-food. Agri-food, because of its very nature of feeding the population, is a very important matter for countries. Given its importance, an increase in productivity in this sector can have a very significant impact on a region's or country's development. The food industry is often wrongly seen as a relatively mature, slow-growing industry with relatively little investment in research and development (R&D) and innovation. However, recently, stringent legal requirements related to the environment, food safety and health have forced food companies to invent new products and increasingly innovative and complex production processes. In addition, changes in consumption habits, and consequently in the supply of and demand for food, are associated with an ever-increasing search for competitiveness (Solleiro et al., 2017). Furthermore, it is a sector in which GVCs are very well developed.

I decided to inquire into the development of food GVCs first with a sectoral analysis. To this end, I use a dataset in value added (OECD-TiVA) to sketch the global situation of the food industry network with a particular focus on Argentina. Argentina possesses an historically important agri-food industry. As already mentioned and as reported in Brambilla et al. (2018), Argentina has a fundamental comparative advantage in agriculture as well as a strong food industry, which has been export-oriented for a very long time.

Taglioni and Winkler (2016) underline the importance of certification for GVCs. As GVCs grow, every link in the chain becomes more distant in the production process. Certifications can insure a minimum level of quality and standards, or more generally a product's technical specification. Certification in this sense is then an efficiency tool as it may limit asymmetric quality information costs[4]. Certifications are also particularly important for food GVCs, as they also guarantee food safety.

I complement the sector analysis with an examination of the behaviour of Argentine food companies operating in global value chains. The aim of this part is to test whether firms that enter international

4 This importance of certifications explains, in part, why we can proxy GVC participation as traders which possess at least one international certification.

supply chains enjoy a productivity premium. To understand if and to what extent GVC participation increases local productivity, I compare the food industry to the other Argentinian industries.

In chapter 1, I explore the relationship between productivity and internationalization for a panel of firms selected in South American countries (Argentina, Bolivia, Ecuador, Peru, Uruguay and Paraguay, the only countries for which the panel at a firm level was available). The conclusions of chapter 1 led me to analyse, in chapter 2, a particular sector, the food industry, and concentrate on Argentina, a country with a long history of export-oriented agro-food. The third and final chapter focuses on the analysis of the evolution of competition in the agro-food sector, especially as regards soybeans, between the two main South American countries, Argentina and Brazil.

The exam of the export structure of the panel of South American countries (the same panel as in chapter 1, with the addition of the dominant regional economy, Brazil) shows that the share of exports for these countries, even if we account for different quality levels (low, medium and high), is relatively stable over the period studied (2000-2017). The analysis of the extensive margin of trade by country (number of different goods traded) suggests that products exported are relatively few in number, and highlights the importance for these countries of a specific agri-food product: soybeans. I therefore decided to focus on soybeans. There are several reasons for this. The first is that while analysing this product, I realized that it had some very interesting features. First of all, on both the producer and the consumer side, the market is highly concentrated. Six of the top eleven soybean producers are in America, and Argentina and Brazil account for almost 50% of world production. On the consumer side, China is by far the world's largest importer. Moreover, this product has a standardised and easily measurable industrial quality (quantity of proteins, fats, etc.) which makes the price a good proxy for quality. In chapter 3, I argue that the quality level of exported goods matters as much as its kind or its destination market. Countries with different economic structures, consumption habits, income per capita or, more generally, different development levels are not likely to buy the same quality level of a product. I use the Fontagné et al. (2008) methodology which allows a price-base quality discrimination. I then break down the change in the “market share” of an exporter into its two main components following the methodology of Batista (2008) and Liu et al. (2018). The first component describes the direct competition effect, which is due to a country competitiveness evolution. The second component is the indirect competition effect, also called structural effect. This is determined by changes in the global economy. This analysis, run separately for low quality, medium quality and high quality, derived from a detailed analysis in line with Fontagné et al. (2008), suggests that what seems at first sight to be Brazil's total domination over Argentina reflects in fact a partial truth. Argentina is competitive when it comes to high quality, even though Brazil has had a much higher rate of growth in the production of this product in recent years.

In summary, this thesis contributes to a better understanding of the involvement into complex modes of internalization of firms located in selected countries in South America with a special focus on those in Argentina. It also contributes to the discussion on the agri-food value chain and focuses on a very peculiar product, soybeans, which is crucial for Argentina and Brazil exports both as final and intermediate product, used as input in global value chains. Finally, it highlights the fact that quality matters and helps explaining how non price competition can change firms' (and country's) strategies. Argentina seems to have increased the quality of its soybeans and has therefore been able to respond to the price competition from Brazil improving its share in the Chinese market, the biggest importer of soybean in the world.

I have used different methodologies in the thesis: beside descriptive analysis, I estimated the Total Factor Productivity (using Petrin et al. (2004) method), I used Propensity score matching to tackle with potential endogeneity issues, I used network analysis to depict world trade and specific industry characteristics, I computed the statistics related to network, such as centrality, to assess the importance of different countries in different graphs, I use the Fontagné et al. (2008) methodology to divide products into different quality levels, and finally I use the constant market share analysis to single out the competitive components from the other (Batista (2008) and Liu et al. (2018)) in a specific market for a specific good.

References

Alcacer, J., Oxley, J.E., 2012. Learning by Supplying. SSRN Journal.

Antràs, P., 2020. Conceptual Aspects of Global Value Chains. Policy Research Working Paper 9114 World Development Report, 36.

Aw, B.Y., Chung, S., Roberts, M.J., 2000. Productivity and Turnover in the Export Market: Micro-level Evidence from the Republic of Korea and Taiwan (China). The World Bank Economic Review 14, 65–90.

Baldwin, R.E., 2016. The great convergence: information technology and the new globalization. The Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Batista, J.C., 2008. Competition between Brazil and other exporting countries in the US import market: a new extension of constant-market-shares analysis. Applied Economics 40, 2477–2487.

Bernard, A.B., Jensen, J.B., 1999. Exceptional exporter performance: cause, effect, or both? Journal of International Economics 47, 1–25.

Bernard, A.B., Jensen, J.B., Redding, S.J., Schott, P.K., 2007. Firms in International Trade. Journal of Economic Perspectives 21, 105–130.

Brambilla, I., Galiani, S., Porto, G., 2018. Argentine trade policies in the XX century: 60 years of solitude. Lat Am Econ Rev 27, 4.

Clerides, S., Lach, S., Tybout, J., 1998. Is Learning by Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco. The Quarterly Journal of Economics, Oxford University Press 113, 903–947.

Cohen, D., 2007. Mythes et paradoxes de la mondialisation.

Fontagne, L., Gaulier, G., Zignago, S., 2008. Specialisation Across Varieties Within Products and North-South Competition. Economic Policy 23, 52–91.

Greenville, J., Kawasaki, K., Beaujeu, R., 2017. Estimating Global Trade in Value Added within Agriculture and Food Sectors. Organisation for Economic Co-operation and Development.

Johnson, R.C., Noguera, G., 2012. Accounting for intermediates: Production sharing and trade in value added. Journal of International Economics 86, 224–236.

Liu, Y., Shi, X., Laurenceson, J., 2018. Are China's Exports Crowding Out or Being Crowded Out? Evidence from Japan's Imports. China & World Economy 26, 1–23.

Mayer, T., Ottaviano, G.I.P., 2008. The Happy Few: The Internationalisation of European Firms: New Facts based on Firm-level Evidence. Intereconomics 43, 135–148.

Melitz, 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. Econometrica 71, 1695–1725.

Merino, F., 2012. Firms' internationalization and productivity growth. Research in Economics 66, 349–354.

Petrin, A., Poi, B.P., Levinsohn, J., 2004. Production function estimation in Stata using inputs to control for unobservables. Stata journal 4, 113–123.

Solleiro, J.L., Castañón, R., Rodríguez, K., Mejía, O., 2017. Innovation in the Agri-Food Sector in Latin America and the Caribbean, in: The Global Innovation Index 2017: Innovation Feeding the World. World Intellectual Property Organization, Geneva.

Taglioni, D., Winkler, D., 2016. Making global value chains work for development, Trade and development series. World Bank Group, Washington, DC.

UNCTAD, 2020. Global trade impact of the coronavirus (COVID-19) epidemic (Trade and development eport update No. DITC/INF/2020/1). United Nation Conference on Trade and Development.

World Bank (Ed.), 2019. World development report 2020: trading for development in the age of global value chains. World Bank Group, Washington.

Chapter 1

Internationalisation and Productivity: Firm level analysis for a panel of South American countries

Abstract

Firms engaged in international trade enjoy a productivity premium. The origin of this premium is still an open question. Do the most productive firms self-select into the export market? Is internationalisation the source of this productivity premium? The answer is probably that self-selection is the main effect, although not the only one.

Focussing on a panel of South American countries, we use a dataset that provides a very detailed firm-level representative sample of private sector in manufacturing over the period 2006 to 2017.

In this chapter, we compare the productivity of firms with different international trading status. We single out five different groups (partially overlapping): importers, exporters, two-ways traders, domestic firms, and GVC members. We compute different estimates of individual firms' Total Factor Productivity (TFP). We then perform the productivity evolution analysis in two steps. First, we analyse the pre-internationalisation period. This analysis allows a better understanding of productivity evolution of future international traders. In a second step we analyse the post-internationalisation period. This analysis compares firms' productivity evolution after the change of their trading status. In both situations the productivity evolution is compared to firms remaining domestic (or traders) over the same period. It is then a retrospective analysis of firms' productivity before and after they change their trading status.

This chapter shows, for an original panel of South American countries, that most productive firms do self-select for international trade. Several results are highlighted in the analyses. First, firms that remain international trader over the period enjoy a significant productivity premium compared to domestic firms. Second, the productivity of firms becoming international traders during the period of the analysis is already significantly greater than domestic firms' one. This assessment is true even years before their entry. Third, despite a high productivity level compared to domestic firms, this level is still low compared to firms remaining traders over the period considered.

These points lead to two important conclusions. First, firms chose to engage in international trade because they already enjoy higher productivity that firms that remain domestic. Self-selection is then observed, even for this panel of countries. Second, productivity continues to grow after firms entry into international markets and tends to reach the productivity level of firms always engaged in international trading activities. In addition, we realise that the productivity does not grow quicker for traders. Firms engaged in international trade just seem to maintain their higher productivity.

Table of contents

List of tables

List of figures

Introduction

Globalization is characterized by the free movement of goods, capital, services, people, technology and information. It is a process of market integration which results from trade liberalization and from the development of the transport of both people and goods on a global scale.

In the early 2000s the stylized fact that firms that are able to internationalize are rare and enjoy very specific characteristics was put forward. Bernard et al. (2007), for instance, show that in 2000, a period when globalisation already enjoyed an important development, exporting was still a rare activity for a firm. Only four percent of US firms were engaged in exporting activities. However, ten percent of these firms represented 96% of total US exports. It follows that the other 90% of exporting companies accounted for only 4% of US exports. The ability to export is then highly concentrated. Melitz and Ottaviano (2008) extended the analysis to cover other countries (Belgium, France, Germany, Hungary, Italy, Norway and the UK) They show that International Firms are "superstars". They are rare and most of the global international activity is produced by very few of them. Moreover, they have very different features compared to other companies. They are generally larger, generate more value added, require more capital per worker and more skilled workers (with higher wages), and therefore have higher productivity.

These findings led researchers to investigate international firms' specificities. So far, international economics had focussed on other, more aggregated, aspects of international trade, such as absolute and comparative advantage, increasing return to scale or consumer variety preference. The underlying ideas was that countries were competing. Firms at the origin of traded goods and services, as well as their diversity, were never considered. The empirical facts put forward in the early 2000s challenged old as well as new (imperfect competition) trade theories. New models then appeared in an attempt to explain these empirically discovered peculiarities.

The link between trade and productivity and their relations has been widely studied in the last fifteen years, but is still undefined. We know that an exporter's productivity premium is observed. How trade liberalization can raise industry productivity is a question which was partially treated (Bernard et al., 2007). Only the most productive domestic firms can have lasting access to international markets. If they are not productive enough, competition with other internationalised companies will be very harsh. Their lack of productivity will force them to exit an excessively competitive international market. On the other hand, internationalisation gives access to new production processes, new good practices, etc. ... Hence, this "learning process" can drive up firms' productivity. The question is then: to what extent?

The aim of this chapter is to offer a clear view of firms' productivity evolution through time, according to their trading status. We compute Total Factor Productivity (TFP) of a panel of South American firms followed between 2006 and 2017. Over this period, some firms saw a change in their international trading status. This chapter pays a particular attention to firms that become, during this period, Global Value Chains (GVC) members (defined as certified international traders). Their pre-GVC-entry or post-GVC-entry productivity evolution is analysed. This evolution is then compared to the productivity of firms that remained domestic, or remained GVC members, over the same period.

This chapter discusses, then, for South American firms, the important, and as yet unresolved, issue of trader productivity premium, origin and evolution.

The chapter is structured as follows. It will first present a review of the literature in order to introduce the concepts on which it is based. It will then present, in section 2, the data used and descriptive statistics. In section 3, Total Factor Productivity is defined and computed. The last two sections present the results of the analyses carried out and some robustness controls.

1. Literature review

The very end of the last century saw the publication of a number of purely empirical articles highlighting a self-selection of more productive firms into export markets. This might have remained anecdotal evidences provided by Clerides et al. (1998) for Colombia, Mexico and Morocco, Bernard and Jensen (1999) for the US, or Aw et al. (2000) for Korea and Taiwan. Some of these articles suggest that less productive firms are forced to exit this international market. In 2003 Melitz provided a theoretical rationale for these empirical results with a model explaining that firms in different countries and with different international status were competing, not countries. It was a pathbreaking article which gave rise to the so called "new new trade theory". According to Bernard et al. (2007), it emerged that firms engaged in international trade are a minority. Only 4% of US companies were exporters in 2000. They also show that this sector is extremely concentrated. Indeed, a very small minority of firms represents the majority of a country's export flows. The case of US in 2000 is a good example of this situation: 10% of its exporting firms accounted for 96% of total exports.

This particular situation initiated a new research dynamic: the understanding of trading firms' specificities became the new objective. Till the early 2000s, international trade focused more on countries competition driven by absolute and comparative advantage, or by increasing return to scale or consumer variety preference. Firms and more specifically their heterogeneity were not taken into consideration. The scarcity of traders, and its implications, challenged old as well as new trade theories. New models then appeared in an attempt to explain the peculiarities discovered empirically. Why are only few highly productive firms engaged in export? Why do different productivity levels choose different ownership structures and supplier locations? These questions found some answers in Melitz (2003) and Antràs and Helpman (2004). These articles were pioneers in considering the heterogeneity of firms and their production processes.

The mode of internationalisation (imports, exports, two ways firms, Foreign direct investments) is also an important matter, as are measures of GVC participation (backward or forward linkages). Amongst many others, Helpman et al. (2004) analyse the relation between internationalisation, investment (FDI), and productivity. Formai and Caffarelli Vergara (2015) examine the productivity effects of GVCs. Baldwin and Venables (2010) underline the importance of the distinction between sequential GVCs (snakes) and horizontal GVCs (spiders).

2. Dataset and descriptive statistics

2.1. Data used

The World Bank Enterprise Survey (WB-ES) is "a firm-level survey of a representative sample of an economy's private sector. The surveys cover a broad range of business environment topics including access to finance, corruption, infrastructure, crime, competition, and performance measures". This database is particularly efficient in carrying out elaborated micro-economic analyses. Indeed, it provides a very detailed firm-level representative sample of private sector enterprises in manufacturing. In this paper we analyse the relation between productivity level and internationalisation. A high level of data disaggregation is needed to compute productivity properly and then understand its determinants.

Since our analysis aims to shed light on the causes and effects of internationalisation on productivity and *vice versa*, it is important that the dataset used should have the following characteristics:

- every single firm needs to be followed via a survey which makes it possible an analysis of the evolution of this single firm economic situation through time;
- the period of time covered must be long enough to allow the detection of possible economic changes;

- the survey needs at least three waves to allow a retrospective analysis of the situation pre-internationalisation (*ex-ante*) or post-internationalisation (*ex-post*).

WB-ES originally published its datasets by country. We build a panel dataset by aggregating country level surveys into a single dataset containing the following countries: Argentina, Bolivia, Ecuador, Paraguay, Peru, and Uruguay.

We then have a panel covering a little more than a decade with three survey waves (2006, 2010 and 2017). It provides a range of information about firms' characteristics. For instance, information about their size, ownership, trading status and performances is given. We also find information about firms' business environment. Access to finance or presence of corruption are examples of the information included.

Table 1 - Panel structure (number of observations)

	Argentina	Bolivia	Ecuador	Paraguay	Peru	Uruguay	Total
2006 only	565	433	335	460	318	334	2445
2010 only	425	97	152	153	460	269	1556
2017 only	680	197	275	246	629	235	2262
2006 and 2010 only	636	196	204	180	332	452	2000
2010 and 2017 only	262	170	74	110	452	102	1170
2006, 2010 and 2017	540	246	120	189	444	183	1722
Total	3108	1339	1160	1338	2635	1575	

Source: Author's elaboration based on WB-ES

Table 1 displays the structure of this new dataset. The data extraction represented in this table can be somewhat misleading. Indeed, it could give the impression that our sample is composed of 1.722 firms. This number does not represent single firms but the number of observations. The panel follows then 574 firms considered one time per wave. In other words, 180 firms are followed for Argentina, 82 for Bolivia, 40 for Ecuador, 63 for Paraguay, 148 for Peru, and 61 for Uruguay. We are aware that the sample may be considered small. This is one of the reasons why a single country analysis is unlikely to be robust.

2.2. Descriptive statistics

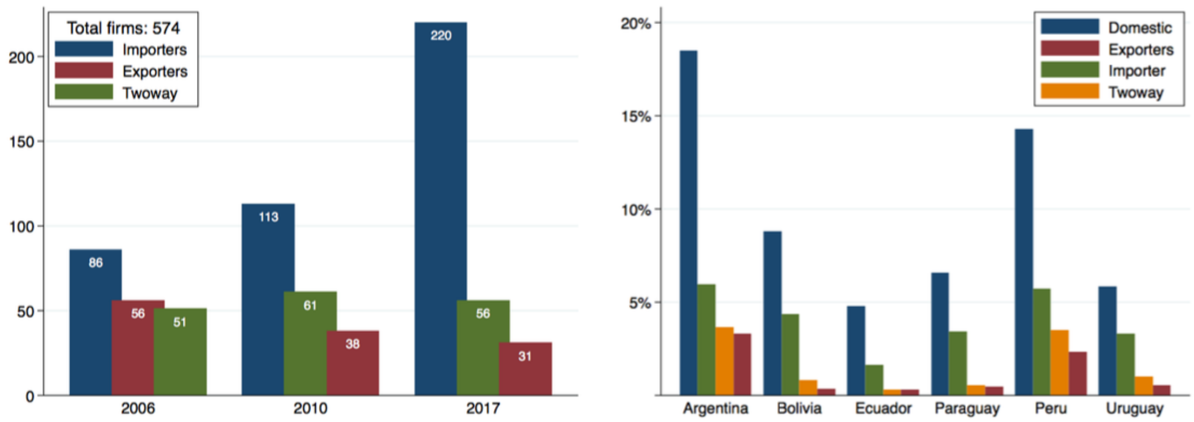
Let us start with some descriptive statistics. Table 2 shows a selection, for the firms of our panel for the first and last year, 2006 and 2017 respectively. It emerges from this table that the number of missing values is negligible for all trading variables: *Exporters*, *Importers*, *Two-way traders*, *GVC*, *FDI*, as well as for some structure variables such as the *Age* of the firm and its *Employment* level. In line with Taglioni and Winkler (2016), we proxy GVC participation as traders (indifferently, exporters, importers of two-ways traders) which possess, at least, an international certification (this latter being most of the time an ISO-9000 or 9001).

Table 2 - Panel summary statistics

	2006			2017		
	# firms	%		# firms	%	
Trading variables						
Exporters	56	9,76%		31	5,40%	
Importers	86	14,98%		220	38,33%	
Two-way Traders	51	8,89%		56	9,76%	
GVC	61	10,63%		99	17,25%	
FDI	34	5,92%		35	6,10%	
	# Obs	Mean	Std.Dev.	# Obs	Mean	Std.Dev.
Structure variables						
Age of firm	573	27,13	22	573	35,28	22,02
Employment (ln)	573	3,44	1,33	569	3,71	1,47
Skilled workers (%)	291	0,57	0,35	234	0,69	0,33
Capital Intensity (machinery)	189	8,22	1,57	140	9,15	1,69
Intermediate variables						
Sales (ln)	525	13,97	1,86	509	14,63	2,06
Capital (ln)	190	11,81	2,19	140	13,26	2,31
Input costs (ln)	240	12,73	2,14	213	13,53	2,42

Source: Author's elaboration based on WB-ES

In accordance with the New New Trade Theory (NNTT) literature, we observe that very few firms are engaged in international trade. The pure exporters, engaged only in export and not in import activities, were 9.76 % in 2006 and dropped to only 5.40 % in 2017. Over the same period, the number of two-way traders, a more complex form of internationalization, increased slightly. Indeed, firms engaged in both export and import activities amounted to 8.89 % in 2006 and rose to 9.76 % in 2017. Figure 1 illustrates this situation.



(a) Number of Firms by Trading Category (b) Percent of Panel by Category and Country

Figure 1 - Panel trading firms situation

Figure 1 shows that for each country considered most firms remain purely domestic. This is once again consistent with the NNTT literature. Indeed, for the latter, only the most productive firms can access the international market.

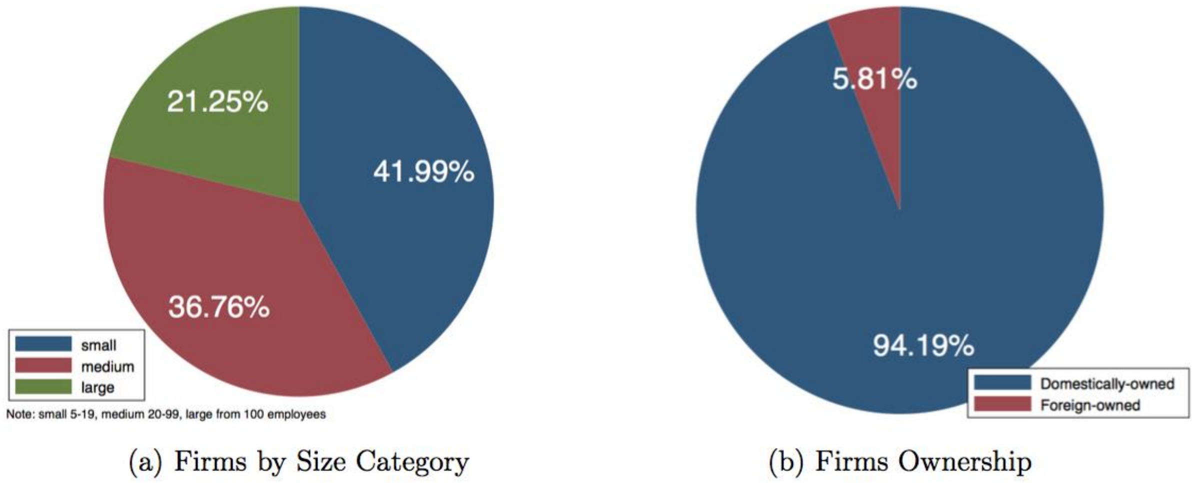


Figure 2 - Firm size and ownership

Our panel is relatively balanced in terms of firm size (Figure 2). Small firms represent nearly 42. Medium and large firms represent respectively a little less than 37% and about 42%. Note that firms are defined as small if they have 5-19 employees, medium if 20-99, and large if over 100.

Looking at the foreign ownership, we observe that a little less than 6% of our panel has at least 10% of their capital foreign owned.

3. Productivity analysis

3.1. Productivity measures

Productivity measures the degree of contribution of one or more production factors to the variation of the final output. These factors are in general capital and labour. Productivity is then an analysis of a firm's production process which is linked to the notions of effectiveness and efficiency. Productivity can be expressed as a ratio reporting the result obtained (output) to the observed consumption of input factors. It is therefore a performance measure. For example: yield per hectare of agricultural production, etc.

Many different measures of productivity exist (Gordon, Zhao, and Gretton 2015; Schreyer 2001). In this paper we will use the following: Sales/emp, VA/emp or Total Factor Productivity (TFP). Sales/emp corresponds to the sales divided by employment level while VA/emp corresponds to the value added divided by employment level.

TFP corresponds to the relative growth in wealth that is not explained by an increased employment of production factors. A simple illustration would be, for example, sunshine increasing agricultural production, ceteris paribus. TFP's main element is the technical progress which, with the same combination of production factors, makes it possible to create more wealth. We note that TFP growth can also result from a change in production organization[1] or from its production structure[2].

[1] E.g. a better capital and labour combination which increases production with the same quantity of production factors.

[2] E.g. increase in product diversity.

3.2. Methodology used to compute Total Factor Productivity (TFP)

To estimate TFP we follow the methodology of Levinsohn and Petrin (2003) . Let first assume a Cobb-Douglas production function. This function takes the following form:

$$Y_{it} = A_{it}K_{it}^{\beta_k}L_{it}^{\beta_l}M_{it}^{\beta_m} \tag{1}$$

Where Y_{it} represents the output of firm i in time t, Ait is the Hicksian neutral efficiency level, and K_{it}, L_{it}, M_{it}, are respectively the capital, labour and material inputs.

The variables Y_{it}, K_{it}, L_{it}, and M_{it} are observable and, in our case, also known... A_{it} is instead unobservable. Taking the natural logarithm of Equation 1 we obtain:

$$\mathrm{y_{it}} = \beta_0 + \beta_k \mathrm{k_{it}} + \beta_l \mathrm{l_{it}} + \beta_m \mathrm{m_{it}} + \varepsilon_{it} \tag{2}$$

Lower case refers to natural logarithms. We note that:

$$\beta_0 + \varepsilon_{it} = \mathrm{a_{it}} = \ln(\mathrm{A_{it}}) \tag{3}$$

Where β_0 is the mean efficiency while ε_{it} is the deviation from the mean (which is firm and time specific). This later coefficient can be divided into two components: the first predictable (υ_{it}) and the latter unobservable (u_{it}). Equation 2 can then be rewritten as follow:

$$\mathrm{y_{it}} = \beta_0 + \beta_k \mathrm{k_{it}} + \beta_l \mathrm{l_{it}} + \beta_m \mathrm{m_{it}} + \upsilon_{it} + \mathrm{u_{it}} \tag{4}$$

We can then estimate a firm's productivity level $\widehat{\omega}_{it} = \hat{\upsilon}_{it} + \hat{\beta}_0$ as illustrated in Equation 5:

$$\widehat{\omega}_{it} = \hat{\upsilon}_{it} + \hat{\beta}_0 = \mathrm{y_{it}} - \hat{\beta}_k \mathrm{k_{it}} - \hat{\beta}_l \mathrm{l_{it}} - \hat{\beta}_m \mathrm{m_{it}} \tag{5}$$

3.3. TFP estimation

The estimation method sketched above was used here in two different ways. First, we estimated the TFP considering the entire available dataset. We run a simple pooled OLS regression and $\widehat{\omega}^{pooled}$ was estimated according to the β_j estimated. The results were convincing and closely correlated with our two other productivity measures (Sales/emp. and VA/emp.) as illustrated in Table 3 column (1). To be more accurate, we estimated the TFP, a second time, considering the panel components of the dataset. In this situation we executed a panel regression and re-estimated $\widehat{\omega}^{panel}$ subsequently. The result is convincing. $\widehat{\omega}^{panel}$ is more correlated with our two other productivity measures than the previously computed $\widehat{\omega}^{pooled}$, as shown in Table 3 column (2).

Table 3 - Productivity measures correlations

	(1) $\widehat{\omega}^{pooled}$	(2) $\widehat{\omega}^{panel}$
VA per emp. (ln)	0.732***	0.844***
sales per emp. (ln)	0.614***	0.775***

Source: Author's elaboration based on WB-ES
* p<0.05,** p<0.01,*** p<0.001

Unfortunately, these traditional methods to estimate TFP, widely used in the literature, have a methodological drawback. For instance, as explained by Van Beveren (2012, p.98), "because productivity and input choices are likely to be correlated, OLS estimation of firm-level production functions introduces a simultaneity or endogeneity problem".

This is why we follow the methodology of Levinsohn and Petrin (2003). According to the existing literature, this methodology resolves many issues related to TFP estimation. In this method, value added is used as output variable (Y_{it}) and the inputs (M_{it}) are used to control for unobservable.

It is important to notice here the presence of a "simultaneity bias" due to "endogeneity of inputs"[3]. This creates an upward bias in β_l and β_m and a downward bias in β_k. As it is said "for a two-input production function where labour is the only freely variable input and capital is quasi-fixed, that the capital coefficient will be biased downward if a positive correlation exists between labour and capital" (Van Beveren, 2012 p.101).

Table 4 - TFP & productivity measures correlations

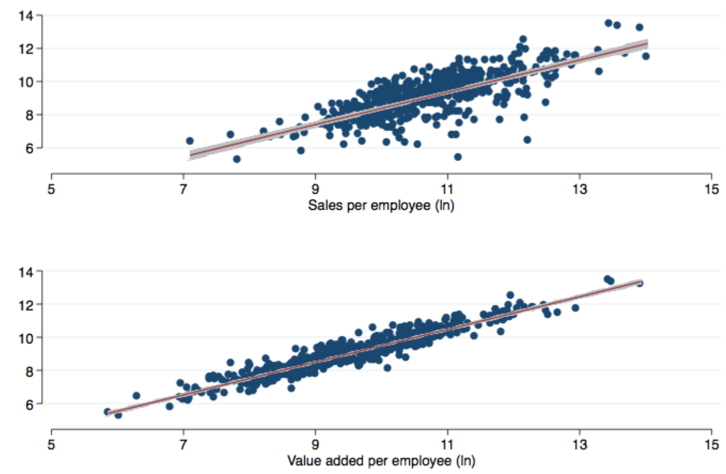
	(1) $\widehat{\omega}^{pooled}$	(2) $\widehat{\omega}^{panel}$	(3) $\widehat{\omega}^{lp}$
VA per emp. (ln)	0.732***	0.844***	0.948***
sales per emp. (ln)	0.614***	0.775***	0.753***

Source: Author's elaboration based on WB-ES
* p<0.05,** p<0.01,*** p<0.001

This last $\widehat{\omega}^{lp}$ estimated is more correlated than the two previously calculated $\widehat{\omega}^{pooled}$ and $\widehat{\omega}^{panel}$ estimates with our reference productivity measure *VA/emp.*. We observe a lower correlation than $\widehat{\omega}^{panel}$ estimation with *sales/emp.*, but it is nevertheless acceptable since it is above the significance threshold of 0.75. Table 4 (3) displays these improvements in terms of accuracy. Figure 3, illustrates these positive correlations graphically.

[3] There is a correlation between ε_{it} and inputs because a firm's beliefs about ε_{it} influence its choice of inputs

Figure 3 - TFP and other productivity measures



Source: Author's elaboration based on WB-ES

Table 5 summarizes statistics of different productivity measures. In this chapter, as mentioned above, because of its better characteristics, we use Levinsohn and Petrin's coefficient ($\widehat{\omega}^{lp}$) as TFP estimate. We will refer to it as "TFP" in the following sections.

Table 5 - Productivity measures stat. (2017)

	Obs	Mean	Std.Dev.
Productivity measures			
Sales per emp. (ln)	507	10.91	1.11
VA per emp. (ln)	276	9.98	1.27
TFP (ln)	131	9.31	1.27

Source: Author's elaboration based on WB-ES

3.4. TFP estimates

One can wonder if these estimations are consistent with the real world, or, let's say, with the stylized facts we are faced with. Figure 4 plots a TFP density for selected industries. As we expected, and in agreement with the existing literature, such as Alam et al. (2008, Ch.2), Machinery and equipment and Chemicals are the most productive sectors. Garments and Textiles are less productive. We also notice that the productivity curves are relatively centred around their means. This represents a kind of intra-industry homogeneity in terms of productivity. Looking at the Food Industry curve (here dashed-lined), we see that this sector is flatter, and more on the right than the other ones. This peculiarity indicates that this sector has part of its industry with a low/medium productivity and the other part much more productive. Indeed, it is interesting to note that it has a second peak to the right of the first, suggesting that it has a good number of firms with high productivity.

Figure 4 - TFP density by industry sector

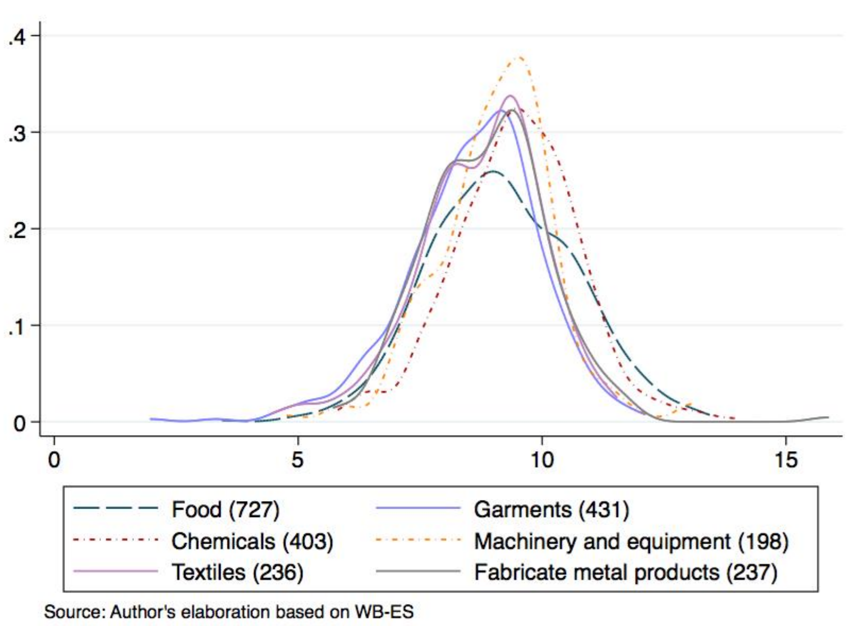


Table 6 summarises our Total Factor Productivity (TFP) computed by country for our three-waves panel[4]. We notice that Ecuador is the country with the lowest dispersion in our panel. It is also the one with the highest productivity. We could conclude that this is due to an interesting homogeneity of its economy. Indeed, a low dispersion coefficient, in this case the standard deviation, indicates that all values are centred around the mean which is a clear sign of homogeneity. This result, however, is more probably caused by the limited number of observations for this country.

In terms of productivity performance, two countries stand out, namely Argentina and Peru. They possess indeed similar mean TFP, 9.14 and 9.05 respectively. Their dispersion coefficients (1.20 and 1.33) minimum (5.77 and 5.41) and maximum values (13.32 and 13.44) are quite comparable as well. We will come back to this similarity in section 4.5.

[4] We observe that we "lost" some observations. This is mostly due to the absence of information about some firms' capital in the survey. This information is fundamental to compute TFP following the Levinsohn and Petrin (2003) methodology.

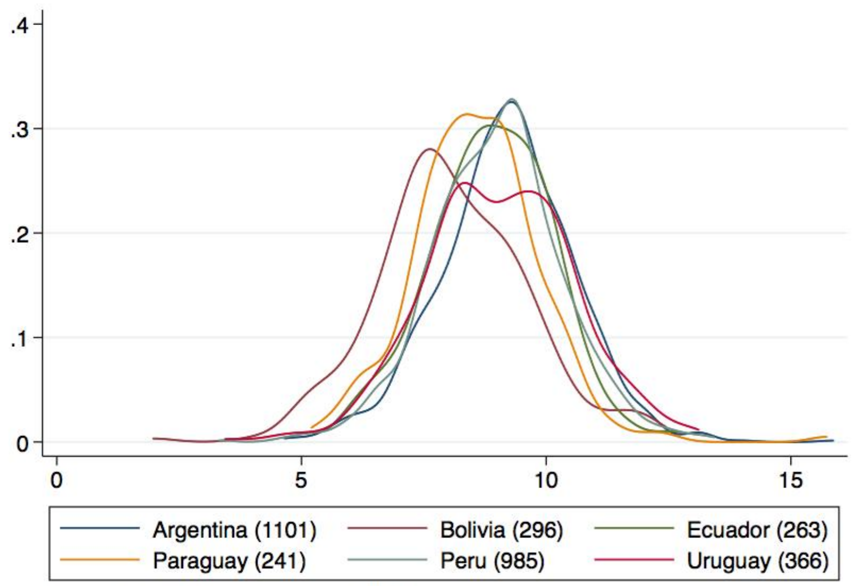
Table 6 -TFP summary statistics

	Obs.	Mean	Std. Dev.	Min	Max
Argentina	204	9.14	1.20	5.77	13.32
Bolivia	39	8.55	1.31	5.25	11.62
Ecuador	22	9.34	1.06	7.37	10.84
Paraguay	50	8.73	1.14	6.14	11.14
Peru	170	9.05	1.33	5.41	13.44
Uruguay	43	9.51	1.29	6.45	11.79

3 waves panel only (2006-2010-2017)
Source: Author's elaboration based on WB-ES

Figure 5 illustrates this point plotting the density of these TFP newly computed by country. The similarity between Argentina and Peru is here easily observed. Indeed, their density curves follow a very similar trend and "cover" each other most of the time.

Figure 5 - Productivity density by country



Source: Author's elaboration based on WB-ES

4. Results

4.1. Ex-ante mean TFP evolution

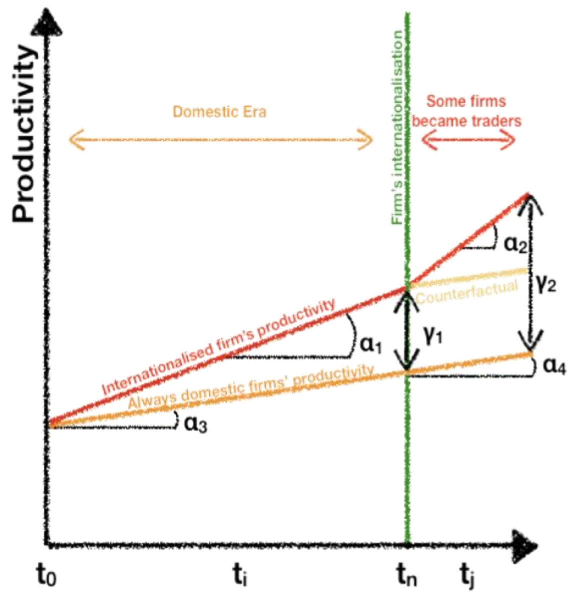
As mentioned earlier, the literature on international trade theory has long assumed equal productivity for all firms (at least within a given industry). The early 2000s saw the surge of the New New Trade

Theory (NNTT) which, after observing some peculiarities not explained by traditional trade theories, started to considered a certain heterogeneity in terms of a firm's productivity.

We illustrate in Figure 6 the pre-trade situation of an economy based on the NNTT assumption. The expression *ex-ante* is used to analyse what is happening before a change in international status. Conversely, the expression *Ex-Post* is used to analyse what happens after a change in international status.

The situation represented in Figure 6 is a textbook case. It represents the *ex-ante* productivity situation and the possible evolution of productivity, according to the future trading status of the firms. We observe two categories of firms. Those which will become traders at time t_n and those that will remain domestic. At the hypothetical time t_0, all firms are expected to have the same productivity. However, NNTT claims that firms engaged in international trade are more productive than domestic one. This situation is here illustrated by the gap γ_2. It is a productivity gap. It represents the productivity difference between firms engaged in international trade and domestic ones. In a similar way, it is normal to consider the productivity gap γ_1 to be positive. Indeed, since traders are more productive than the domestic firms, it may be because they were already more productive at the moment of their entry into international market. The theoretical γ_0 at t_0, is, if taken in a run long enough, supposed to be close to zero. It means that at the very beginning there is no difference in terms of productivity between firms. Let us assume for simplicity that at t_0, all firms are then domestic, with the same productivity.

Figure 6 - Theoretical ex-ante mean TFP evolution



Source: Author's elaboration based on NNTT principles

Firms being similar in terms of productivity at t_0, productivity growth during the "domestic era" will be quicker for businesses that will become traders after t_n than for those which remain domestic after this date. This is illustrated by the coefficients α_1 for the future internationalised firms and α_3 for those that will remain domestic. We suppose that α_1 will be greater than α_3. This will be the case, however, only if the t_i period analysed is long enough.

The literature often underlines that GVC inclusion, or, more generally, international trade participation implies learning effects. Companies on this internationalised market have access to new (good?) practices. They also need to remain even more competitive since they now compete with the world's best enterprises. This learning effect is represented here via the difference between the coefficients α_1 and α_2. The presence of learning effects will only be verified in the situation where α_2 is greater than α_1.

Figure 7 - Ex-ante mean TFP evolution all countries

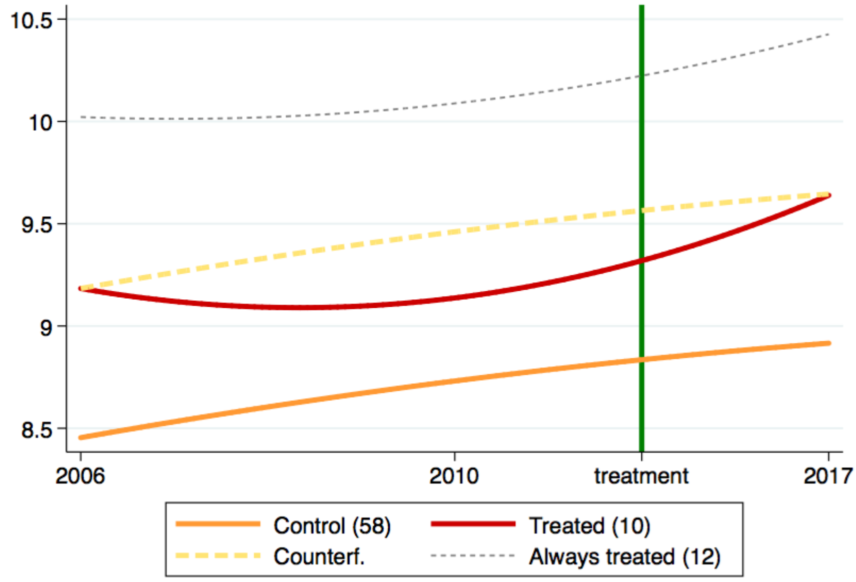


Figure 7 illustrates the theory described above with the computation results based on our dataset[5]. We first assign a group to each individual firm. We then computed the average of the TFP outcome per year before smoothly linking these points with respect to their assigned group. The green "treatment" line roughly materialises the moment (between 2010 and 2017) in which the "treated" firms enter GVC.

We can observe, in red, the situation of firms entered GVC between 2010 and 2017 (treated group). The control group is composed of businesses that remained non GVC members throughout the entire period. The always treated group is composed of firms always involved in GVC. The counterfactual represents what could have been the treated group if the initial gap between treated and control remained fixed over time. In other words, it illustrates the "minimum" that a new trading firm should achieve in terms of productivity.

As expected we clearly observe that gaps γ_1 and γ_2 are both positive (with respective values of 0.41 and 0.72). Compared to the control firms' productivity, it represents a "trading premium" of +4.65% just before entering GVC, which became +8.11% after the entrance. We also observe that γ_2 is greater than γ_1 as previously expected. This finding supports the NNTT assumption. It also suggests the presence of learning effects via GVC participation.

In terms of growth, our assumption α_2 greater than α_1 is verified (if not we could not have γ_2 greater than γ_1). We also observe that productivity growth is greater for firms engaged in GVC (α_2 = 0.0717) than for domestic ones (α_4 = 0.0264)[6].

Conversely, we do not observe α_1 greater than α_3. We recall, however, that this could be observed, as well as γ_0 close to 0, only if t_i was long enough. The time dimension can be an important factor which underlines more these differences clearly. All numerical results of this analysis are summarised in Table 7.

[5] Note that Figure 6 and Figure 7 follow roughly the same colour code to facilitate interpretation.

[6] The α coefficients represent the slope of their respective curve computed according to the following linear equation: y = αx + b.

Table 7 - Ex-ante analysis: results

	value	premium
γ_0	0.73	+8.63%
γ_1	0.41	+4.65%
γ_2	0.72	+8.11%
α_1	-0.0116	
α_2	0.0717	
α_3	0.0693	
α_4	0.0264	

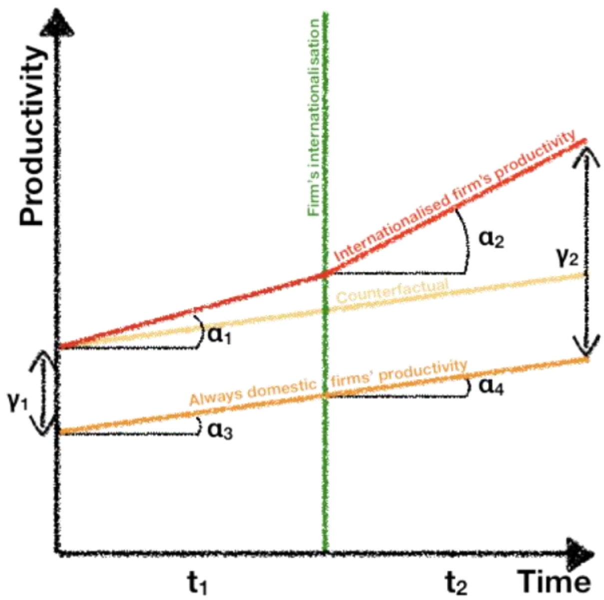
Source: Author's elaboration based on WB-ES

4.2. Ex-post mean TFP evolution

Similarly to what was seen in the previous subsection, we illustrate in Figure 8 the theoretical evolution of firms' productivity based on the NNTT assumption. This figure shows the hypothetical firms' productivity evolution through time according to their trading status.

Figure 8 illustrates the *ex-post* situation of firms which enter GVC. The domestic era is here represented by the t_1 period while the trading period is the t_2 one. The red line represents firms that will enter GVC between t_1 and t_2. The orange one represents companies that will remain domestic, and finally, the yellow one represents the counterfactual (a growth of productivity identical to the domestic one but starting at a productivity level of a future GVC firms). This is illustrated by the gap γ_1.

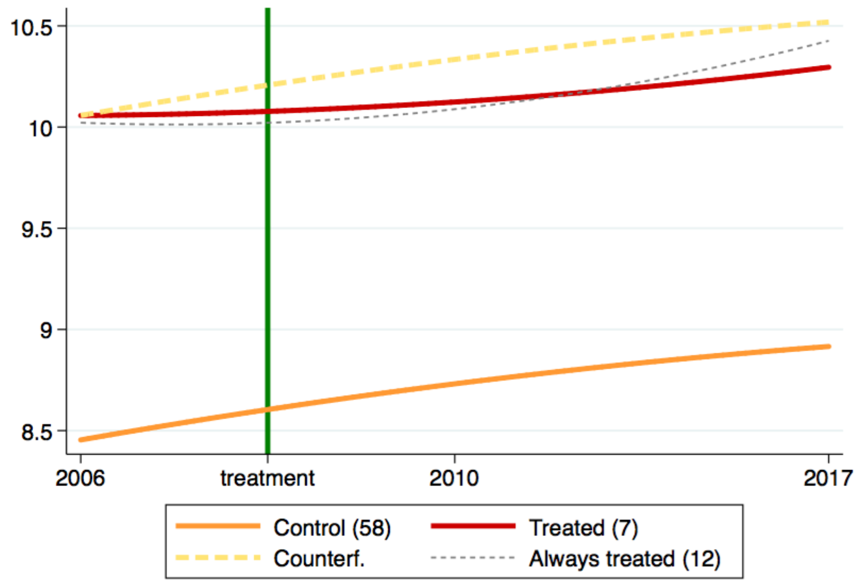
Figure 8 - Theoretical Ex-post mean TFP evolution



Source: Author's elaboration based on NNTT principles

NNTT states that GVC participating firms are more productive than domestic ones. Gaps γ_1 and γ_2 are then positive. Since internationalised firms being more productive, we can expect a higher growth rate. This is illustrated here by a α_1 greater than α_3 and α_2 greater than α_4. According to the existing literature, GVC inclusion, or more generally international trade participation, can imply learning effects. In the presence of learning, we will observe an α_2 greater than α_1. Indeed, α_1 represents the productivity growth of a firm that will soon become a GVC member but still is, for the moment, domestic. Figure 9 illustrates our panel situation following the methodology previously illustrated in Figure 8.

Figure 9 - Ex-post *mean TFP evolution all countries*



Source: Author's elaboration based on WB-ES

We observe here that firms willing to enter GVC in 2006 (and which are GVC members in 2010 and 2017) are already at a productivity level similar to the always treated group. In other words, companies that are about to enter GVC are already as productive as GVC members. This "pre-entrance" gap γ_1 is already quite important since it represent a productivity "premium" of +19%. Both treated and always treated firms follow a very similar trend and tend toward a point close to the final counterfactual one, although *in fine* slightly lower. The fact that both, always treated and treated, are slightly under the counterfactual in 2017 while they were nearly at the same point in 2006 means that the control group grew more quickly than they did in terms of productivity over the period. This indicates that the productivity growth of control firms was greater than the GVC ones. This evolution naturally led to a gap reduction, both in value, passing from 1.60 to 1.38, and in relative terms: in 2017 accounted for 15% of domestic productivity as opposed to 19% in 2006[7].

We observe that α_2 is greater than α_1. This suggests the presence of learning effects due to GVC inclusion as assumed by the international trade literature. This positive effect should not, however, be overly emphasised. Indeed, α_3 is greater than α_1 and α_2 is slightly lower than α_4. This means that over both periods control firms performed better than GVC ones. This performance is also due to the starting point of the control group. The control group productivity level, at the beginning, is lower than both the

[7] Of course these exercises are ceteris paribus and between 2006 and 2017 there was the world financial crisis and a large reduction of intenational trade, whose elasticity to world GDP passed from round 2% in the previous years to around 1% after 2008. This evolution has been explained in the recent literature by referring to the unfolding role of GVC after the financial crisis, when firms had to regain trust of their partners.

treated and the always treated groups. The faster growth, in terms of productivity, may be due to the fact that they had very low productivity at the beginning. The observed learning effect ($\alpha_2 > \alpha_1$) is then somehow quite relative. All the numerical results of this analysis are summarised in Table 8:

Table 8 - Ex-post *analysis: results*

	value	premium
γ_1	1.60	+19%
γ_2	1.38	+15%
α_1	0.0167	
α_2	0.0245	
α_3	0.0693	
α_4	0.0264	

Source: Author's elaboration based on WB-ES

4.3. Robustness of results

To assess the robustness of these results we performed several tests. The first, presented in Table 9, is a t-test designed to compare means of the same variable between two groups. We divide our panel of firms into different groups according to their trading status. We distinguish five different groups. First, we define the domestic group (*Dom*) as a group composed of companies not engaged in import or export activities. This group is composed, then, exclusively of firms focused on a domestic market. We then define the importers (*Imp*) group as a group of firms engaged in import activities. Similarly, the exporters group (*Exp*) includes firms engaged in export activities. The two-way traders group (*2w*) encompasses firms engaged in both import and export activities. Finally, the traders group (*Trad*), is composed of businesses engaged in, indifferently, import or export activities, or both at the same time. This group, then, regroups the three previous groups (import, export, two-way) in a single one. Using the domestic firms as a reference (control group), we compare the mean productivity estimation (TFP or Sales per employee) with a t-test designed to compare means. Since these subjects are randomly selected by construction, from a larger population of subjects, we can apply this test assuming similarity of variances.

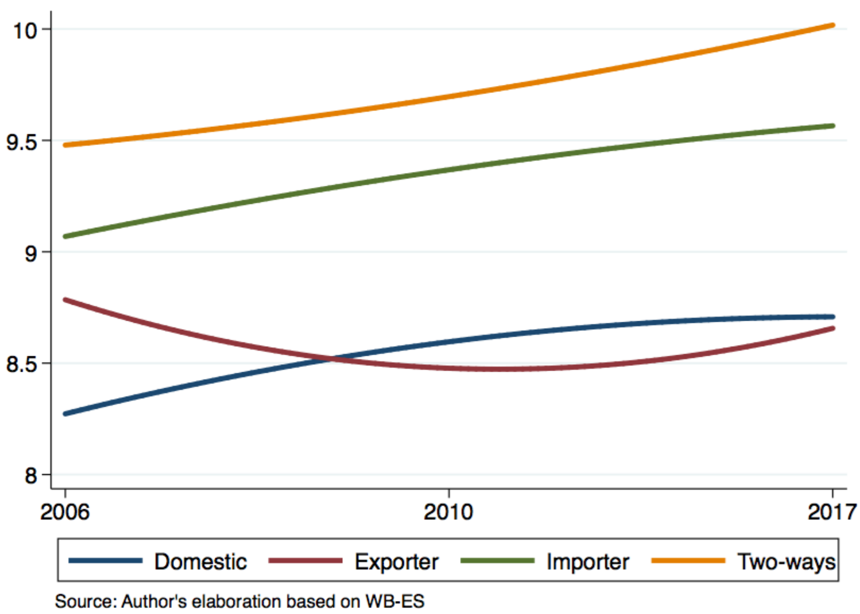
Table 9 - Mean test comparison by internationalisation mode

	Dom/Trad	Dom/2w	Dom/Exp	Dom/Imp
TFP (ln)	-0.886*** (-8.25)	1.204*** (8.64)	-0.340*** (-5.85)	0.430*** (4.23)
Observations	528	308	1539	1041
Sales/emp (ln)	0.131 (0.63)	0.0568 (0.49)	0.828*** (6.84)	0.387*** (5.60)
Observations	227	997	379	1267

t statistics in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$
Source: Author's elaboration based on WB-ES

We observe that with both productivity measure, TFP (ln) or Sales/employee (ln), the mean productivity difference between domestic firms and traders, two-way traders and importers is significant at a very high level. The only result which is not significant is the difference between domestic and exporters' mean productivity. This specificity can be easily explained. If we look at Figure 10 we clearly see that a kind of (expected) hierarchy emerges among traders. Two-way traders, engaged in both import and export, outperform both domestic firms and firms involved exclusively in importing or exporting activities.

Figure 10 - TFP (ln) by internationalisation mode



Importers outperform both domestic firms and exporters. Finally, exporters and domestic firms are at too similar a level over the period to definitely, and significantly, conclude that the productivity of the former is greater than that of the latter (which is always verified in the long run). This hierarchy, in this order, and the peculiar position of exporters is not new to the literature. It was already observed by Castellani et al. (2010), Bekes and Altomonte (2009), or Wagner (2011) for different groups of countries.

If we look more into the details of the mean difference significance of our control (*Cont*), always treated (*Altr*), and treated groups (*Treated*)[8], we observe that the TFP mean difference is always significant (See Table 10). To check for robustness, the same analysis was carried out using another productivity measure, and similar results were observed.

[8] Note that this treated group is an aggregate of units treated between t_1 and t_2 (*T.t1*) and units treated between t_2 and t_3 (*T.t2*).

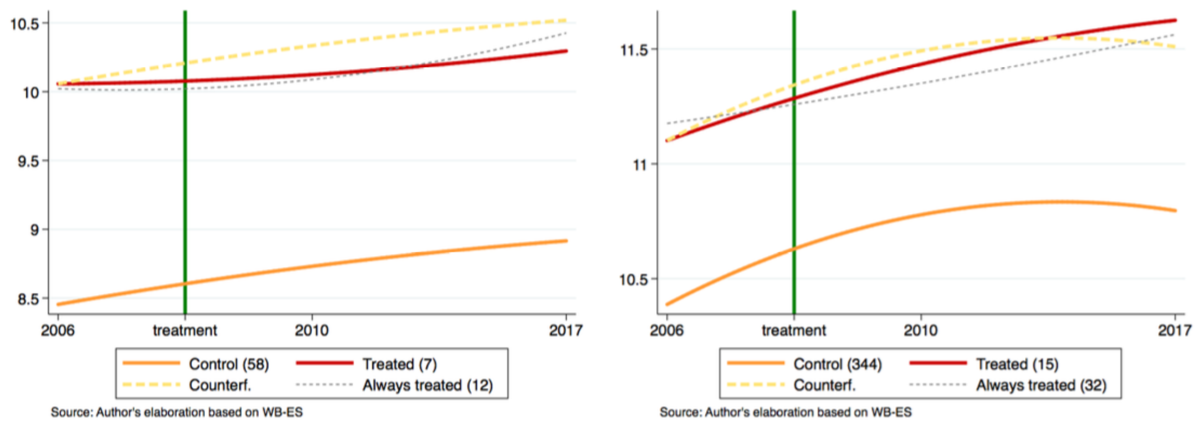
Table 10 - Mean test comparison by GVC category

	Cont/Altr	Cont/Treated	Cont/ T.t1	Cont/T.t2
TFP (ln)	1.511*** (4.69)	1.005*** (3.60)	1.380*** (3.41)	0.828** (3.11)
Observations	97	104	92	403
Sales/emp (ln)	0.766*** (3.91)	0.360* (2.21)	0.723* (2.09)	0.132 (0.67)
Observations	419	438	95	421

t statistics in parentheses
* p<0.05,** p<0.01,*** p<0.001
Source: Author's elaboration based on WB-ES

We can claim, then, that our results can be trusted . Next we need to test their robustness. The strategy here is fairly simple. As done above, we use another productivity measure, in this case the sales per employee (we recall that the mean difference significances were tested earlier) and compare the results obtained while using the same procedure as with the TFP.

Figure 11 - Productivity - treated between T_1/T_2



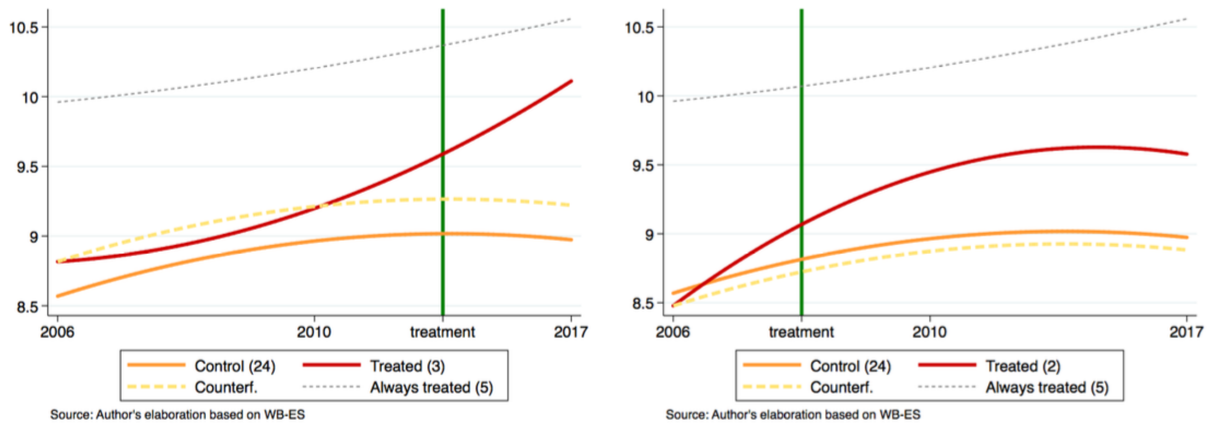
(a) TFP (ln) (b) Sales/emp. (ln)

As an illustration we replicate our ex-post analysis. Figure 11 displays the ex-post analysis performed with two different productivity measures. We note that in both Figure 11(a) and Figure 11(b), the productivity evolution for all groups is fairly similar. This is true independently of the productivity measure used. The results differ slightly, which is normal, but the global trend is perfectly respected, which makes us confident that the analysis is robust. The main difference is the quantity of firms observed in Figure 11(b), which increased for all categories. This is a further proof of the robustness of this analysis. Indeed, it confirms, the generalizable feature of our analysis.

4.4. Mean TFP evolution: analysis by country

A question arises. Why is international productivity growth not greater than domestic? One explanation could lie in the heterogeneity of our panel. Indeed, this panel covers different South American countries with different economic structures. We already observed in section 2.2 that these countries were different in term of productivity. To push forward our analysis it could be interesting, then, to analyse these countries individually. Let us start with Argentina, the most important economy of our panel.

Figure 12 - Argentina mean TFP evolution



(a) *Ex-ante* (b) *Ex-post*

Figure 12 displays an analysis similar to that performed in the previous section but focussing only on Argentina. The trend observed in Figure 12(a) is coherent with our expectations. We clearly see that in 2006 (t_{-2}) the productivity of future GVC members is already slightly higher than that of purely domestic firms. The same can be said about the situation in 2010 (t_{-1}). At this time, we observe that the productivity growth rate of future GVC members takes off. At the same time, domestic businesses stagnate or decrease. The always treated group is always more productive than the others and also grows faster than they do. This is in line with our expectations, illustrated in Figure 6 and Figure 8. The productivity of the firms which became internationalised over the period (*treated group*) tends to reach the productivity level of firms always engaged in international trade (*always treated*). This is also as expected.

Figure 12(b) illustrates how the trend for Argentinian companies has a pattern similar to that identified for the whole panel. We note that in this graph, both the always treated and control groups are the same with Figure 12(a). This is normal. The only change concerns the treated group because the treatment date changed. In the previous graph we analysed the evolution of a group that was treated between 2010 and 2017. Here we analyse a group treated between 2006 and 2010.

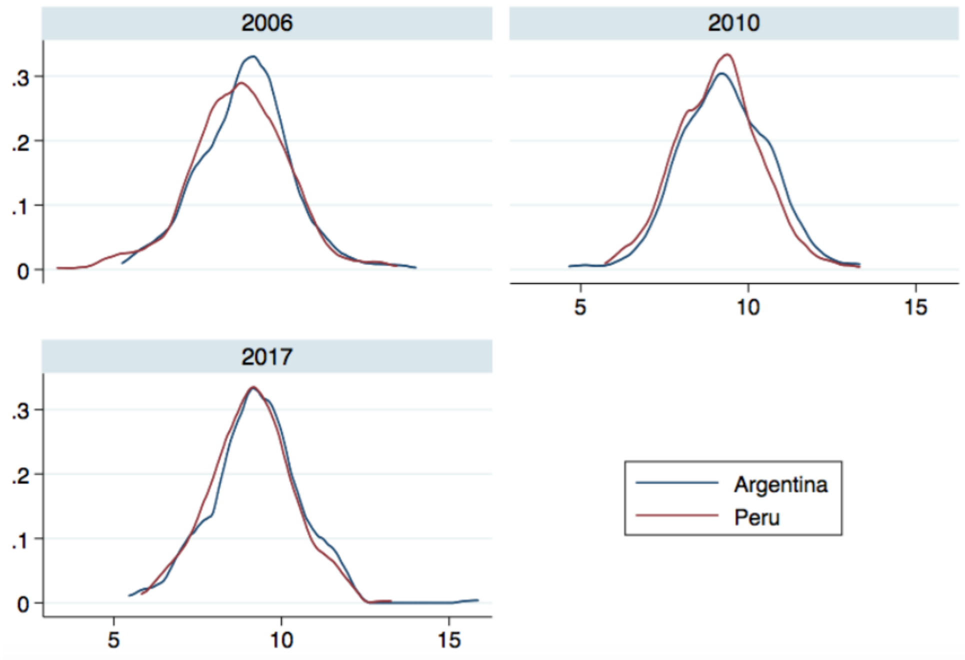
We observe that the productivity of both control and treated groups are in 2006 relatively similar. The treated productivity nonetheless takes off while the control group's tends to stagnate. Once again, and as previously, the always treated group, is always more productive with a steady (and greater) productivity growth.

The small number of companies present in our panel forced us to refrain from further analysis at the country level. Argentina is the country with the highest number of businesses, and already in this case the country analysis is subject to criticism due to the low number of firms considered.

4.5. Mean TFP evolution: analysis by countries with similar characteristics

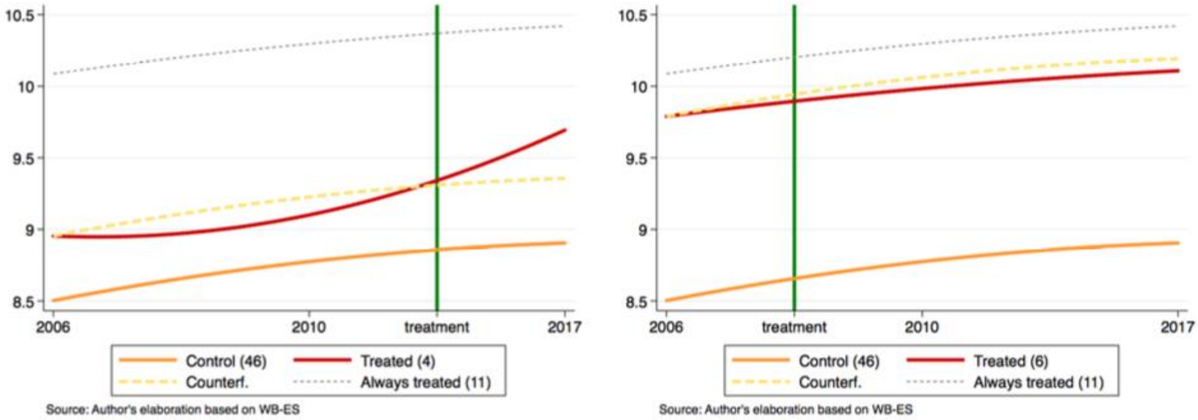
We observed in subsection 2.2 (Table 6 -TFP summary statistics) that Argentina and Peru possess similar characteristics in terms of productivity. Their productivity similarity is plotted in Figure 13. We clearly see that their productivity density curves follow a very similar trend.

Figure 13 - Argentina & Peru productivity similarity



Let us now consider, in a single analysis, Argentina and Peru, two countries which display the same productivity characteristics. Figure 14 shows the graphic results of our two-country analysis. The trend observed in Figure 14(a) is, once again, consistent with our expectations. It is also quite similar to the one observed in Figure 12(a). We observe that in 2006 (as well as in 2010) the productivity of future GVC members is already greater than that of purely domestic firms. Moreover, the inclusion of Peru increases the gap γ_0, which was smaller previously when we analysed only Argentina, confirming that the future GVC productivity growth rate takes off while the domestic one stagnates. The always treated group is more productive than the others. It also experiences a more pronounced growth in productivity. This is consistent with both the literature and our precedent analysis of Argentina. The treated group productivity tends to reach the always treated one, which is, once again, to be expected.

Figure 14 - Argentina & Peru mean TFP evolution



(a) *Ex-ante* (b) *Ex-post*

If we look at Figure 14(b) we observe results that are more consistent with the NNTT than those observed with the simple analysis of Argentina (Figure 12(b)). Here the productivity is already greater for the future GVC firms, growing at a rate very similar to the domestic one (see counterfactual).

This analysis confirms perfectly the trends suspected during the analysis performed in subsection 4.4. The addition of Peru, which, it is to be remembered, possesses productivity characteristics similar to those of Argentina, increased the robustness of the analysis by adding new independent observations[9].

5. Robustness analysis – Propensity Score Matching (PSM)

In order to further assess the robustness of the results obtained above, we use propensity score matching (PSM). The first step in PSM is to determine the propensity score. This is the probability for one unit to get a treatment and meet the balancing property. The balancing property verifies for every observation with the same propensity score, the similarity (or better, equality) of the distribution of observable characteristics, independently of their treatment status.

To do so we follow the procedure developed in Khandker et al. (2010).We focus here on the following outcomes: Total Factor Productivity (TFP) first, and then, sales per employee as an additional robustness check. As before, we define the treatment group as those firms participating in a GVC. The control variables, observed and considered as independent of treatment status, are the firm's size, capital intensity, skilled workers' ratio, trader status and inward FDI presence. For simplicity we focus on the years 2010 and 2017. The panel here is slightly different, then, from the one considered in the previous analysis.

The estimation of propensity score defines here five blocks in which the propensity score is not different for treated and control groups. The identified area of common support, defined as lowest and highest estimated values for treated units, is [0.11531315, 0.95716291]. Finally, the balancing property is here satisfied.

These propensity scores having been generated, we can compare the outcome of interest between the treated and control groups.

[9] Bearing in mind that the development of these two countries is relatively different.

As matching algorithm, we chose the Nearest Neighbour Matching method (NNM). This method compares units of the first group with the closest unit (in terms of propensity score) of the other group.

Table 11 - ATT estimation with NNM method

	n. treat.	n. contr.	ATT	Std. Err.	T
Analytical Std. Err.	104	52	-0.458	0.300	-1.524
Bootstrapped Std. Err.	104	52	-0.458	0.057	-8.060

Source: Author's elaboration based on WB-ES

Table 11 shows the results obtained with this method. We observe that the average treatment effect on the treated (ATT) is negative and significant with the standard analytical method. It becomes more significant after bootstrapping standard errors. There is, then, a significant difference in productivity between these two groups.

As a robustness check, we compute ATT estimation using the Stratification and Interval Matching (SIM). This method partitions the common support into strata (intervals) and calculates the impact within each stratum. Results are reported in Table 12.

Table 12 - ATT estimation with SIM method

	n. treat.	n. contr.	ATT	Std. Err.	T
Analytical Std. Err.	104	123	-0.163	.	.
Bootstrapped Std. Err.	104	123	-0.163	0.057	-2.870

Source: Author's elaboration based on WB-ES

We notice that the ATT value is not the same, due to the computation method. Nevertheless, its sign is still negative and significant, which confirms our previous results.

Conclusion

This paper observes the difference in terms of productivity between firms which enter global value chain and those that remain domestic for a panel of South American countries. This difference in productivity is always verified in our panel.

We also observe an increase in productivity growth after entry into GVC. This tends to confirm the learning effect suggested by the international trade literature. In other words, GVC participation implies learning effects due precisely to this internationalisation. These effects can be, for instance, acquiring the experience of new good practices. The fact is: firm internationalisation increases productivity ex-post.

However, the productivity growth difference between domestic and internationalized firms is not as large as expected. In other words, the increase in productivity is not directly due to the internationalisation of the companies. Indeed, domestic firms, too, experience a similar growth (in percentage). One explanation for this is the starting point of domestic firms. Since they are less productive at the beginning, it is then easier for them to growth faster. As the productivity curve of these firms seems to be convex, it is easier to grow faster at low levels.

Firms which engage in GVC, then, are more productive from the very beginning. This is in line with the NNTT and is supported by the results. These GVCs firms are (ex-ante) more productive. The learning effect, and therefore the fact that they are more productive because they are traders, is not supported by our results: our panel GVC firms do not seem to exhibit faster productivity growth than domestic ones (in percentage).

References

Alam, Asad, Paloma Anós Casero, Faruk Khan, and Charles Udomsaph. 2008. *Unleashing Prosperity - Productivity Growth in Eastern Europe and the Former Soviet Union*. The International Bank for Reconstruction and Development. Washington, DC, USA: The World Bank.

Antràs, Pol, and Elhanan Helpman. 2004. "Global Sourcing." *Journal of Political Economy, University of Chicago Press* 112 (3): 552–80.

Aw, B. Y., S. Chung, and M. J. Roberts. 2000. "Productivity and Turnover in the Export Market: Micro-Level Evidence from the Republic of Korea and Taiwan (China)." *The World Bank Economic Review* 14 (1): 65–90.

Baldwin, Richard, and Anthony Venables. 2010. "Spiders and Snakes: Offshoring and Agglomeration in the Global Economy." *National Bureau Of Economic Research*, no. Working Paper 16611 (December): 25.

Bekes, Gabor, and Carlo Altomonte. 2009. "Trade Complexity and Productivity." *SSRN Electronic Journal*.

Bernard, Andrew B, and J Bradford Jensen. 1999. "Exceptional Exporter Performance: Cause, Effect, or Both?" *Journal of International Economics* 47: 1–25.

Bernard, Andrew B, J Bradford Jensen, Stephen J Redding, and Peter K Schott. 2007. "Firms in International Trade." *Journal of Economic Perspectives* 21 (3): 105–130.

Bernard, Andrew B, Stephen J Redding, and Peter K Schott. 2007. "Comparative Advantage and Heterogeneous Firms." *Review Of Economic Studies* 74: 31–66.

Castellani, Davide, Francesco Serti, and Chiara Tomasi. 2010. "Firms in International Trade: Importers' and Exporters' Heterogeneity in Italian Manufacturing Industry." *World Economy* 33 (3): 424–57.

Clerides, Sofronis, Saul Lach, and James Tybout. 1998. "Is Learning by Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco." *The Quarterly Journal of Economics*, Oxford University Press, 113 (3): 903–47.

Formai, Sara, and Filippo Caffarelli Vergara. 2015. "Quantifying the Productivity Effects of Global Value Chains." *Cambridge-INET Institute*, no. Working Paper 1564 (December): 30.

Gordon, J., S. Zhao, and P. Gretton. 2015. "What Is Productivity and How Is It Measured?" *Australian Government - Productivity Commission*, PC News, , May, 17–19.

Helpman, Elhanan, Marc J Melitz, and Stephen R Yeaple. 2004. "Export Versus FDI with Heterogeneous Firms." *American Economic Review* 94 (1): 300–316.

Khandker, Shahidur R., Gayatri B. Koolwal, and Hussain A. Samad. 2010. *Handbook on Impact Evaluation: Quantitative Methods and Practices*. Washington, D.C: World Bank.

Levinsohn, James, and Amil Petrin. 2003. "Estimating Production Functions Using Inputs to Control for Unobservables." *The Review of Economic Studies* 70 (2): 317–341.

Melitz. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71 (6): 1695–1725.

Melitz, Marc J, and Gianmarco I.P. Ottaviano. 2008. "Market Size, Trade, and Productivity." *Review Of Economic Studies*, 295–316.

Schreyer, Paul. 2001. *Measuring Productivity: Measurement of Aggregate and Industry-Level Productivity Growth ; OECD Manual*. Statistics. Paris: OECD.

Taglioni, Daria, and Deborah Winkler. 2016. *Making Global Value Chains Work for Development*.

Trade and Development Series. Washington, DC: World Bank Group.

Van Beveren, Ilke. 2012. "Total Factor Productivity Estimation: A Practical Review: Total Factor Productivity Estimation." *Journal of Economic Surveys* 26 (1): 98–128.

Wagner, Joachim. 2011. "Productivity and International Firm Activities: What Do We Know?" *Nordic Economic Policy Review* Productivity and competitiveness (Number 2).

Chapter 2

Food Industry and Global Value Chains: The case of Argentina

Abstract

In this chapter we analyse the participation of Argentina's food industry in global value chains and its implication for competitiveness. We first sketch the global network of the food industry sector, focusing particularly on the case of Argentina. This analysis shows that Argentina is an important producer of intermediate goods and that it is well integrated in this global market. We then investigate empirically if and how Argentinian firms of this industry are affected by internationalisation and GVC participation. We show that Argentina's food industry is on average more productive than the other industries considered together. We finally see that firms participating in GVC and, more generally, internationalised firms perform better.

Table of contents

List of tables

List of figures

Introduction

Never have the Global Value Chains (GVC), and in particular food global value chains, been as present in the news as they are in 2020. An Argentinian newspaper expressed concern in April 2020 about an FAO statement warning that a global food crisis is imminent if food value chains are not supported[1]. How are these food value chains organized? Does Argentina have a reason to be concerned? These issues are very important. This chapter addresses these topics. In particular, the place of the Argentine food industry in the GVC and the micro analysis of its food companies' productivity, key features of GVC participation.

Globalization has led to the fragmentation of production. The various tasks required to produce a finished product (design, manufacture, logistics, etc.) can be spread out over a wide range of geographical regions. Antràs (2020, p.5) defines the global value chains as "[…] a series of stages involved in producing a product or service that is sold to consumers, with each stage adding value, and with at least two stages being produced in different countries. A firm participates in a GVC if it produces at least one stage in a GVC." In this definition, Antràs identifies the essence of the GVC: the fragmentation of the production of value added. Value added is understood as the difference between the final value of production and the value of the goods and services that have been consumed in the production process (e.g. intermediates). It quantifies the increase in value that the enterprise adds (as a result of its own productive activity) to intermediate goods and services that come from third parties (its suppliers).

A globalized value chain can take many forms. Baldwin and Venables (2010) define two main configurations. The first, *the spider*, is a horizontal type of GVC. The spider involves the simultaneous production of several components of a single product, which will be assembled as a final good. The second, *the snake*, is a sequential type of GVC. A product passes from one link in the chain to another, each actor adding new features (and thereby added value) to the product. Obviously, the production of complex goods can lead to the presence of both types of GVC for the production of a single good. These two forms, spider and snake, highlight a key element of global value chains, that is: the importance of intermediate goods (or services) in the production process. Intermediate goods, also called producer goods or semi-finished products, are goods that are destinated to be transformed into other goods (by incorporation or by destruction). They are therefore produced to be sold to other firms, domestically or abroad. The geographical localisation of competences and the decrease of quotas, tariffs and border taxes, favoured the development of global chains of production in which these goods are at the centre of the trade. The importance of international trade of intermediate goods enables a large number of firms to enter this globalised production system by producing only one type of intermediate good (or service) according to their production capacities. Firms have then the possibility to specialise in task (or function) rather than products. Giovannetti et al. (2015) and Agostino et al. (2015) argue that the productivity and competitiveness of small and medium firms may be fostered by joining international supply chains. Firms that lack the ability to perform the complete production of a good can now participate in GVC production by producing just one component of (or adding a feature to) a more complex product.

This reality of a fragmented productive system is poorly understood by the usual international accounting system, which considers the nominal values of import or export flows. In this approach, components and services which constitute a final product are counted several times (each time they cross a border). This accumulation of gross flows artificially inflates the figures of real world trade. Let's take, as an illustration, the case of a common product designed in country A and exported to country B. It will be assembled in country C with components coming from various parts of the world. The usual

[1] See Clarin, 11 April 2020 *Por qué el coronavirus es un riesgo para la seguridad alimentaria global*,

accounting system records an export flow from country C to country B and various import flows of country C from its suppliers. Thus, the components and services composing this product are accounted many times: once as an export from C's suppliers, and then a second time, after assembly, as an export from C to B. When a country imports a product, it imports a combination of tasks and operations carried out by different suppliers located in several countries around the world. Usual accounting of international trade is not adequate for measuring these types of exchange. However, they are perfectly gauged when trade flows are measured in terms of value added. In this way, double-counting is avoided. By measuring trade in terms of value added, each country's individual contributions to the production of a final product is effectively captured (United Nations Conference on Trade & Development, 2013).

Previously, stages in the production process where performed in close proximity (geographical, but not exclusively (Johnson and Noguera, 2012)). The global fragmentation of production had moved away producers of a same GVC, creating complex networks. This production distance (geographical, cultural and productive) between producers can create a lack of information (and to some extent some trust issues between firms). The compliance with certain standards becomes, then, a prerequisite to enter in this globalised production network. Nadvi (2008, p. 325) defines standards as “commonly accepted benchmarks that transmit information to customers and end-users about a product's technical specifications, its compliance with health and safety criteria or the processes by which it has been produced and sourced”. As far as GVCs are concerned, we can add to this definition the importance of information transmission between actors (producers, suppliers) present in the chain. The standards “must be respected along the entire value chain, because every stage of production could affect the quality of the final product or service” say Taglioni and Winkler (2016, p190)before continuing: “firms providing trade-related technical and capacity building focused on compliance with safety and quality standards.” Standards cover several aspects of production. Some standards are related to the production process (social, environmental standards, etc.) and others are related to the product itself (such as quality). The standards in a value chain can also be either public (imposed by national or supranational entities) or private (imposed by the actors in the chain: buyers, suppliers, etc.). In any case, a minimum level of standards can be guaranteed by certifications. This guarantee fosters greater trust between the producers, distant from each other, but linked in a global chain. Official, or at least, recognised, certifications of these standards are therefore important for economic efficiency as they may cancel quality asymmetric information costs.

The food industry is particularly sensitive to this asymmetric information issue. Certifications are recommended and sometimes required for entry in GVCs, this is true for most industrial sectors. However, for the food industry sector’s certifications and standards are more compelling, because they may guarantee food safety. Consumers and public regulators are quite sensitive to the origin of food and its production process. Public authorities’ concern for quality assurance has led to the establishment of standard rules in order to ensure safe food. The concern of national (states) and supra-national (EU) authorities in terms of food safety, as developed by Codron et al. (2005), was triggered by a series of food scares in the nineties (the dioxin affair in 1999, or the Bovine spongiform encephalopathy (BSE / “mad cow disease”) crisis in 1996). In the meantime, retailers reorganized their supply chains around notions of traceability, food safety, and quality assurance. This reorganisation led a number of companies to develop new private standards and certifications (Ouma 2010). According to a recent business survey carried out by the OECD/WTO which regrouped 250 firms in the agri-food sector in 79 countries: “the ability to meet standards and product specifications” was also prominently identified, together with other factors such as “the regulatory environment and labour skills.”(OECD and WTO, 2013 p.102). According to this report, the “ability to meet quality and safety standards” ranks at the second most important factor (60% of responses) in influencing sourcing and investment decisions in agri-food value chains (behind the production costs (64%)). Suppliers of these GVCs also ask for support and better access to "internationally recognised standards"[2]. At the same time the lead firms of GVCs wish for "better standards infrastructure and certification capacity"[3].

The term "food industry" groups many distinct and diverse businesses. If food processing, understood as the manufacture of prepared food products, is the main activity of this industry, it is not the only one. For instance, as urbanisation kept consumers far from food production areas, wholesale and food distribution became essential activities as well. As explained by Whitworth, et al. (2017, p. 131):

> [...] Food supply chain providing urbanised Western consumers has become increasingly industrialised. Where once food was a localised system of household or community relationships, developments in agricultural practices, production, storage, preparation and distribution have transformed the system (Godfray et al., 2010). The food sector has now become a global market with products sourced from all over the world to meet a growing demand for variety and consistency of products, regardless of seasonality. The resultant long and complex supply chains limit traceability and often involve multiple, specialised actors who generally do not have detailed knowledge of each other's processes and procedures (Sivadasan et al. 2006).

The Food industry has very interesting features. Unlike other types of industry, it is present in every country in the world. As explained by Maslow (1943), food is a physiological need, required for human survival. No country, then, can ignore this industrial sector. It is important for all countries to achieve (at least a certain degree of) food production self-sufficiency. As such, "domestic value chains" are then present worldwide. This "growing demand for variety and consistency of products, regardless of seasonality" clearly favours the development of food GVCs which can benefit from the presence of regional and domestic chains, which are often very dynamic (World Bank, 2019a). This geographical dispersion and high diversity tends to complicate the elaboration of aggregated data on this sector. Nevertheless, the World Bank estimated in 2013 that, for example, in Africa, Agriculture as well as food processing and food trade represented half of total economic activity (World Bank, 2013). We can therefore clearly see the importance that this sector can have in terms of development. An increase in productivity in this sector can have many important effects such as job creations, incomes increase etc.

We saw in the first chapter of this thesis that the productivity density of South American firms involved in the food industry was quite different from that of other manufacturing sectors. In order to better understand this peculiarity, in this chapter we carry out a two ways analysis. First we will study the case of the Argentinian food industry and its intertwining in the global network. Argentina (a country already included in our previous analysis) has indeed very interesting characteristics with regard to the food industry; it is a historically important sector, export-oriented, and still accounts for a substantial share of the country's GDP. In order to understand the global dynamics and the place of Argentina in this network, we will sketch the global network of the food industry, taking into account the intermediate goods as well as the final consumption. Subsequently, in light of the previous results, we carry out a micro analysis of Argentine companies of this sector. The importance of micro level analysis has been underlined by several studies (see for instance Melitz (2003), Giuliani et al. (2005) or, Waldkirch and Ofosu (2010)). In line with their considerations, we explore the determinants of productivity of the Argentine food industry, which can be seen as one of the main features related to the country's position in the GVC.

[2] In 5th position after, in this order, *better access to finance, incentives for investment, better market access, and investment in infrastructure*.

[3] In 5th position as well after, in this order, *better market access, investment in infrastructure, better public-private dialogue with national authorities, trade facilitation measures*

1. Context, methodology and data

1.1. Context

Global value chains are particularly important for agricultural and food processing industries. The geographical dimension is therefore particularly important for this sector. Indeed, food production is, for certain types of good, impossible to move for obvious reasons of climate, soil composition, etc. For this reason, food goods, such as, wine, oil and wheat, have been (internationally) traded since ancient times. The current growing demand of final consumers for variety (and consistency) of products, regardless of seasonality, has amplified the globalisation and the fragmentation of food industry (Whitworth, et al. 2017). As a matter of fact, the GVCs in both the agriculture and the food industries have expanded since 1995 (World Bank, 2019b).

Argentina is a country with a fundamental comparative advantage in agriculture (Brambilla et al., 2018). Its low population density[4] of 17 people per km^2 and large agricultural land (1 487 000 km2, nearly 54% of land area) favours this country for the exploitation of agricultural and natural resources. Considered wealthy during the first wave of globalisation (1870- 1914) (De La Balze 1995), Argentina saw a convergence in real wages and GDP *per capita* (Solimano, 2001), until its economic peak in 1913 (12th world GDP). At the time, the *Pampas* area was supplying the world with cereals, wool and meat. The *Great Depression* and the subsequent decline in agricultural prices blocked the Argentine economy which experienced a long period of recession (the so called "*Década Infame")*. In order to save its food-industry the Argentine Republic signed in 1933, the Roca-Runciman Treaty. This treaty, at the price of neo-colonial domination, allowed the *Pampas* area to become the main meat supplier of the United Kingdom. The agriculture and food industry sectors would continue to remain an important component of the Argentinian economy.

Argentina is both a Latin America & Caribbean (LAC) country and an Upper Middle Income (UMI)[5] country. We will therefore take these two categories as point of reference to describe the trend of Argentina's economy. Argentina's GDP ranks 24st in the world in 2018[6]. If we look at Argentina's GDP growth from 1980 to 2020, illustrated in Figure 1, we can see that it follows generally (but more intensively) the LAC trend, except during the Argentine economic crisis (1998-2002). Considering the post-crisis years from 2003 to 2016, the Argentine economy grew on average 4.09% a year. During the same period, LAC countries growth was 2.98% while UMI countries performed better at 5.71%[7].

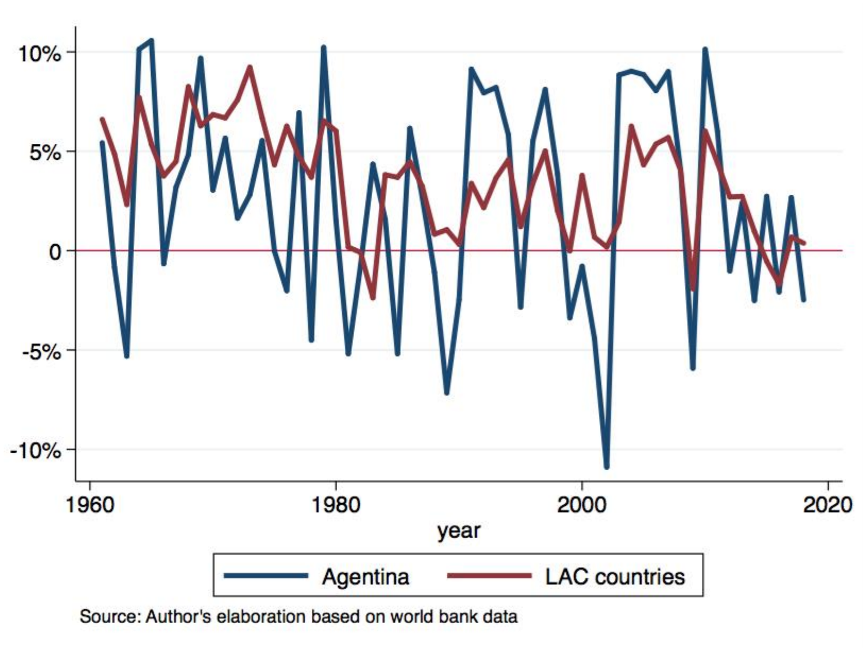
[4] Argentina is the 8th largest country in the world (2 780 400 km^2) with a population of 44 494 502 in 2018. For more details see INDEC's *Población estimada al 1 de julio de cada año calendario por sexo. Años 2010-2040*

[5] The World Bank in its World Bank Analytical Classifications has considered Argentina as an Upper Middle Income (UMI) since 1991. In 2014, this country was even considered as High Income but decreased to UMI the year after. For more explanation about these categories or the evolution of a country's situation please see the following links: World bank Country Classification and historical classification by income (XLS format)

[6] Source: Author's elaboration based on World Bank Data (indicator code: NY.GDP.MKTP.CD - *GDP (current US$)*)

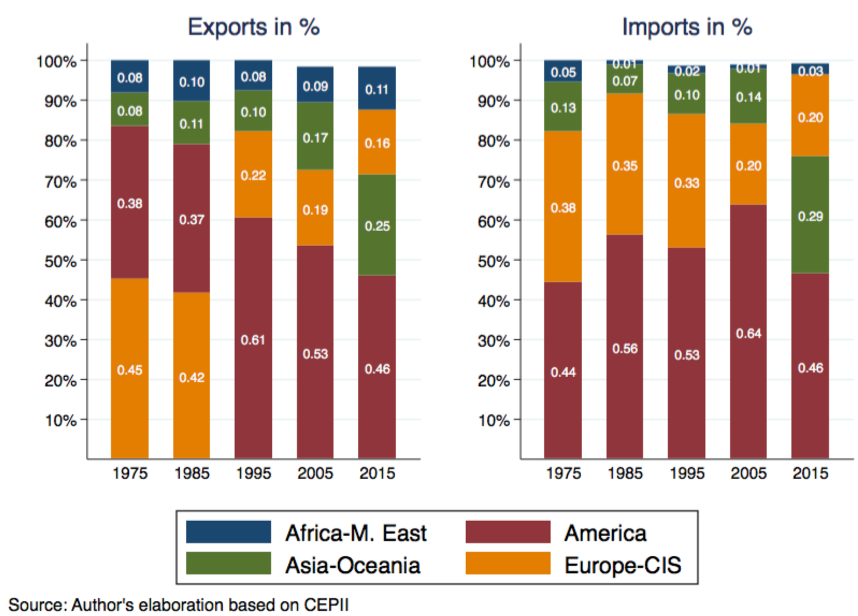
[7] Source: Author's elaboration based on World Bank Data (indicator code: NY.GDP.MKTP.KD.ZG - *GDP growth (annual %)*). The standard deviation (s.d.) for these three figures is somehow similar: 4.86 for Argentina, 5.01 for LAC and 5.15 for UMI

Figure 1 - GDP Growth - 1980 2018



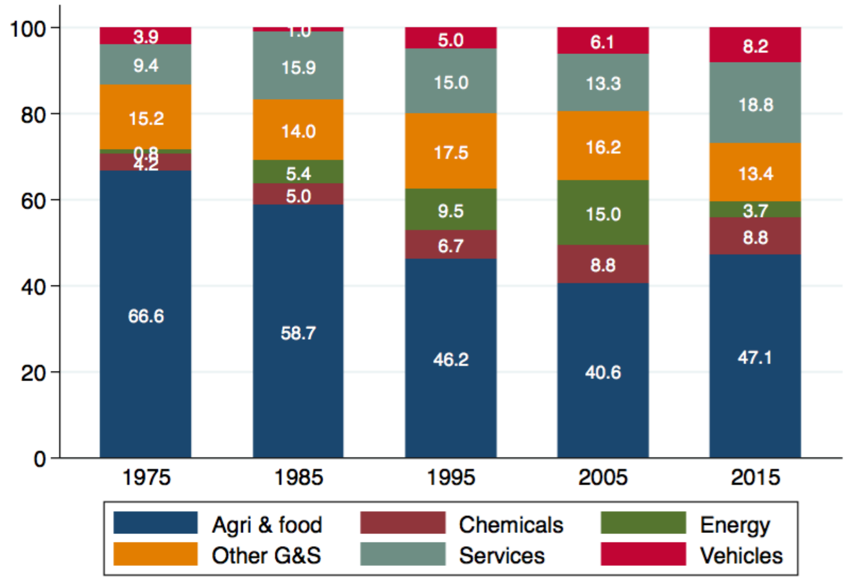
The Argentinian economy is traditionally oriented towards Europe. Despite its attempt to strengthen its position within its own region, we note that the importance of Asia is growing (Figure 2). This is true for exports as well as imports. It should be noted that the reorientation of exports towards the emerging players, India and China, is mainly based on agri-food products. In 2017, 82.94% of exports to China were agri-food based and 95.44% to India.

Figure 2 - Argentina's Trade Partners



Agriculture is still an important component of Argentina's economy. Argentina's agriculture share of the GDP decreased slightly from 9.64% in 1970 to 6.1% in 2018, with an average of 7.32% for the period[8]. This slight decrease marks a big difference with the other groups UMI and LAC groups. Agriculture's share of GDP decreased drastically in the UMI group: from more than 25% in 1960 to less than 6% in 2018. The LAC group shows a similar pattern: the share dropped from more than 20% in 1960 to less than 5% in 2018. Compared to these groups, Argentina's agriculture share of the GDP remained relatively stable.

Figure 3 - Argentina's Exports by Trade Sector



Source: Author's elaboration based on CEPII

Figure 3 displays the composition of Argentina's exports. We observe a clear decline of agri-food exports over the forty years (1975-2015) period. The agri-food exports are composed of agricultural products (primary products) and processed food (agro-manufactured products). This trend is mainly due to a decrease in the exports of agricultural products. The products of the food industry experienced a significant increase in the 1980s and have remained stable since then. Consequently, the trend in the share of exports of other manufactured products almost mirrors the trend in agriculture (Brambilla et al., 2018). We do, however, see a minor exemption to this mirror rule. From 1980 to the mid-2010s Argentina had a surplus oil production. This surplus allowed the country to export energy, explaining the tendency in green on the graph. The energy sector in Argentina is dominated by fossil fuels, particularly natural gas and oil. National oil production has long covered the country's needs. Since the end of the oil exports we observe a deficit due to the increase in national consumption and a decrease in production (*BP Statistical Review of World Energy*, 2019).

Entering into the details of food exports, we consider the food export share relative to total merchandise exports. This ratio is quite high in Argentina. In 1962, 71.52% of merchandise exports were food exports. For the LAC countries this rate was slightly below 50%. For this same category, the rate faced an important drop, falling to a little more than 24% in 2018. At the same time, Argentina decreased to a little more than 56% (which is still a high figure)[9]. This sector, historically important and export-oriented, is still today a major contributor to exports. However, it evolved deeply over the years.

[8] Source: Author's elaboration based on World Bank Data (indicator: NV.AGR.TOTL.ZS - *Agriculture, forestry, and fishing, value added (% of GDP)*).

[9] Source: Author's elaboration based on World Bank Data (indicator: TX.VAL.FOOD.ZS.UN - *Food exports (% of merchandise exports)*).

Long based on meat and wheat exported to Europe, these exports are now increasingly directed to China and consist mainly of soybean products and its derivatives.

1.2. Methodology

The analysis proposed in this chapter consists of two parts. First, we explore the structure of the global food value chain from a network perspective. Analysing a GVC in terms of networks provides a better understanding of the GVC as a complex web of interactions, where production is fragmented among multiple actors. Such fragmentation makes the use of conventional accounting inappropriate. As mentioned above, conventional accounting inflates world trade figures and makes it impossible to net out the real contribution of each productive phase to the determination of the final value of a product. To solve this issue, we resort to trade in value-added, where the value that is actually created is attributed to each stage of production (and therefore to each country). We compute this network using two different methodologies, using value-added data in both cases. These two different methodologies are useful because they make it possible to provide two completely different perspectives on the reality of the food industry network and the particular role of Argentina within this network. In the first network analysis we focus exclusively on the final demand. We model the relationship between countries using the foreign value added in domestic final demand and the domestic value added in foreign final demand. This approach will give us some insights about what nodes (here countries) are important. The analysis in terms of foreign value added in domestic final gives us an idea of who the biggest end-users of foreign value-added are. In the second case, the analysis in terms of domestic value added in foreign final demand provides an overview of the main food-value-added exporters. The second part of this network analysis focuses exclusively on intermediate goods. The fragmentation of the production processes and the sourcing of inputs across national borders have significantly increased trade in intermediate goods. Intermediates being a key element in understanding GVC, mapping this network helps us to understand who the producers of intermediate goods are, which are important links in the GVC. This analysis considers two cases; in a first we highlight the principle world “intermediate-consumers” by considering the import of intermediate goods. In a second, we focus on the producer side of this market by looking at the export of intermediate goods.

These networks depict the structure of the global food industry network and the position of Argentina within it. In the second part of the chapter, we explore the determinants of productivity in the Argentinian food industry. Productivity is a key factor for internationalisation and many authors maintain that only the most productive companies have access to the international market[10]. To better understand food companies’ productivity can help to understand also aspects of Argentina’s position in the food GVC.

There are many different measures of productivity (Gordon et al., 2015; Schreyer, 2001). We focus on the following: sales per employees (Sales/emp.), value added per employees (VA/emp.) and Total Factor Productivity (TFP). To estimate productivity as Sales/emp., we use the logarithm of a firm's sales divided by the regularly full-time employed workers. For VA/emp., we use the logarithm of a firm's value added divided by the regularly full-time employed workers, the value added corresponding to the sales minus the costs of labour and inputs. As in the previous chapter of this PhD thesis, we estimate TFP following Levinsohn and Petrin (2003). The complete methodology and estimates are reported in the Appendix.

We focus on the link between firm’s productivity and internationalization. Our econometric model is summarized by Equation 1:

$$\mathrm{Y_{it}} = \beta_0 + \beta_1 \mathrm{X_{it}} + \beta_2 \mathrm{Cert_{it}} + \beta_3 \mathrm{Z_{it}} + \varepsilon_{\mathrm{it}} \qquad (1)$$

[10] See for example Bernard et al. (2007), or Melitz (2003)

Where Y_{it} is the productivity measure (as mentioned above we use three different measures: Sales/emp., VA/emp. or TFP) of firm i in year t[11]. $X_{it}$is the firm internationalisation mode (importer, exporter or two-way trader). We know that certification is important for GVC membership, and even more important for the food industry: we include information on certification adding a dummy variable to the estimates $Cert_{it}$. This dummy takes value 1 if a firm is internationally certified. The term Z_{it} includes all the firm level-control measures, such as *FDI* which takes the value 1 if the firm is foreign owned at, at least, 10%; *capital intensity*, which corresponds to the logarithm of the total capital divided by the number of workers, *employment level*, and *age* of the firm etc. Results are estimated from a pooled standard ordinary least squares regression.

To check for the robustness of our main results we test the inclusion of lagged values in order to eliminate possible simultaneity. The baseline equation in this case is:

$$\mathrm{Y_{it}} = \beta_0 + \beta_1 \mathrm{X_{it}} + \beta_2 \mathrm{Cert_{it}} + \beta_3 \mathrm{Z_{it_{-1}}} + \varepsilon_{\mathrm{it}} \qquad (2)$$

Firms however could be heterogeneous in terms of productivity (linked to different modes of internationalization, as suggested by the recent literature reviewed in chapter 1). We therefore execute some Welch tests to understand is the productivity difference between different groups of firms is significant. We control for firms participating into GVC and firms not participating, certified versus non-certified firms. We also explore possible differences between food industry and the other industries. Since these differences are significant, we consider the following situation where firms are grouped into 4 different categories according to a “treatment status”[12]. The “treatments” we consider are having an international certification, and participating into a GVC. Certified traders are more productive than other, both ex ante and ex post. Not considering the trading status of firms a priori, allows us to eliminate the possible endogeneity due to this status. We identify four categories of firms:

- Control - not treated at both time t and t + 1
- Treated - not treated at time t and treated at t + 1
- Always treated - treated at both time t and t + 1
- Quitters - treated at time t and not treated at t + 1

We will see for all these groups the trends of both, the mean and the median TFP.

1.3. Data and descriptive statistics

The data used for the empirical part of this chapter come from different sources. For the exploration of the specificities of the Argentinian position in the Food GVC, we use the **Trade in Value Added (TiVA)** Database from the OECD. It provides indicators for 63 OECD and non-OECD economies[13]. Data are available by industrial sector divided following the OECD ANBERD code (ISIC Rev. 3) rules. In its most recent published 2016 edition, indicators are available for all years from 1995 to 2011. In particular, we focus on four indicators. The first two, used for the analysis in terms of final demand, are “domestic final demand foreign value added” (*DFD_FVA) and* “foreign final demand domestic value added”

[11] Note that only Argentine food industry firms are considered here

[12] Here the “treatment” is to be understood as a change of characteristic. enterprises with a changed characteristic (which therefore receive the “treatment”) are compared with enterprises with unchanged characteristics over a period. Depending on the case, the characteristic is either present during the whole period (“always treated”) or absent during the period (“never treated - control group”).

[13] For more details see Table 7 in the Appendix page 24.

(*FFD_DVA*). The first one (*DFD_FVA)* represents the foreign value added (FVA) embodied in domestic final demand (DFD) in millions of USD. The second (*FFD_DVA)* corresponds to the domestic value added (DVA) embodied in foreign final demand (FFD), also expressed in millions of USD. In both cases we know the origin country (source) and the destination ones (target). We also know the trade value (in value added) which can be divided by industrial sector. These datasets have about 5.700.000 observations for each file. The two last indicators used are "gross import of intermediates" (*IMGR_INT*) and "gross export of intermediates" (*EXGR_INT*). The first one represents gross (GR) import (IM) of intermediate (INT) goods and services while the second one is the gross export (EX) of intermediate goods and services. They allow an analysis in terms of intermediate goods. Such an analysis singles out the intermediate manufacturers along the value chain. These interactions are more complicated or even impossible to identify with traditional types of analysis, using traditional import and export data. Since this network analysis focuses exclusively on food industry, we isolate precisely this very sector. The food industry corresponds to the code: **C15T16**: *Food Products, Beverages And Tobacco* according to the OECD ANBERD code (ISIC Rev. 3) nomenclature.

To analyse the determinants of productivity in the Argentinian food industry we use data from the **World Bank Enterprise Survey (WB-ES).** This database provides a representative sample of the Argentinian private sector, with a high level of disaggregation. The survey rounds we use can be aggregated to form a panel, covering the years 2006 and 2010. The survey provides considerable information about a firm's characteristics and their business environment, such as their size, ownership, trading status and performances but also the access to financing, the presence of corruption etc. *Table 1* shows some summary statistics of the food companies present in the panel (100 from a panel of 498 firms). We report more detailed statistics of our Argentine panel, for both the food industry and the non-food industry sector, in the Appendix (Table 9).

Table 1- Food Industry Summary Statistics (2010)

	Obs	Mean	Std.Dev.
Trading variables			
Exporter	100	0.15	0.36
Importer	100	0.11	0.31
Twoway trader	100	0.21	0.41
GVC	100	0.34	0.48
FDI	100	0.03	0.17
Structure variables			
Age firm	100	40.67	29.95
Employment (ln)	100	4.12	1.95
Skilled workers (%)	98	0.56	0.35
Capital intensity (ln)	74	10.87	1.42
Intermediate variables			
Sales (ln)	90	16.67	2.56
Capital (ln)	78	15.08	2.76
Inputs cost (ln)	88	15.62	2.60

Source: Author's elaboration based on WB-ES

The table displays some descriptive statistics for the food industry firms. We note that if the number of observations is not equal to 100, it means that some information is not available. For instance, we can notice that only 2% of firms did not report their share of skilled workers. When we compute variables such as Capital intensity, Sales/emp, VA/emp, TFP) for which the use of some intermediate variables

(Sales, Inputs cost, or Capital) is needed, there are more missing entries so that the number of observations is lower.

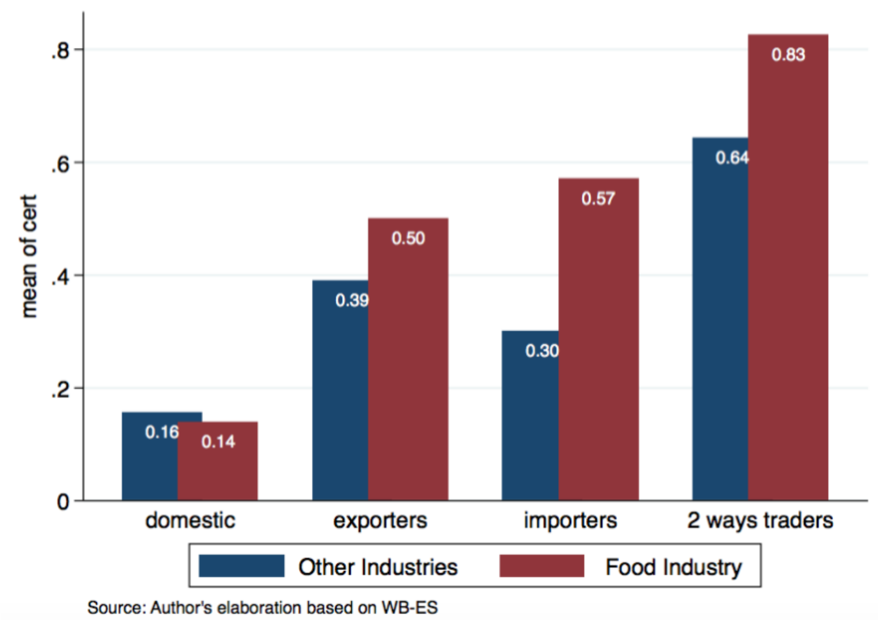
We distinguish between firms which are involved in international trade, the **traders**, and **domestic** firms which are not engaged in import or export activities. We distinguish four different groups. We first define firms engaged in export activities as **exporters.** Similarly, the **importers** are firms engaged in import activities. The **two-way** traders category encompasses firms engaged in both import and export activities. We can rank the modes of internationalization in order of complication, from the simplest to the most complicated. The simplest mode of internationalisation is importing. This mode only requires knowledge of a firm's national custom services. We can expect a company to be familiar with its own national legislation. Then comes exporting. It requires knowledges about the destination country, and it may be, from an administrative, and cultural, point of view, more complicated. Two-ways traders come next because they need to manage the difficulties linked to these two activities simultaneously. Finally, in line with Taglioni and Winkler (2016) we proxy GVC participation as traders, indifferently importers, exporters or two-ways traders, which possess an international certification. The **GVC** group is then composed of certified firms engaged in international trade.

52.5% of food industry firms in the panel data are domestic. The percentage of domestic firms is above 56% for the other industries. Considering the structure of the Argentinian economy and its propensity to export food-type goods, the fact that there are somewhat fewer purely domestic companies in the food sector comes as no surprise.

As expected, import is the most frequent trading activity considering the non-food industry (16.08%). Interestingly, for this industry, the share of two-way traders (14.95%), is slightly higher than that of the exporters (12.69%).

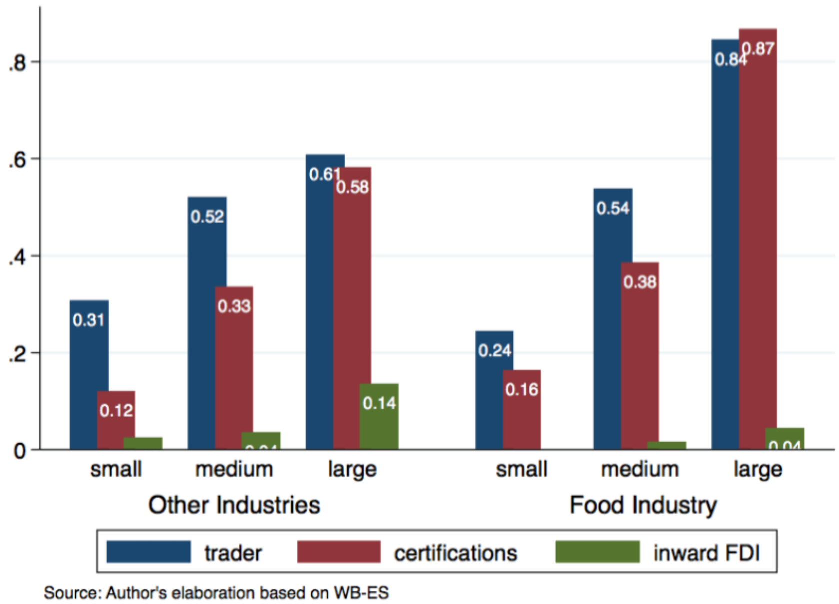
The situation is different if we consider only the food industry firms. Pure importers represent 10.50% while the exporters reach 14%. Surprisingly, the food industry has a 23% two-way traders rate. It is far above the two other figures. It is also, eight points above the equivalent rate of the non-food industry, suggesting that food firms are more likely participate in global value chains.

Figure 4 - Share of Certificated Firms



We have seen that compliance with standards is of crucial importance to participate in Global Value Chains and, more broadly, for participation in world trade. We also know that this importance is even more pronounced when it comes to food industry companies. Certification is a procedure by which an external entity provides assurance that a product, process or service conforms to certain standards. *Figure 4* compares firms of our dataset and considers their mode of internationalisation and presence of certification. If we consider only trading industries, food industries are, on average, "more certified" than the other industries. We can also notice that 84% of the two-way traders in the food industry are certified. This is a very high ratio, but perfectly consistent with our expectations to see food industry companies as more certified. If we compare the firms by size, as illustrated in *Figure 5*, we can observe that levels of internationalisation and certification grow more quickly for food than for other industries.

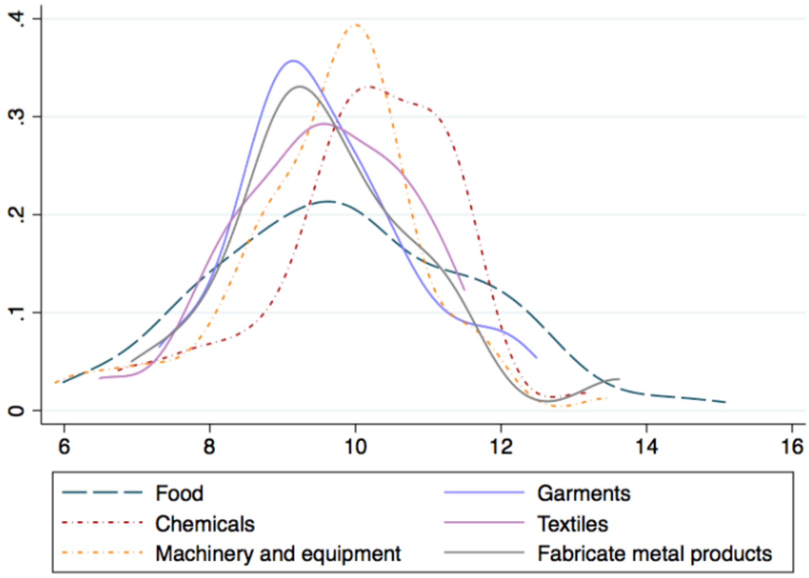
Figure 5 - Share of Traders, Certified, & Foreign Owned firms by Size



We compute firm's Total Factor Productivity (TFP)[14] of firms and represent, in *Figure 6*, a TFP plot of the density for some selected Argentine industry sectors. We point out that Machinery and equipment and Chemicals are the most productive sectors while Garments and Textiles are least productive. This is totally consistent with our expectations and the literature (see: Alam et al. 2008, Ch.2). We also notice that these curves are relatively centred around their means. This concentration around the mean implies a low dispersion coefficient (low standard deviation). This low dispersion coefficient indicates in this case that the intra industry productivity of firms is not very dispersed, not very spread. In other words, we observe a kind of homogeneity in terms of firms productivity belonging to these industries. Food industry firms's productivity is peculiar: we observe a bimodality. Looking at the Food Industry curve (the green dashed-line in *Figure 6*), we see that TFP of this sector is flatter than the others. This shape, together with a second peak to the right of the first, suggests that this sector has part of its industry with a low/medium productivity (first mode) and the other part more productive (the second mode).

Figure 6 - TFP Density by Industry Sector

[14] For more details please see Methodology page 10 and in the appendix TFP estimations page 21 and following.



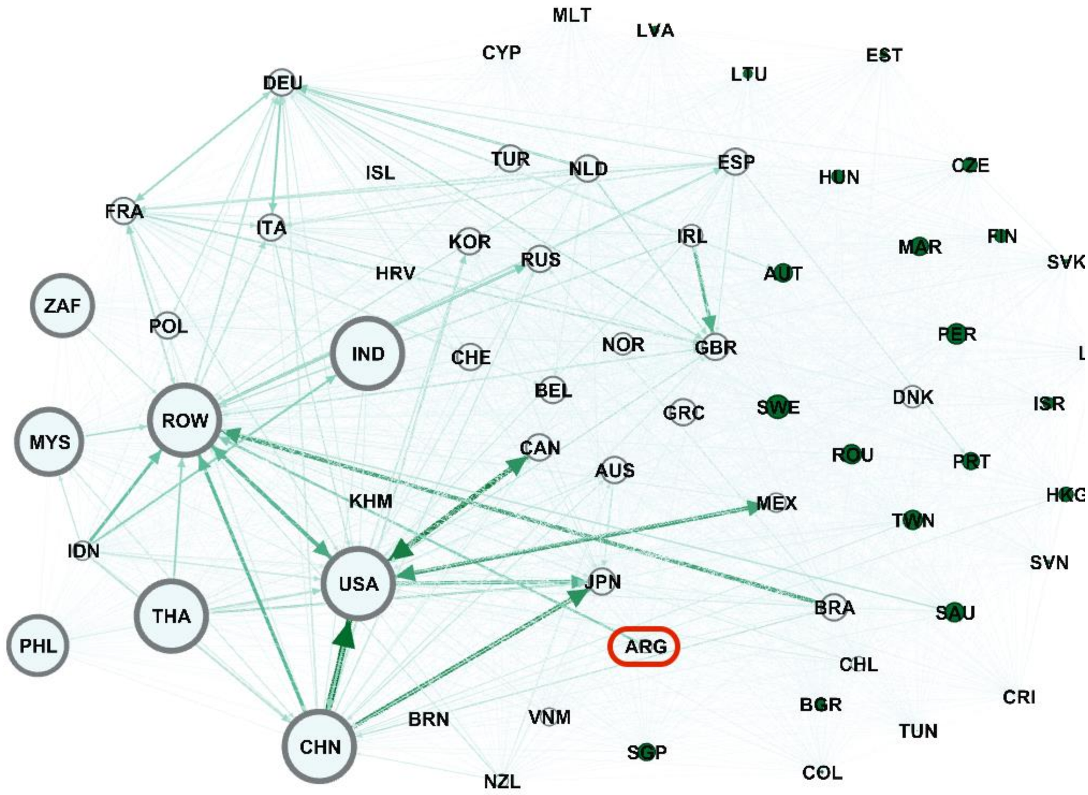
2. The global network of the food industry

Argentina's geography and history have given shape to a clearly export-oriented food economy. We want to explore how Argentina's food industry is integrated into the global food network, computed as described in the methodology section. To describe the global food industry network, and focus on the specific position of Argentina within this network, we first isolate "food" from other industrial sectors in our database[15]. We focus on the domestic value added embodied in foreign final demand and display this network on *Figure 7*. This analysis points out the most important producers of added value consumed abroad. Node size represents the country's importance in terms of betweenness centrality. This measure considers how often a node appears on the shortest paths between any other ordered couple of nodes in the network. Node colour intensity indicates the eccentricity degree of a country that is, the distance from a given starting node to the node farthest from it in the network. Edge thickness and colour intensity are proportional to the between countries relation's weight.

When analysing the world trade network in terms of domestic value added embodied in foreign final demand, we clearly see that the main hubs for the food industry are China (CHN), India (IND), and the United States of America (USA). As these countries are the most populous in the world, this role is hardly surprising. Argentina (circled red in the graph) is, together with Brazil, the most important player among the LAC countries.

[15] It is worth noting that in this section food industry includes industries corresponding to the following code: C15T16: *Food Products, Beverages And Tobacco* of the OECD ANBERD code (ISIC Rev. 3) nomenclature.

Figure 7 - World Food Industry Domestic VA in FFD (2011)



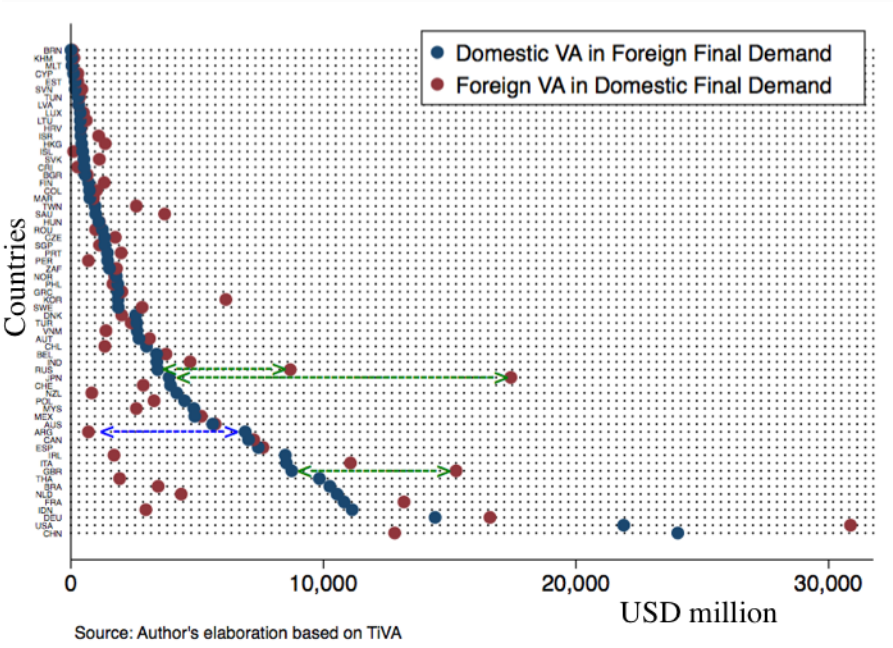
Source: Authors' elaboration based on TiVa Dataset

Node Size represents country's importance in terms of betweenness centrality.
Node colour intensity indicates the eccentricity degree
Edges thickness and colour intensity are proportional to the between countries relation's weight

The parallel of this analysis is the global food network considering the foreign VA in domestic final demand (which we report in the Appendix, Figure 16). This analysis identifies, at the global level, the countries that consume the most foreign value added. we know that Argentina imports almost no food. We do not expect then, that Argentina should appear as one of the most important players in such graph, and indeed, it does not. Also, Figure 16, in the appendix, underlines the central role of China, United States of America in the network. Once again, it is not illogic to realise that they "capture most of the traffic".

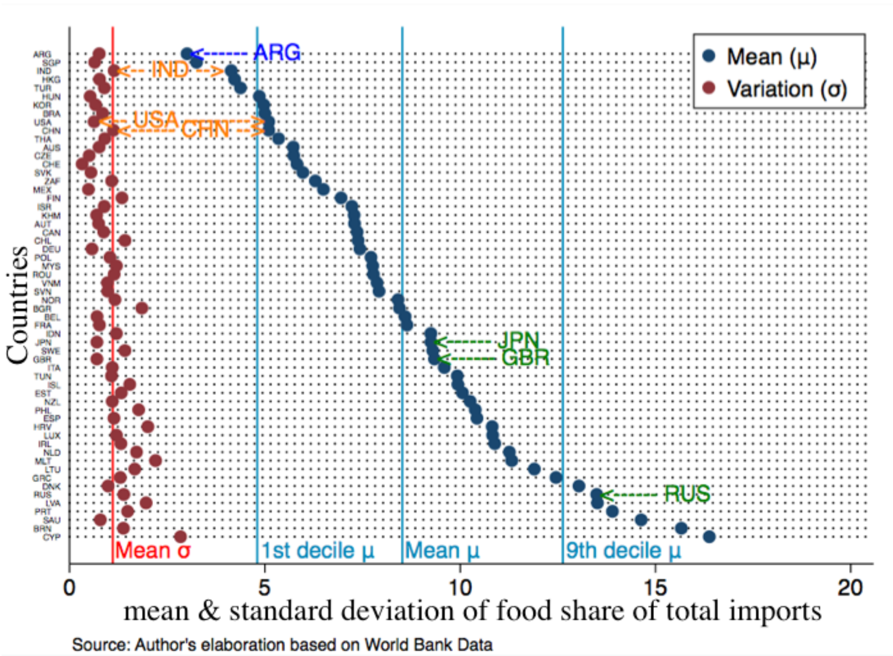
Let's consider now, at the same time and for the same year 2011, the domestic value added in foreign final demand and the foreign value added in domestic final demand. Knowing that Argentina is an important exporter of food related goods, we ranked the data according to the domestic value added in final foreign demand, this indicator underlying more the "export side". This situation is illustrated on Figure 8. On this figure, the red dots represent the foreign value added in the domestic final demand, while the blue dots represent the domestic value added in the foreign final demand. We observe that, in some cases, the red dot on the left of the blue one. It means that for these countries the foreign value added in their own domestic consumption is less important than the value added produced in their country and consumed abroad. It represents, in a sense, a positive gap. It is the case of Argentina which exports more added value than it imports.

Figure 8 - Food Industry Trade in VA (2011)



Let's now consider the food share of total imports. We plot in *Figure 9* the average country import over export ratio for the 2006-2016 period and its dispersion coefficient. Argentina is the country for which the share of food import is the lowest, since it represents only 3% of the total imports. This situation is also relatively structural since its coefficient of dispersion for the period is relatively low (0.76) compared to the country selection average (1.11).

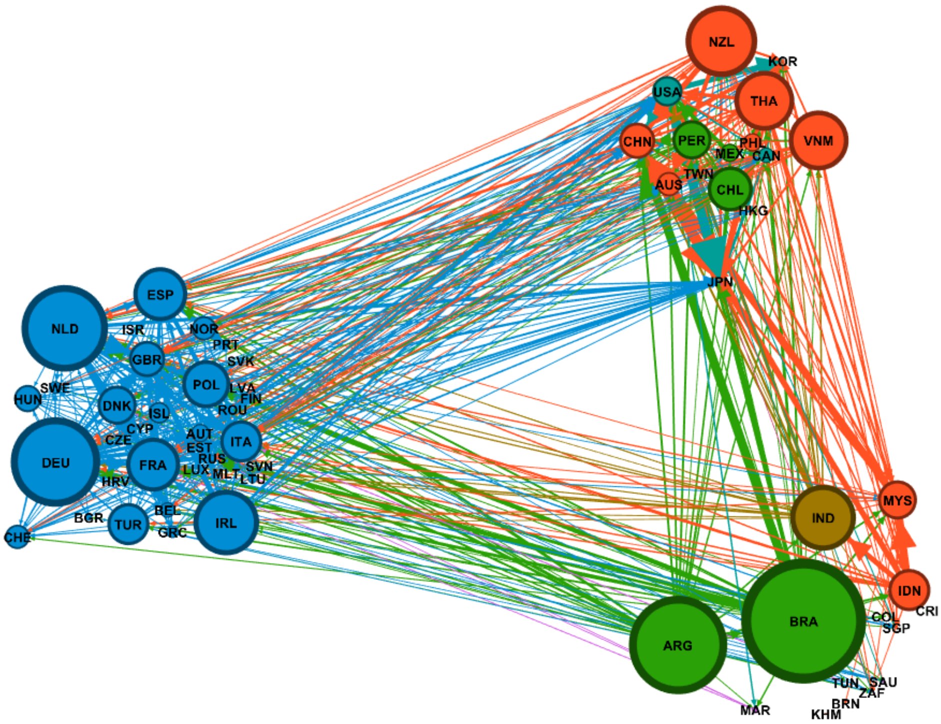
Figure 9 - Food share of total imports – mean & standard deviation (2006-2016)



This computation is based on Word Bank data indicator code: TM.VAL.FOOD.ZS.UN - *Food imports (% of merchandise imports)*
for reasons of consistency, we only selected countries available in the TiVA dataset. We regret the absence of Tawain (TWN), unavailable for this World Bank indicator

So far, this analysis has focused exclusively on final demand (both domestic or foreign). This analysis helps to give a clear visual idea of the centrality of certain countries and the importance of their interactions. We have seen that although Argentina is not a central hub in this network, it is nevertheless present. In order to better understand the global food industry, we need to consider intermediate goods which are absolutely fundamental for global value chains. *Figure 10* displays the network of the world food industry intermediate goods producers. In order to have a clearer view of the situation, we emphasised the edges according to their out-going degree and the nodes are function of the edges. In other words, the node size is proportional to the country's net-exports of intermediate goods. We clearly see here that Brazil and Argentina are very important players for intermediates. We can also note that both have a special connection with China, particularly clear in the case of Brazil (the link is much thicker).

Figure 10 - World Food Industry Intermediates Producers (2011)



Source: Authors' elaboration based on TiVa Dataset

Edges were emphasised according to their out-going degree
The nodes are function of the edges and are coloured according to the macro-region the country belongs to. LA is in green

Argentina is an important exporter of intermediate goods. The three main destinations are countries in the Asia-Pacific Economic Cooperation Area (APEC)[16], Europe (ZEUR)[17], and other regions (ZOTH)[18]. We saw above that Europe was a historical destination for Argentinean exports. It is therefore logical that a

[16] APEC is composed of the following countries: AUS, CAN, CHL, JPN, KOR, MEX, NZL, USA, BRN, CHN, HKG, IDN, MYS, PHL, RUS, SGP, THA, TWN, VNM. For more details, please see Table 7 and Table 8.

[17] ZEUR is composed of the following countries: AUT, BEL, CZE, DNK, EST, FIN, FRA, DEU, GRC, HUN, ISL, IRL, ITA, LUX, NLD, NOR, POL, PRT, SVK, SVN, ESP, SWE, CHE, GBR, BGR, CYP, HRV, LTU, LVA, MLT, ROU, RUS. For more details, please see Table 7 and Table 8.

[18] ZOTH is composed of the following countries: AUS, ISR, NZL, TUR, IND, SAU, TUN, ZAF, ROW. Please note the presence of "rest of the world" (ROW) which is already an aggregated value. For more details, please see Table 7 and Table 8.

large part of the added value of Argentinean exports goes to this region. Similar reasoning applies to APEC. Not only this region includes many countries, but also some of the world's largest economy (e.g. USA or China) as well as some countries geographically close (e.g. AUS, NZL). In 2011 Argentina's food export represented 36.16% of total exports[19]. Food products were exported mostly to South America (28.88%), Europe (28.75%), Asia (23.30%). Figure 7 and Figure 16 show that Argentina shares an important edges with ROW. ROW is a component included into the ZOTH group. The importance of the exchange with ZOTH is then driven by the presence of ROW into this category.

Figure 11 - Argentina Food Industry VA Destination (2011)

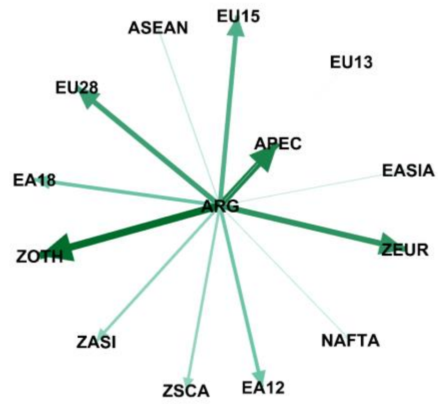
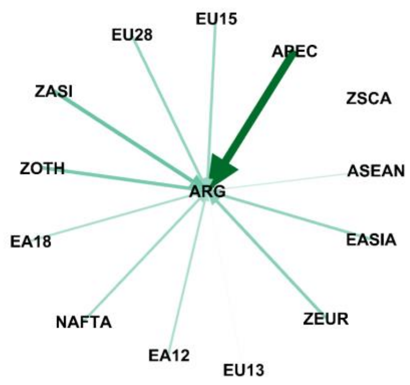


Figure 12 - Source food industry VA in Argentina's final demand (2011)



In *Figure 11*, for the sake of precision Europe is represented by different sub-categories, six in total. They are, going from the largest to the more restrictive: ZEUR, EU28, EA18, EU15, EU13, and EA12[20]. Where ZEUR is Europe, EU28 is the European Union (28 countries[21]). EA18 is the Euro Area (18 countries). EU15 is the European Union with its historical 15 countries. EU13 is EU28 excluding EU15. Finally, EA12 is the historical Euro Area considering the 11 founding member (1999) and Greece (2001). Argentina's trade with ZEUR and EU28 are relatively equivalent, but once EU28 divided into EU15 and EU13 we see that most of the trade is with EU15 and nearly none with EU13. The very same conclusion can be done comparing EA18 and EA12 meaning that the six country of difference between the two groups do not influence the trade with Argentina. Hence, we can say that Argentina's trade in value added with Europe is, not surprisingly, mainly carried out with Western Europe. Finally, we note the importance of APEC. This presence is interesting. It is an important destination of Argentina's food industry value added but it is also the main source of foreign value added in imported food products consumed in Argentina, as illustrated on *Figure 12*. Of course, this category is very wide and contains important actors of food industry sector such as China, United States of America, Indonesia Malaysia and Japan to mention but a few. Countries which compose it should be analysed singularly since they are all main actors of the industry. This analysis is however outside the scope of this chapter. Let us now look at productivity of the food sector. To do this, as explained above, we pass from the macro analysis and data used to compute the networks to micro data (WBES) and firm level analysis.

[19] Source : HAEC dataset. Total exports are understood without the services.

[20] For the precise list of countries composing these categories please see Table 7 and Table 8.

[21] All analysis was carried out before the Brexit which took place officially on the 1st of February 2020

3. Argentina's food industry productivity and GVC

3.1. Internationalisation and productivity

Let us estimate the model described in Equation 1. Table 2 reports the results and suggests that there is a positive and significant relationship between internationalisation and individual firm's productivity. This is coherent with the literature maintain that only the most productive firms are able to cover the sunk cost of internationalisation (Antràs and Helpman, 2004).

Table 2 - Internationalisation and TFP (Pooled)

	Dependent variable:		
	Total Factor Productivity (log)		
	(1)	(2)	(3)
Exporters	2.042***	2.025***	1.849***
	(0.396)	(0.409)	(0.406)
Importers	1.549***	1.532***	1.390***
	(0.431)	(0.444)	(0.470)
Two-way traders	2.474***	2.456***	1.721***
	(0.362)	(0.378)	(0.405)
Age	0.017***	0.017***	
	(0.005)	(0.005)	
Certification	0.025	0.018	
	(0.337)	(0.341)	
Capital intensity		0.015	
		(0.084)	
Employment (ln)			0.283***
			(0.083)
Human Capital			0.623*
			(0.371)
Constant	7.541***	7.423***	6.802***
	(0.216)	(0.692)	(0.375)
Observations	85	85	87
R^2	0.616	0.616	0.594
Adjusted R^2	0.592	0.587	0.569
F Statistic	25.335***	20.859***	23.674***
	(df = 5; 79)	(df = 6; 78)	(df = 5; 81)
Note:	** p<0.1, ** p<0.05, *** p<0.01*		

Comparing Columns (1) and (2), we notice that the coefficient for two-way traders is higher than that of both importers and exporters. This finding seems to indicate that being two-way trader has a higher positive impact on productivity than being "only" exporter or importer. This result is in line with Bekes and Altomonte (2009) (who studied the specific cases of Belgium and Italy), and with Wagner (2011) who regrouped the results different empirical studies. We also observe that firm's age is positively and significantly correlated to productivity. This result was highly expected since thanks to its experience firms acquire know-how, good practices and *savoir faire* which increase productivity.

In Column (3) we extend our baseline equation by adding two new control variables: employment and skilled workers. Employment level and quality are likely to be function of age and experience of an enterprise, so, in order to avoid multicollinearity, we exclude the age of the firm. In our equation, employment level is positively and significant, which is coherent with the literature. Human capital is significant at a 0.1 significance level.

Table 2 suggests that certification is not correlated with the productivity. We discussed previously the importance that can have quality certifications, especially for food industry. Finding that certification is not significantly correlated to productivity could be justified on the ground that certification is a guarantee of compliance with a number of standards requested for an industry, so it may not be directly related to productivity.

Capital intensity, variable is included in our second regression, is not significant on this model. However, when we replicate these regressions, as robustness, using the two other measures of productivity (Sales/emp. and VA/emp.), we observe that capital intensity is significantly correlated with the productivity measures. These robustness regressions give similar results but are not reported here for reasons of space (see Table 10 in the appendix). We replicate the analysis in Table 2 considering the variable for "GVC membership" instead of the separate internationalisation mode of the firms (imp, Exp, two ways). The results are reported in Table 11 in the appendix. GVC participation is always positively associated with the performance of firms. This result is also robust to different productivity measures.

Table 3 - Internationalisation and TFP (lag)

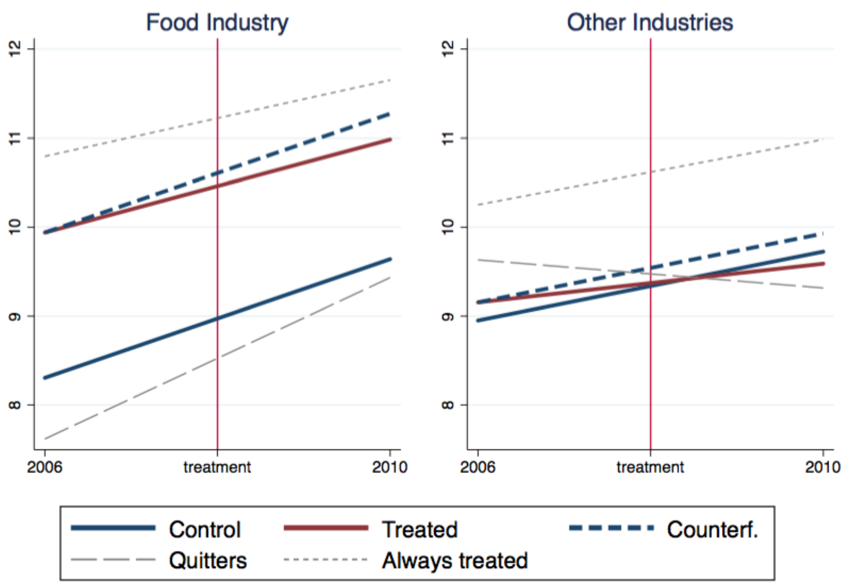
	Dependent variable:		
	Total Factor Productivity (log)		
	(1)	(2)	(3)
Exporter	1.939***	1.545***	1.545***
	(0.427)	(0.439)	(0.441)
Importer	1.408***	1.013**	0.993**
	(0.465)	(0.471)	(0.478)
Two-way trader	1.753***	1.271***	1.241***
	(0.396)	(0.417)	(0.430)
Employment lag (log)	0.255***		0.035
	(0.077)		(0.109)
Sales lag (log)		0.282***	0.262***
		(0.063)	(0.089)
Constant	7.336***	4.470***	4.626***
	(0.283)	(0.825)	(0.961)
Observations	87	77	77
R^2	0.584	0.612	0.613
Adjusted R^2	0.564	0.591	0.585
F Statistic	28.799***	28.414***	22.469***
	(df = 4; 82)	(df = 4; 72)	(df = 5; 71)
Note:	** p<0.1, ** p<0.05, *** p<0.01*		

We test the inclusion of lagged values of our control variables in order to eliminate some possible simultaneity. The results are in Table 3. To avoid a significant loss of observations, we use the lagged-variables as reported in the questionnaire. During the interview, companies were asked what the value of their sales and employment was three years ago. This value is a lagged variable, but not by construction. We control for the lagged values of employment and sales. The main results hold. The involvement into international trade is associated to a significant and better performance of firms.

3.2. GVC participation and productivity

Let us see results if firms are grouped into 4 different categories, according to a "treatment". Let us call these categories: Control[22], Treated[23], Always treated[24] and the Quitters[25]. There is no reason to think that being certified impact directly the productivity level of a firms. Productivity does not magically grow after certification. Though we know that certification was not significant in the TFP regression. Certification and productivity are, however, two important features of GVC participation. Let's then consider the following treatment: being internationally certified. Not considering the trading status of firms a priori, allows to eliminate the possible endogeneity do to this status.

Figure 13 - Mean TFP Evolution certification



Source: Author's elaboration based on WB-ES

Figure 13 displays the results of such analysis. The output observed is the evolution of TFP's mean, and the results were divided into food industry in the left panel, and the other industries are displayed in the right panel to allow for some comparison. Results for the other industries are really coherent with our expectations. First, the always treated group is more productive than the other ones and its productivity continues to grow. Second, the quitters, were more productive than the treated in 2006 and became less productive in 2010, which is logical. Third, the control group has a regular, slow growth. Finally, the treated group grows, but less quickly than the control group. This is coherent since higher the productivity, less important is the growing rate. However, the treated group was expected to (at least) perform as the control group (see counterfactual on graph). Instead it performs less than predicted, up to reach a level slightly below the control group. The reason could be related to 2008 crisis. The two survey waves of our panel were done in 2006 and 2010. 2008 global crisis touched before all firms that are internationally oriented, most of these firms were also internationally certified.

Looking at the food industry sector, we observe that, first, the always treated group is always more productive than the other groups and its productivity continue to grow, similarly, but more than our previous panel. Second, the control group reached a level comparable to the other industries while it

[22] not treated at both time t and t + 1

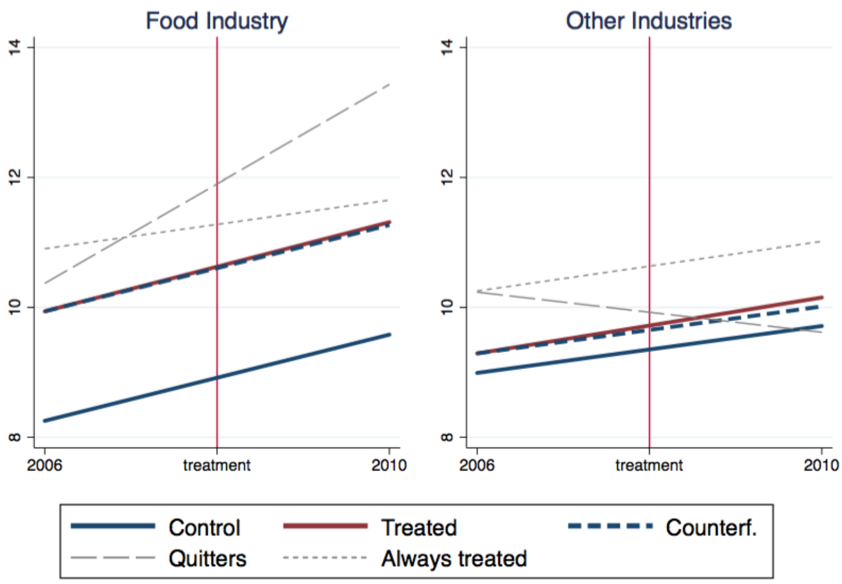
[23] not treated at time t and treated at t + 1

[24] treated at both time t and t + 1

[25] treated at time t and not treated at t + 1

started from far below. Third, the treated group performed better than the control one, but less than the expected counterfactual. It remains nonetheless at a very high level especially if we compare to the other industries where it decreased importantly. Finally, the "quitters" seem to perform much better than expected, even though they remain below the normal productivity standard level. This strange trend could be explained by two main factors. First they started from very low level, and therefore the possibility to grow is high. Second, the abandonment of international certification while they were, at the very beginning at this low level of productivity make sense. How could they compete on international market? Re-centring their activity on domestic market seemed then common sense. In addition, it probably protected them (at least a little) from the international crisis, allowing an important development of productivity. While looking at all trends, it seems that Argentinian food industry is more sheltered from the international economic crisis of 2008, relatively to other sectors. Indeed, none of these group knew a productivity decrease over the period[26].

Figure 14 - Mean TFP evolution GVC



Source: Author's elaboration based on WB-ES

It is interesting to consider also the internationalization status. Let us consider the case of GVC membership[27], reported in Figure 14. The results are coherent with the previous ones. With regard to the other sectors of Argentina, we observe the expected hierarchical order in terms of productive performance. Indeed, the group "always treated" (GVC members for the whole period) is more productive than the treated ("firms that joined GVC in the second period, i.e. new members"), which in turn performs better than both the counterfactual and the control group. the quitters had a similar performance to the GVC group in 2006 and are in 2010 at the level of the control group which makes sense. As far as food companies are concerned, we find the same logical hierarchical order as with companies in other sectors. Productivity of the GVC members is higher than the new member which performed following the counterfactual over the period. Both these groups are more productive than the control group as expected.

To conclude we run some significance Welch test on the mean TFP of some groups. The TFP difference between GVC member and non-members is significant. The TFP difference between certified a non-

[26] Figure 19 in the appendix, considers the median TFP as output, instead of the mean. This analysis gives very similar results which confers some robustness to our analysis.

[27] We recall that a GVC member is defined as an international trader certified

certified is significant. Finally, the TFP difference between food industry and the other industries is statistically significant.

References

Africa's Food Markets Could Create One Trillion Dollar Opportunity by 2030. World Bank. URL http://www.worldbank.org/en/news/press-release/2013/03/04/africas-food-markets-could-create-one-trillion-dollar-opportunity-2030 (accessed 7.10.18).

Agostino, M., Giunta, A., Nugent, J.B., Scalera, D., Trivieri, F., 2015. The importance of being a capable supplier: Italian industrial firms in global value chains. International Small Business Journal 33, 708–730.

Alam, A., Anós Casero, P., Khan, F., Udomsaph, C., 2008. Unleashing Prosperity - Productivity Growth in Eastern Europe and the Former Soviet Union, The International Bank for Reconstruction and Development. ed. The World Bank, Washington, DC, USA.

Antràs, P., 2020. Conceptual Aspects of Global Value Chains. Policy Research Working Paper 9114 World Development Report, 36.

Antràs, P., Helpman, E., 2004. Global Sourcing. Journal of Political Economy, University of Chicago Press 112, 552–580. https://doi.org/10.1086/383099

Aw, B.Y., Chung, S., Roberts, M.J., 2000. Productivity and Turnover in the Export Market: Micro-level Evidence from the Republic of Korea and Taiwan (China). The World Bank Economic Review 14, 65–90. https://doi.org/10.1093/wber/14.1.65

Baldwin, R., Venables, A., 2010. Spiders and snakes: offshoring and agglomeration in the global economy. National Bureau Of Economic Research 25.

Bekes, G., Altomonte, C., 2009. Trade Complexity and Productivity. SSRN Journal. https://doi.org/10.2139/ssrn.1463198

Bernard, A.B., Jensen, J.B., 1999. Exceptional exporter performance: cause, effect, or both? Journal of International Economics 47, 1–25.

Bernard, A.B., Jensen, J.B., Redding, S.J., Schott, P.K., 2007. Firms in International Trade. Journal of Economic Perspectives 21, 105–130. https://doi.org/10.1257/jep.21.3.105

BP Statistical Review of World Energy (No. 68th edition), 2019. . BP.

Brambilla, I., Galiani, S., Porto, G., 2018. Argentine trade policies in the XX century: 60 years of solitude. Lat Am Econ Rev 27, 4. https://doi.org/10.1007/s40503-017-0050-9

Clerides, S., Lach, S., Tybout, J., 1998. Is Learning by Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco. The Quarterly Journal of Economics, Oxford University Press 113, 903–947.

Codron, J.-M., Giraud-Héraud, E., Soler, L.-G., 2005. Minimum quality standards, premium private labels, and European meat and fresh produce retailing. Food Policy 30, 270–283.

De La Balze, F., 1995. Remaking the Argentine economy. Council on Foreign Relations Press, New York.

Gephi, 2011. Gephi Tutorial Layouts.

Giovannetti, G., Lanati, M., European University Institute, Robert Schuman Centre for Advanced Studies, India Centre for Migration (ICM), 2015. The indirect pro-trade Effects of Indian ethnic networks. EUI, Florence.

Giuliani, E., Pietrobelli, C., Rabellotti, R., 2005. Upgrading in Global Value Chains: Lessons from Latin American Clusters. World Development 33, 549–573.

Godfray, H.C.J., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Nisbett, N., Pretty, J., Robinson, S., Toulmin, C., Whiteley, R., 2010. The future of the global food system. Philosophical Transactions of the Royal Society B: Biological Sciences 365, 2769–2777. https://doi.org/10.1098/rstb.2010.0180

Gordon, J., Zhao, S., Gretton, P., 2015. productivity-and-how-measured-pc-news-201505.pdf. Australian Government - Productivity Commission, PC News 17–19.

Johnson, R.C., Noguera, G., 2012. Accounting for intermediates: Production sharing and trade in value added. Journal of International Economics 86, 224–236.

Levinsohn, J., Petrin, A., 2003. Estimating production functions using inputs to control for unobservables. The Review of Economic Studies 70, 317–341.

Maslow, A., 1943. A Theory of Human Motivation. Psychological Review 370–396.

Melitz, 2003. The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. Econometrica 71, 1695–1725.

Nadvi, K., 2008. Global standards, global governance and the organization of global value chains. Journal of Economic Geography 8, 323–343.

OECD, World Trade Organization, 2013. Aid for Trade at a Glance 2013: Connecting to Value Chains, Aid for Trade at a Glance. OECD. https://doi.org/10.1787/aid_glance-2013-en

Ouma, S., 2010. Global standards, local realities: private agrifood governance and the restructuring of the Kenyan horticulture industry. Economic Geography 86, 197–222.

Schreyer, P., 2001. Measuring productivity: measurement of aggregate and industry-level productivity growth ; OECD manual, Statistics. OECD, Paris.

Sivadasan, S., Efstathiou, J., Calinescu, A., Huatuco, L.H., 2006. Advances on measuring the operational complexity of supplier–customer systems. European Journal of Operational Research 171, 208–226. https://doi.org/10.1016/j.ejor.2004.08.032

Solimano, A., 2001. The evolution of world income inequality: assessing the impact of globalization, Serie macroeconomía del desarrollo. Naciones Unidas, CEPAL, Economic Development Div, Santiago, Chile.

Taglioni, D., Winkler, D., 2016. Making global value chains work for development, Trade and development series. World Bank Group, Washington, DC.

United Nations Conference on Trade & Development, U., 2013. Global Value Chains and Development - Investment and value added trade in the global economy, Advance unedited version. ed. United Nation Publication.

Van Beveren, I., 2012. Total Factor Productivity Estimation: A Practical Review: Total Factor Productivity Estimation. Journal of Economic Surveys 26, 98–128. https://doi.org/10.1111/j.1467-6419.2010.00631.x

Wagner, J., 2011. Productivity and international firm activities: What do we know? Nordic Economic Policy Review Productivity and competitiveness.

Waldkirch, A., Ofosu, A., 2010. Foreign Presence, Spillovers, and Productivity: Evidence from Ghana. World Development 38, 1114–1126.

Whitworth, E., Druckman, A., Woodward, A., 2017. Food scares: a comprehensive categorisation. British Food Journal 119, 131–142. https://doi.org/10.1108/BFJ-06-2016-0263

World Bank, 2019a. World Development Report 2020: Trading for Development in the Age of Global Value Chains. The World Bank. https://doi.org/10.1596/978-1-4648-1457-0

World Bank (Ed.), 2019b. World development report 2020: trading for development in the age of global value chains. World Bank Group, Washington.

Appendix

TFP estimations

To estimate TFP we follow the methodology of Levinsohn and Petrin (2003). Let's assume a Cobb-Douglas production function which takes the following form:

$$Y_{it} = A_{it}K_{it}^{\beta_k}L_{it}^{\beta_l}M_{it}^{\beta_m} \tag{3}$$

Where Y_{it} represents the output of firm i in time t, A_{it} is the Hicksian neutral efficiency level, and K_{it}, L_{it}, M_{it}, are respectively the capital, labour and material inputs.

The variables Y_{it}, K_{it}, L_{it}, and $M_{it}$are observable and, in our case, also known... A_{it} is instead unobservable. Taking the natural logarithm of Equation 1 we obtain:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \varepsilon_{it} \tag{4}$$

Lower case referring to natural logarithms. We note that:

$$\beta_0 + \varepsilon_{it} = a_{it} = \ln(A_{it}) \tag{5}$$

Where β_0 is the mean efficiency while ε_{it} is the deviation from the mean (which is firm and time specific). This later coefficient can be divided into two components: one predictable (υ_{it}) and another one unobservable (u_{it}). Equation 2 can then be rewritten as follow:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \upsilon_{it} + u_{it} \tag{6}$$

We can then estimate firm's productivity level $\widehat{\omega}_{it} = \hat{\upsilon}_{it} + \hat{\beta}_0$ as illustrated in Equation 5:

$$\widehat{\omega}_{it} = \hat{\upsilon}_{it} + \hat{\beta}_0 = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} \tag{7}$$

The estimation method sketched above was used here in two different ways. First, we estimated the TFP considering the entire available dataset. We run a simple pooled OLS regression and $\widehat{\omega}^{pooled}$ was estimated according to the β_j estimated. The results were convincing and closely correlated with our two other productivity measures (Sales/emp. and VA/emp.) as illustrated in Table 4 - Productivity Measures Correlations column (1). To be more accurate, we estimated the TFP, a second time, considering the panel components of the dataset. In this situation we executed a panel regression and re-estimated $\widehat{\omega}^{panel}$ subsequently. The result is convincing. $\widehat{\omega}^{panel}$ is more correlated with our two other productivity measures than the previously computed $\widehat{\omega}^{pooled}$ (Table 4 - Productivity Measures Correlations column (2)).

Table 4 - Productivity Measures Correlations

	(1) $\widehat{\omega}^{pooled}$	(2) $\widehat{\omega}^{panel}$
VA per emp. (ln)	0.794***	0.810***
sales per emp. (ln)	0.716***	0.751***

Source: Author's elaboration based on WB-ES
* p<0.05, ** p<0.01, *** p<0.001

These traditional methods to estimate TFP, widely used in the literature, have a methodological drawback. For instance, as explained by Van Beveren (2012, p.98), "because productivity and input choices are likely to be correlated, OLS estimation of firm-level production functions introduces a simultaneity or endogeneity problem". Hence, we decided to follow the methodology of Levinsohn and Petrin (2003). According to the existing literature, this methodology resolves many issues related to TFP estimation. In this method, value added is used as output variable (Y_{it}) and the inputs (M_{it}) are used to control for unobservable. It is important to notice here the presence of a "simultaneity bias" due to "endogeneity of inputs"[28]. This creates an upward bias in β_l and β_m and a downward bias in β_k. As it is said "for a two-input production function where labour is the only freely variable input and capital is quasi-fixed, that the capital coefficient will be biased downward if a positive correlation exists between labour and capital"(Van Beveren, 2012 p.101).

Table 5- TFP & Productivity Measures Correlations

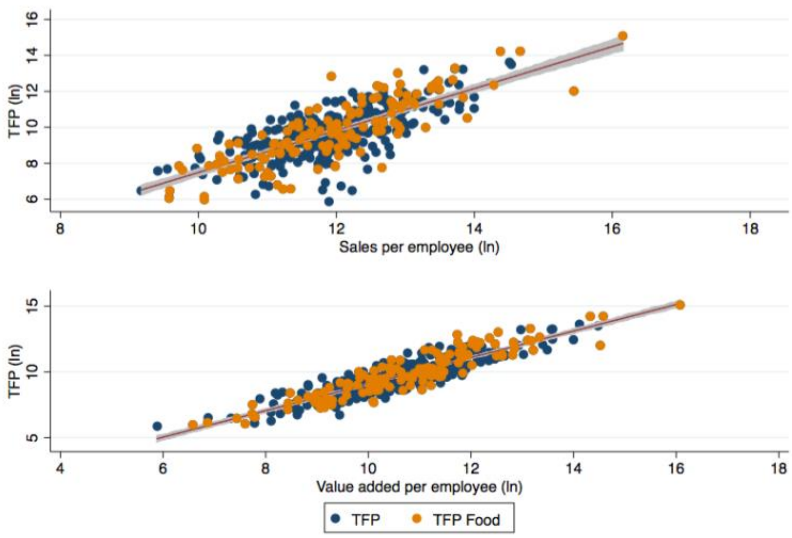
	(1) $\widehat{\omega}^{pooled}$	(2) $\widehat{\omega}^{panel}$	(3) $\widehat{\omega}^{lp}$
VA per emp. (ln)	0.794***	0.810***	0.906***
sales per emp. (ln)	0.716***	0.751***	0.769***

Source: Author's elaboration based on WB-ES
* p<0.05, ** p<0.01, *** p<0.001

This last $\widehat{\omega}^{lp}$ estimated is more correlated than the two previously calculated $\widehat{\omega}^{pooled}$ and $\widehat{\omega}^{panel}$ estimates with our reference productivity measure *VA/emp.*. We observe a lower correlation than $\widehat{\omega}^{panel}$ estimation with *sales/emp.*, but it is nevertheless acceptable since it is above the significance threshold of 0.75. Table 5 (3) displays these improvements in terms of accuracy. Figure 15 illustrates graphically these positive correlations.

[28] There is a correlation between ε_{it} and inputs because a firm's beliefs about ε_{it} influence its choice of inputs

Figure 15 - TFP and Other Productivity Measures



Source: Author's elaboration based on WB-ES

Table 6 summarizes statistics of different productivity measures. According to Van Beveren (2012), the Levinsohn and Petrin (2003)'s coefficient ($\widehat{\omega}^{lp}$) is the more accurate TFP estimate.

Table 6 - Food Industry Productivity Measures Stat. (2010)

	Obs	Mean	Std.Dev.
Productivity measures			
sales per emp. (ln)	90	12.45	0.99
VA per emp. (ln)	80	11.25	1.34
TFP (ln)	69	10.40	1.62

Source: Author's elaboration based on WB-ES

Figures and tables

Table 7 - Country Code and Name List

OECD

AUS	Australia	KOR	Korea
AUT	Austria	LVA	Latvia
BEL	Belgium	LUX	Luxembourg
CAN	Canada	MEX	Mexico
CHL	Chile	NLD	Netherlands
CZE	Czech Rep.	NZL	New Zealand
DNK	Denmark	NOR	Norway
EST	Estonia	POL	Poland
FIN	Finland	PRT	Portugal
FRA	France	SVK	Slovak
DEU	Germany	SVN	Rep. Slovenia
GRC	Greece	ESP	Spain
HUN	Hungary	SWE	Sweden
ISL	Iceland	CHE	Switzerland
IRL	Ireland	TUR	Turkey
ISR	Israel	GBR	United Kingdom
ITA	Italy	USA	United States
JPN	Japan		

Non-OECD Countries

ARG	Argentina	MYS	Malaysia
BRA	Brazil	MLT	Malta
BRN	Brunei	MAR	Morocco
BGR	Bulgaria	PER	Peru
KHM	Cambodia	PHL	Philippines
CHN	China (PRC)	ROU	Romania
COL	Colombia	RUS	Russian Fed.
CRI	Costa Rica	SAU	Saudi Arabia
HRV	Croatia	SGP	Singapore
CYP	Cyprus	ZAF	South Africa
HKG	Hong Kong	TWN	Chinese Taipei
IND	India	THA	Thailand
IDN	Indonesia	TUN	Tunisia
LTU	Lithuania	VNM	Viet Nam
ROW	Rest of the World		

Table 8 - Aggregated Regions Composition

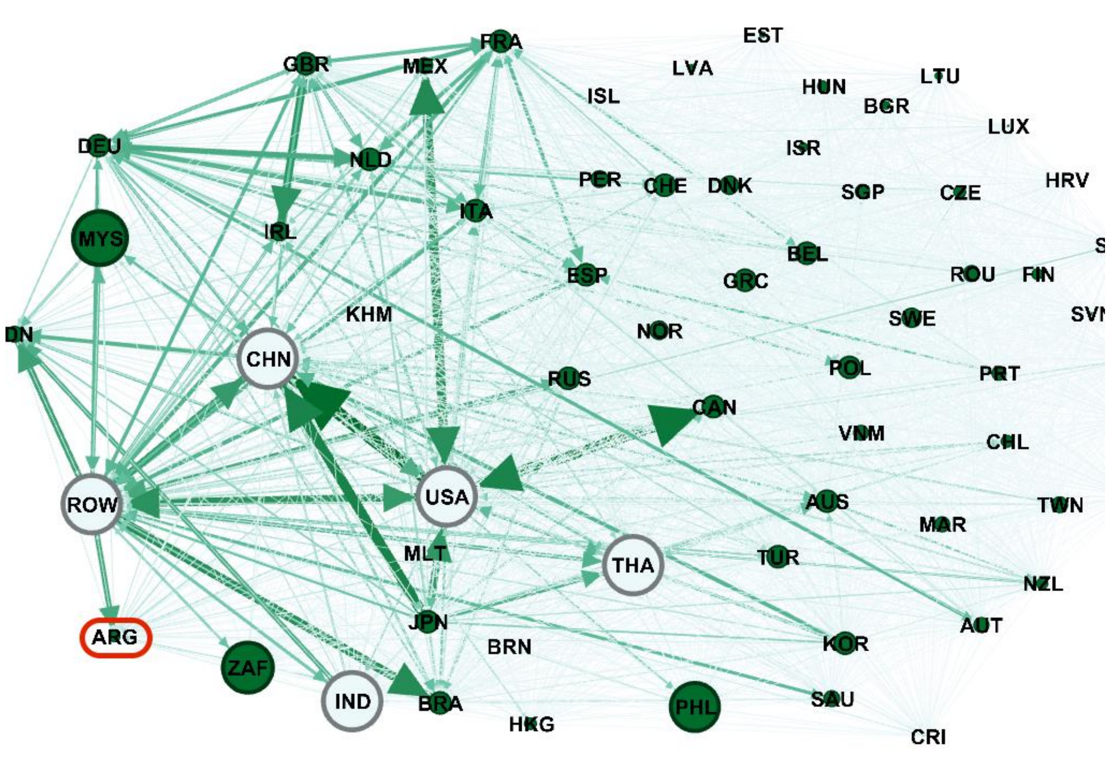
APEC	Asia-Pacific Economic Cooperation	AUS CAN CHL JPN KOR MEX NZL USA BRN CHN HKG IDN MYS PHL RUS SGP THA TWN VNM
ASEAN	Association of South East Asian Nations	BRN IDN KHM MYS PHL SGP THA VNM
EASIA	Eastern Asia	JPN KOR CHN HKG TWN
EU28	European Union (28 countries)	AUT BEL CZE DNK EST FIN FRA DEU GRC HUN IRL ITA LUX NLD POL PRT SVK SVN ESP SWE GBR BGR CYP HRV LTU LVA MLT ROU
EU15	European Union (15 countries)	AUT BEL DNK FIN FRA DEU GRC IRL ITA LUX NLD PRT ESP SWE GBR
EU13	EU28 excluding EU15	CZE EST HUN POL SVK SVN BGR CYP HRV LTU LVA MLT ROU
EA18	Euro area (18 countries)	AUT LUX BEL EST FIN FRA DEU GRC IRL ITA NLD PRT SVK SVN ESP CYP LVA MLT
EA12	Euro area (12 countries)	AUT BEL FIN FRA DEU GRC IRL ITA LUX NLD PRT ESP
ZEUR	Europe	AUT BEL CZE DNK EST FIN FRA DEU GRC HUN ISL IRL ITA LUX NLD NOR POL PRT SVN SVK ESP SWE CHE GBR BGR CYP HRV LTU LVA MLT ROU RUS
ZASI	East and South East Asia	JPN KOR BRN CHN HKG IDN KHM MYS PHL SGP THA TWN VNM
NAFTA	North American Free Trade Asso- ciation	CAN MEX USA
ZOTH	Other regions	AUS ISR NZL TUR IND SAU TUN ZAF ROW
ZSCA	South and Central America	CHL ARG BRA COL CRI
DXD	Domestic	

Table 9 - Panel Summary Statistics (Pooled)

	Food Industry			Other Industries		
	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.
Productivity measures						
Sales/emp. (ln)	186	11.90	1.12	761	11.85	1.06
VA/emp. (ln)	160	10.67	1.52	382	10.66	1.22
TFP (ln)	136	9.84	1.81	305	9.73	1.32
Trading variables						
Exporter	200	0.14	0.35	796	0.13	0.33
Importer	200	0.10	0.31	796	0.16	0.37
Twoway trader	200	0.23	0.42	796	0.15	0.36
GVC	200	0.32	0.47	796	0.19	0.39
FDI	200	0.12	0.33	796	0.12	0.32
Structure variables						
Employment (ln)	200	4.06	1.90	792	3.58	1.52
Capital intensity (ln)	140	10.42	1.59	313	10.00	1.39
Age firm	200	39.85	30.22	794	30.33	22.68
Intermediate variables						
Sales (ln)	186	16.00	2.62	763	15.44	2.03
Capital (ln)	149	14.50	2.83	348	13.65	2.06
Inputs cost (ln)	174	15.02	2.60	419	14.55	2.11

Source: Author's elaboration based on WB-ES

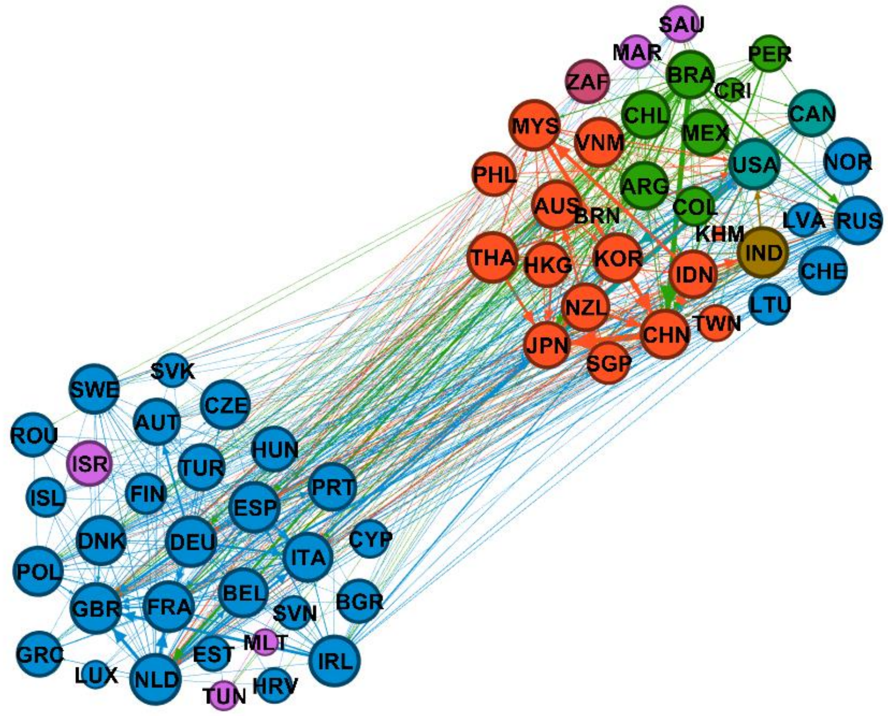
Figure 16 - World Food Industry Foreign VA in DFD (2011)



Source: Authors' elaboration based on TiVa Dataset

Node Size represents country's importance in terms of betweenness centrality.
Node colour intensity indicates the eccentricity degree
Edges thickness and colour intensity are proportional to the between countries relation's weight

Figure 17 - World Food Industry Intermediates Trade (2011)



Source: Authors' elaboration based on TiVa Dataset

Node size represents here the degree of each country, which is the number of relation (edge) it has. On this graph this relation is completely independent of its in or out relation since a node is represented by the sum of its edges (and then scaled from 1 to 200).

Nodes are coloured according to the macro-region.

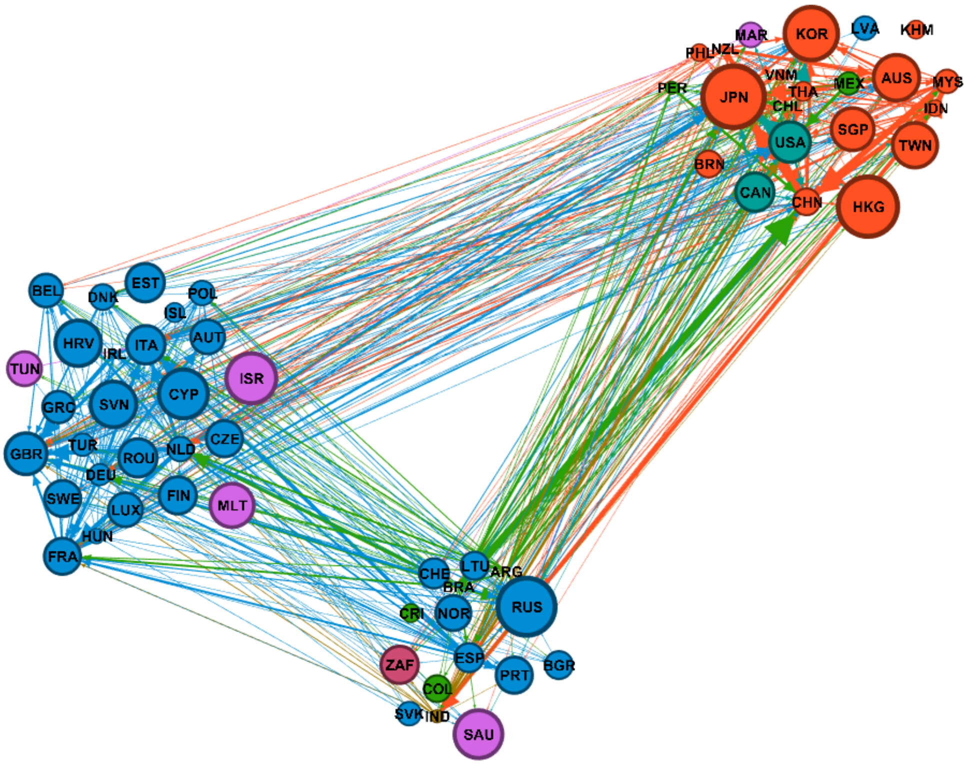
To do this graph we build the network using the food industry gross exports of intermediate goods, from country x to country y per year29 for all available countries30. We do the same for gross imports of intermediates and we matched every origin country to destination country export and import of intermediates for every year. The difference between export and the import gives us the net trade of intermediates from country x to country y at time t. This new built dataset is directed (i.e. edges are not just links between two points: the direction of the flow _ "from to to", in or out _ is taken into account) Adding the direction helps to better understand the global network of food industry intermediates.

Dividing set of countries into groups of nodes with dense connections within groups and sparser connections between groups (Gephi 2011, p27), it emerges that the VA network if made of two subgroups (clusters, communities). Here two subgroups are here clearly illustrated. In short, the world is divided in to Europe on one side, and rest of the world on the other.

[29] Years available from 1995 to 2011

[30] See Table 7. Note that "rest of the world" "ROW" was excluded for this analysis

Figure 18 - World Food Industry Intermediates Recipient (2011)



Source: Authors' elaboration based on TiVa Dataset

This graph is similar to the previous one but it was done using a slightly lower level during the modularity analysis. This new modularity level shows a new sub-cluster, previously invisible. We note that here, the nodes are function of the edges, meaning that the bigger is the node th e more the country is "intermediate-consumer".

Table 10 - Internationalisation and other productivity measures (Pooled)

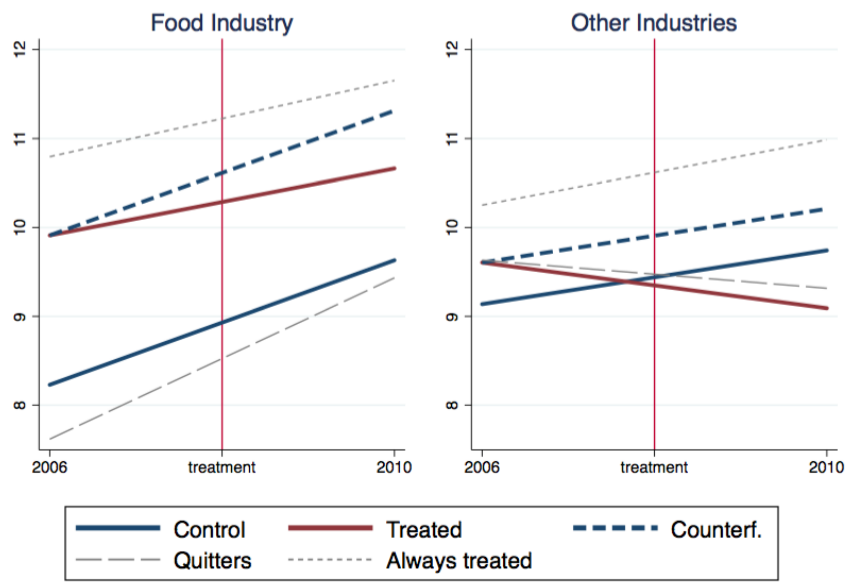
	Dependent variable:					
	Value added / employee (log)			Sales / employee (log)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exporter	1.748*** (0.374)	1.731*** (0.401)	1.869*** (0.390)	1.271*** (0.283)	1.303*** (0.264)	1.325*** (0.275)
Importer	1.337*** (0.371)	1.004** (0.435)	1.476*** (0.413)	0.743*** (0.277)	0.492* (0.284)	0.741** (0.286)
Two-way trader	1.843*** (0.326)	1.779*** (0.371)	1.842*** (0.372)	1.234*** (0.251)	1.086*** (0.249)	1.181*** (0.264)
Age	0.009** (0.004)	0.014*** (0.005)		0.004 (0.003)	0.008** (0.003)	
Certification	0.018 (0.294)	-0.336 (0.335)	0.191 (0.338)	0.078 (0.223)	-0.174 (0.219)	0.069 (0.242)
Capital intensity		0.248*** (0.083)			0.241*** (0.054)	
Employment (log)			0.011 (0.089)			0.058 (0.063)
Human capital			0.436 (0.340)			0.280 (0.240)
Constant	8.513*** (0.197)	6.368*** (0.678)	8.414*** (0.358)	10.177*** (0.149)	8.212*** (0.448)	9.896*** (0.254)
Observations	109	85	106	114	89	110
R^2	0.431	0.531	0.415	0.357	0.559	0.402
Adjusted R^2	0.403	0.495	0.380	0.327	0.527	0.367
F Statistic	15.596*** (df = 5; 103)	14.738*** (df = 6; 78)	11.723*** (df = 6; 99)	11.973*** (df = 5; 108)	17.320*** (df = 6; 82)	11.549*** (df = 6; 103)
Note:						** p<0.1, ** p<0.05, *** p<0.01*

Table 11 - GVC and productivity measures (Pooled)

	Dependent variable:								
	ln_tfp	ln_vaemp	ln_salesemp	ln_tfp	ln_vaemp	ln_salesemp	ln_tfp	ln_vaemp	ln_salesemp
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GVC	1.953***	1.427***	1.022***	1.830***	1.027***	0.707***	1.167***	1.571***	0.947***
	(0.299)	(0.260)	(0.192)	(0.317)	(0.303)	(0.198)	(0.437)	(0.404)	(0.286)
Age	0.014***	0.008*	0.003	0.014***	0.010**	0.005*			
	(0.005)	(0.004)	(0.003)	(0.005)	(0.005)	(0.003)			
Capital intensity				0.104	0.315***	0.283***			
				(0.089)	(0.085)	(0.055)			
Employment (log)							0.333***	0.009	0.053
							(0.100)	(0.093)	(0.067)
Human Capital							0.362	0.198	0.162
							(0.404)	(0.359)	(0.251)
Constant	8.077***	8.936***	10.440***	7.238***	6.203***	8.113***	7.157***	9.000***	10.239***
	(0.217)	(0.191)	(0.141)	(0.755)	(0.720)	(0.473)	(0.447)	(0.393)	(0.276)
Observations	88	113	118	88	88	92	87	110	114
R^2	0.486	0.309	0.258	0.494	0.412	0.447	0.499	0.284	0.281
Adjusted R^2	0.474	0.296	0.246	0.476	0.391	0.428	0.480	0.264	0.261
Residual Std. Error	1.253 (df = 85)	1.241 (df = 110)	0.937 (df = 115)	1.250 (df = 84)	1.194 (df = 84)	0.812 (df = 88)	1.245 (df = 83)	1.270 (df = 106)	0.909 (df = 110)
F Statistic	40.137*** (df = 2; 85)	24.560*** (df = 2; 110)	20.043*** (df = 2; 115)	27.316*** (df = 3; 84)	19.636*** (df = 3; 84)	23.664*** (df = 3; 88)	27.502*** (df = 3; 83)	14.030*** (df = 3; 106)	14.306*** (df = 3; 110)

Note: ** p<0.1, ** p<0.05, *** p<0.01*
the variable certification is not present since we defined GVC members as international traders certified

Figure 19 - Median TFP Evolution certification



Source: Author's elaboration based on WB-ES

Chapter 3

Export Quality in South America: How Argentina and Brazil compete on quality on the soybean market

Abstract

In many markets, price competition does not tell the whole story. There are elements other than prices affecting firms' competitive strategy. This chapter focuses on quality, probably the most important non price factor. With this aim, it first presents an analysis of the export structure, in terms of quality as well as diversity, for a panel of South American countries and, as comparison, for different "free trade areas" in the world. This descriptive analysis shows that the export quality for South American countries is relatively stable over the period studied (2000-2017) and gives us interesting hints on developments in different areas and countries. The analysis of the extensive margin of trade by country (number of different goods traded), first done for the manufacturing sector at the level of free trade zones and then at country level, highlights the importance of one specific product in agri-food sector for South American countries: soybeans, a final consumption good but also an important inputs in several agri-food value chains. The two main producers in the group are Brazil and Argentina, which are responsible for about 50% of soybean world production. Hence, we focus on competition dynamic between them. We use a recently revised version of the constant market share (CMS) analysis method to decompose the aggregated market share of an exporter into two distinct components: the direct competition effect (competitiveness), and the indirect competition effect (structural). The contribution of this chapter is linked to the constant market share analysis at product level. This analysis indicates that what seems at first sight to be Brazil's total domination over Argentina in the exchange of soybeans reflects a partial truth. Argentina is competitive when it comes to high quality, even though Brazil has a much higher rate of growth in the production of this product in recent years.

Table of contents

List of Tables

List of Figures

Introduction

In both Argentina and Brazil, soybean products play a dominant role in terms of production and exports. The soybean industry involves complex production, processing and distribution networks. In fact, only a very small proportion of soybeans is consumed directly as food by humans. Most of the production is milled to produce animal feed, oils, biofuel or processed to produce food related goods or other industrial products (Heron et al., 2018). These production and transformation processes are part of value chains (domestic, regional or global) that are becoming increasingly complex and developed. Bianchi and Szpak (2017) estimate that soybean value chain is responsible for 2.6% of total employment in Argentina and 1.6% in Brazil. At a regional level, the geographical area responsible for soybean production and processing in South America, which covers areas throughout Argentina, Bolivia, Brazil, Paraguay and Uruguay, is considered by some authors to be a single, unified regional economic space, known as the "Soybean Republic" (Turzi 2011). At a global level, China, the world's largest importer, imports a substantial amount of soybean products, more or less processed, transforming these domestic and regional value chains into a complex global value chain. For this market in particular, Globalisation is then a source of opportunities.

Trade liberalization and the removal or reduction of trade restrictions and barriers creates an important increase of inter-country intermediate goods and semi-finished products exchange. In this globalised market, the quality level of exported goods matters as much as its kind or its destination market. Countries with different economic structure, consumption habits, income per capita or more generally, different development level are likely not to buy the same quality level of a product. Demand for “quality goods” is specific. Exporters should then evaluate the importance of exporting products, at the requested quality level. To establish a reputation for producing quality goods takes time while it is much easier to lose it.

Using bilateral trade data by product (Harmonized System – 6 digits’ depth) and following the Fontagné et al. (2008) methodology, which allows a price base quality discrimination, we first perform an analysis of the quality of exports for a panel of South American countries. This panel, the same used in the first chapter of this thesis, includes Argentina (ARG), Bolivia (BOL), Ecuador (ECU), Paraguay (PRY), Peru (PER), and Uruguay (URY). However, here we also add Brazil (BRA), the largest South American country[1]. After checking the consistency of the construction of the quality grouping, taking as an example the evolution over time of the quality level (aggregated by Free Trade Area, FTA[2]) of selected industries, we study the evolution of the export quality shares per country to control for the possible presence of export upgrading (downgrading). We then focus on the extensive margin of trade by country (number of different goods traded). In the light of this analysis, it appears that there is one product (agro-food) which is very important for the exports of the selected group of South American countries: soybeans. The two of the main world exporters of soybean are in South America. Argentina and Brazil are responsible for about 50% of world production and they export soybeans both as final consumer good and as intermediate input in value chains. The soybeans industry is very important for these countries and their economies. As estimated by Bianchi and Szpak (2017, p12) “the share of the whole soybean value chain (which includes activities outside of agriculture[3]) in the Argentine GDP was 5.5 percent in

[1] In Chapter 1 the panel did not include Brazil because there were no firm level data available in the WB Enterprise Survey for the years considered during the analysis.

[2] FTAs are areas where goods are not subject to tariffs or other obstacles, they therefore can provide a good overview of some economic characteristics of a certain geographical area.

[3] The soy processing industry includes a wide variety of industries such as food processing, the production of various oils, the production of agro-fuels, etc.

2014, while a similar estimate for Brazil was 2.4 percent"[4]. Soybean industry is a complex network involving many different economic actors which goes from the soybean producers to the producers of related food products, without forgetting producers of biofuels and other industrial inputs. In addition, Brazilian and Argentine soybean value chains are very integrated into world trade (Bianchi and Szpak 2017).

Focussing on the specific case of Argentine and Brazil, we provide a destination-product-quality based analysis, breaking down the change of the aggregated market share of each exporter into its two main components (a competitive effect and a structural effect (Liu et al., 2018)). This analysis focuses on the dynamics of competition between two countries, for a single good (soybeans) with different quality level to a single market (China). The aim is to understand why, what seems at first sight to be Brazil's total domination over Argentina, reflects a partial truth. Argentina is competitive when it comes to high quality, even though Brazil has a much higher rate of growth in the production and exports of soybeans in recent years.

This paper is structured as follow. The first part, after discussing the data used, explains the methodology, based on quality share decomposition to measure possible crowding-out between competitors. The second part analyses the structure of the exports of the panel of South American countries as well as, for comparison, a number of other countries analysed in free trade areas, before analysing, in a third and final part, the case of soybeans and the competition between Argentina and Brazil in what is now the most important import market for soybeans: China.

1 Context, methodology and data

Considering quality while doing a competition analysis is fundamental. Indeed, comparing two exporters; one specialized in low quality exports while the other one is specialized in high quality, could be misleading. Indeed, in this example, product differentiation is such that, in a sense, they compete in two different (segmented) markets.

1.1 The quality issue

Quality is an important characteristic. It often refers to how "good or bad" something is. It is the "degree of excellence of something"[5]. Often difficult to measure, quality gives a greater or lesser value to a good or a service. It seems complicated to give a single definition of quality. Indeed, it embraces very different concepts. It can be defined as a value, or a conformity to some specifications, or zero defect, or excellency, or more simply, an accordance with the intended use.

For firms, quality is a way to compete on aspects other than the price of a product. For instance, technical or functional upgrading, aesthetics aspects can become more important. The final objective being to compete in the market segments where the important factors are different than price. Design, innovation, and consumer care become the new core business. In this sense, quality upgrading could be a solution to remain competitive on international markets, when price competition becomes too tough. Quality can be defined from (at least) two distinct perspectives. The first one refers to some objective, intrinsic, and measurable characteristics of a product. The second one refers to a subjective evaluation from the consumer.

Given all this, is it possible to measure quality of a product, and if so, how is quality measured?

Measurement is a difficult issue. It is very complicated to attribute a single number to a quality level since many quality aspects are very difficult to quantify. Nonetheless, we can use price as a proxy for

[4] We shall show in the following of the chapter that Brazil has a more differentiated export structure and a wider extensive margin than Argentina; this helps explaining the differences in the shares.

[5] Online Cambridge Dictionary

quality. Of course, price is an outcome variable which depend on market conditions and all markets do not ensure a perfect price-quality correlation. For example, like vertical differentiation (where distinctions between products are objectively measurable and based on the respective quality level of the products), horizontal differentiation, which refers to distinctions in products that cannot be easily assessed in terms of quality, can have an influence on prices. This said, in some situations the price can be a reasonable measure of quality level, especially when horizontal differentiation is not present. This quality-price relation become more correlated for goods which have characteristics easily measurable by the industry. While it is true that even in these situations the price is set by the market, it is also true that part of the price of the units is either increased or decreased according to their intrinsic characteristics. A sugar beet producer will be paid according to the quantity of sugar contained in its beets. In the same way, a milk producer will have a price by litre defined according to the quantity of fat and protein present in the milk. In such cases, the price by litre or metric tons depends of some objective and measurable industrial quality standards. While looking at soybean, its measurement and quality assurance has been controlled from the *U.S. Standards for Soybeans* of 1994 (Paulsen 2008). The quality factors include: heat-damaged kernels, total-damaged kernels, foreign material, [...] as well as the measurement of chemical characteristics such as water, fat, protein, fibre content, etc. (Paulsen 2008; Zhu et al. 2018).

Unfortunately, prices of traded products (export prices) are not readily available. Therefore, in line with Fontagné et al. (2008) and Liu et al. (2018) amongst the others, we proxy export prices by export unit values (UV). Unit values depend on actual market prices but are not the same thing. They correspond to the expenditure, or production value, divided by the quantity (United Nations 1992). Hence, the reliability of value and quantity is directly affecting the approximation of “trade prices” with unit values. Unit values are often criticized. First because their value change according to the Free On Board (FOB)/ Cost, Insurance and Freight (CIF) export/import modality. We chose to use free on board (FOB) export unit values, since they are calculated from exporters' declarations and do not include transport nor insurance costs. The FOB unit value is then a good proxy for the trade price at the factory gate (Berthou and Emlinger 2011). Unit values are also often criticized because they are measured by weight (per kilogram or per (metric) tonne). These measures make little sense when considering computers or clothing. However, in the specific case of the soybean analysis, these measures fit perfectly. Finally, unit value are well suited for our analysis because, as explained by Deaton (1988, p.418): "Consumers choose the quality of their purchases, and unit values reflect this choice." Unit value contains then originally and intrinsically a quality dimension.

1.2 Methodology

In this paper, competition is measured by quality segments. To do so, we use the unit value as a proxy for quality using the following methodology.

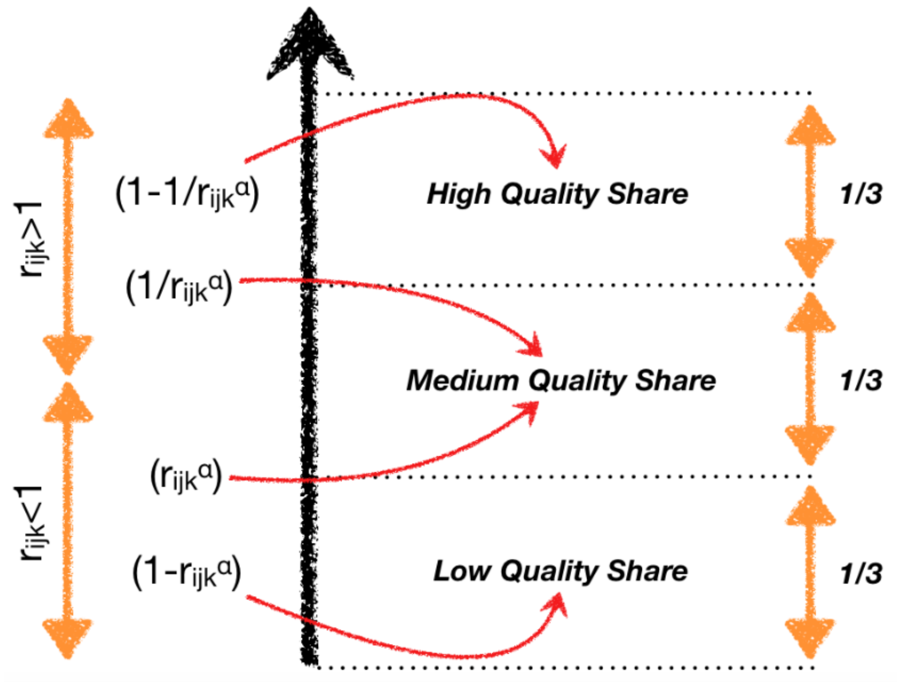
1.2.1 Quality segmentation

Following the methodology developed by Fontagné et al.(2008) we divide all world trade flows into different quality segments. We define here three quality segments: low, medium and high. To do so, we first compute the relative unit value ratio for any flow of product i exported by country j to an importing market k as follow:

$$r_{ijk} = \frac{uv_{ijk}}{uv_{ik}} \tag{1}$$

Where uv_{ijk} is the unit value of the trade flow of product i exported by j to market k. uv_{ik} is unit value average of product i imported by country k. The ratio r_{ijk} compares then the unit value of product i exported by j to the average of all k imports of product i. If this ratio is greater than one, namely, the unit value of imported product i in country k from a country j is greater than the average unit value of all product i imported by k, it is considered that this trade flow has higher quality than the others. Doing so, we of course assume that unit values reflect quality. Once set this ratio, different approaches can be defined. A first approach consists of setting a threshold ratio (e.g.: we attribute the whole UV in the high quality segment if r_{ijk} >1.25, to the medium if 0.75< r_{ijk} <1.25 and to the low if r_{ijk}<0.75). Another possibility could be to use the UV percentiles. Here we consider the method proposed by Fontagné. This method considers that, the greater the ratio, the higher the quality. Conversely, the closer is this ratio to zero, the greater the share attributed to the low quality. This method has the great advantage of smoothing the value distribution to the different quality segments. For instance, if the ratio is between zero and one, it means that the average unit value of the imported good is greater than the exported unit value. In this case, the country export good of lower quality than the imported ones. Therefore, as illustrated on Figure 1, part of the value will be attributed to the low quality and the remaining part to the medium quality. The closer to zero, the greater will be the part attributed to the low quality. If the ratio is closer to 1 than 0, the share attributed to the medium quality will be more important. The modalities of this ratio allocation is detailed on Figure 1.

Figure 1 - Relative unit value allocation



Source: Authors' elaboration

We note the presence of smoothness parameter α. This parameter allows a repartition of quality segments. Originally set to 4 by Fontagné et al.(2008, p. 15), its aim was to make each segment roughly equal to one third of global trade. Since we do not use the same dataset as Fontagné, we need to re-calibrate this parameter. This operation is detailed in section 1.4.1.

1.2.2 Decomposition and distribution of the crowding-out effect

Traditionally, economists measure the presence and the magnitude of a crowding-out effect at a country or sector level. Sector level analysis is interesting, but incomplete since it does not inform about the quality of production and the position into the global value chain. The analysis by quality level is relevant because it details how countries compete, and on which quality level.

Let's take for instance, a more "traditional" approach which will, in its conclusion, attribute a crowding out effect of a country A over a country B for an exported good i. Let's now imagine that this country B is a producer of low quality i while A is a producer of high quality i. These two countries do not really compete against each other. An "aggregated" analysis does not distinguish between the two conditions.

The analysis by quality level, on the other hand, allows us to better understand how competition between countries takes place, and compares only the quality segments that two countries have in common.

It is important to notice that, the impact of a country export crowding-out another one affects differently an industry if this industry is located in the upper or the lower tail of the quality production level. Indeed, we can expect the upper tail to be more productive and less subject to international competition since it is likely to require more know-how and investment. We can then expect this quality segment to be more resilient.

If we observe competition over time, we can wonder if competition is due to a change of the production structure of one or more countries, or if it is due to a moving global environment which indirectly influence competition between countries? In other words, is it due to a structural change or to a change of competitiveness? The constant market share analysis method (CMS) analysis allows us to break down the change of an aggregated market share of an exporter into its two main components (Batista (2008), Liu et al.(2018)). The first component is a direct competition effect. It is due to a country competitiveness evolution. The second component is the indirect competition effect, also called structural effect. It is due to a change into the global economy. It is important to decompose the total change into these two very different components.

To do so, let's first set the parameter a_{ijk}^t, vector of dimension n. It is composed by the ratios of X_{ijk}^t, export of product i from country j to country k during the year t, and M_{ik}^t which is the sum of imported product i by country k during this same year t. a_{ijk}^t represents then the micro shares of product i exported by j to k.

$$a_{ijk}^t = (\frac{X_{1jk}^t}{M_{1k}^t}, \dots, \frac{X_{ijk}^t}{M_{ik}^t}, \dots, \frac{X_{njk}^t}{M_{nk}^t}) \quad (2)$$

Let us now set the parameter b_{ik}^t, vector of dimension n which represent the share of product i in the total imports of country k during the year t.

$$b_{ik}^t = (\frac{M_{1k}^t}{M_k^t}, \dots, \frac{M_{ik}^t}{M_k^t}, \dots, \frac{M_{nk}^t}{M_k^t}) \quad (3)$$

These two parameter (a_{ijk}^t and b_{ik}^t) are important because they are needed to decompose $\Delta M_{jk}^{t+1,t}$, i.e. the change in the aggregate share of country j to importing market k between the years t and t_{+1}. As shown in Equation 4, this change in the share can be divided into two components: the crowding-out effect and the structural effect. The first one is composed by the lag value of the a_{ijk}, namely, the evolution of the micro share of product i during the considered period. It is put in relation with b_{ik}, representing the importance of this product i imports for this country during this year. The second component, i.e the structural effect, is in a sense the inverse since it links the lag value of b_{ik}, namely the evolution of the importance of the share of product i imported by k, and the micro share of this very same i product.

$$\Delta M_{jk}^{t+1,t} \equiv \underbrace{\overbrace{(a_{ijk}^{t+1} - a_{ijk}^t)}^{lag\ a_{ijk}^{t+1,t}} b_{ik}^t}_{\substack{\text{Crowding-out effect} \\ COE_{jk}}} + \underbrace{\overbrace{(b_{ik}^{t+1} - b_{ik}^t)}^{lag\ b_{ijk}^{t+1,t}} a_{ijk}^{t+1}}_{\substack{\text{Structural effect} \\ SE_k}} \quad (4)$$

As shown in Equation 5, another form of decomposition is possible if we change the reference year of b_{ik}^t to b_{ik}^{t+1}.

$$\Delta M_{jk}^{t+1,t} \equiv (a_{ijk}^{t+1} - a_{ijk}^{t})\ \underbrace{b_{ik}^{t+1}}_{change}\ + (b_{ik}^{t+1} - b_{ik}^{t})\ \underbrace{a_{ijk}^{t}}_{change} \tag{5}$$

As explained by Liu et al.(2018, p.10) along the lines first developed by of Fagerberg and Sollie (1987) about the Laspeyres indices (b_{ik}^{t}): "the CMS method can be considerably improved in terms of theoretical consistency as well as empirical applicability if initial years' weights are used throughout the calculations". We will then use the model shown in Equation 4.

Following Batista (2008) and Liu et al.(2018), Equation 6 shows how distributed is the crowding-out effect of a country j across it rivals s.

$$\Delta M_{js}^{t+1,t} = a_{isk}^{t}\ COE_{ijk}^{t+1,t} - a_{ijk}^{t}\ COE_{isk}^{t+1,t} \tag{6}$$

Where a_{isk}^{t} is computed similarly to the previous a_{ijk}^{t} with the difference that now, the exporting country considered is not anymore j but s. Thus, $M_{js}^{t+1,t}$ is the part of the change of country j macro share, between the years t and t_{+1} that can be attributed to crowding out the export of s.

1.3 Data description

As discussed in the previous section, our analysis requires two distinct types of information. First, in order to understand the composition of exports from our panel of South American countries, we use a dataset which contains all sources of exports and imports in value, by year with high level of disaggregation. High disaggregation is important because it allows us to perform an analysis at a product level. In a second step, in order to be able to perform the analysis in terms of competition, we use a second dataset which is composed of the unit values, used as proxy for prices, of the traded products, by year, and by both export and import countries. Both datasets used in this chapter are from COMTRADE and they have been "cleaned" by the Observatory of Economic Complexity (OEC) and the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII) using efficient methodologies, making these data particularly suitable for our analysis

Harmonized System revision 96 (HS96) database[6]

This first dataset is published by the Observatory of Economic Complexity (OEC). It covers all product trade flows in value, by origin and destination country over the 1998 - 2017 period. It uses the international nomenclature for product classification called Harmonized System. In this chapter we use the revision 96 (HS96-6) which classifies goods in a six-digit code system. The six digits can be broken down into three parts. The first two digits (HS96-2) identify the chapter the good classified. The next two digits (HS96-4) identify groupings within that chapter. The last two digits (HS96-6) identify the product. The HS96-6 comprises approximately 5 300 different article/product descriptions. The original data comes from the United Nations Statistical Division (COMTRADE), and is cleaned using BACI's methodology of harmonization.

Some revisions, for instance the 92 revision (HS92), cover a longer time period. The specific choice of the revision 96 (HS96) is due to the obligation to merge this dataset to the Trade Unit Values dataset in which products are declared following this nomenclature.

[6] The dataset can freely be downloaded on OEC website section resources/data. Data have been accessed January 2019.

Trade Unit Values (TUV) database[7]

The second dataset used in this chapter is based on data published by the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII). Data are organized and cleaned following a methodology which aims to provide reliable and disaggregated unit value data. This methodology reduces biases which weaken the reliability of unit values as a proxy for trade prices. We use free on board (FOB) export unit values, since they are good proxy for the trade price at the factory gate (Berthou and Emlinger 2011). Products are declared following the nomenclature of the Harmonized System revision 96 with a 6-digits depth product precision (HS96-6). Data are originally published by individual year. We downloaded and merged these yearly datasets in order to have, *in fine*, a single file regrouping all HS96-6 products unit values, by origin and destination country over the 2000 – 2017 period.

These two datasets previously introduced were matched and merged in order to obtain a single dataset which contains the following information: year, good (HS96-6), origin and destination countries, unit value per metric ton, total flow value. We notice that this aggregation reduces the new built dataset to the lowest common existing year. It therefore covers the 2000 – 2017 period.

1.4 Quality setting and descriptive statistics

1.4.1 The proper alpha quest

We saw in section 1.2.1 that the quality distribution depends on the smoothness parameter α (see Figure 1). Fontagné et al.(2008, p. 15) and Liu, Shi, and Laurenceson (2018, p. 9) set, in both their papers, this parameter to 4. Their aim is to make each segment equal to one third of global trade, (very) roughly. Since we use in this document a dataset that none of these previous authors used, we decided to recalibrate this parameter α.

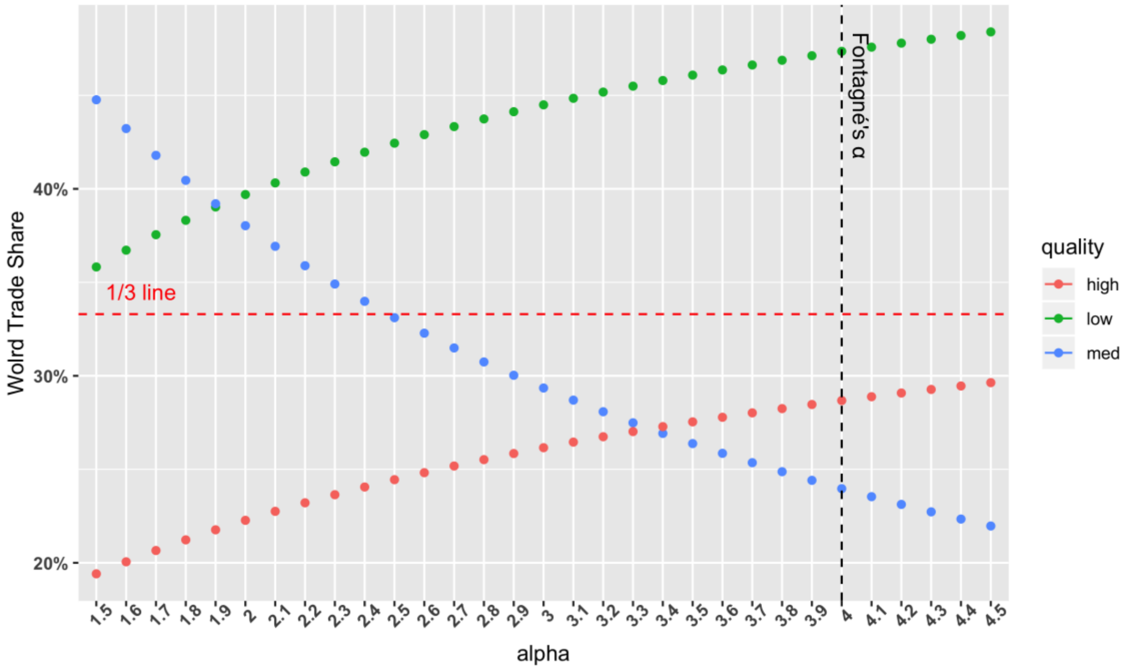
Figure 2 illustrates the evolution of the quality share division of the world global trade according to different smoothing parameter α, using the dataset described above. It displays all quality levels for every 0.1 α point going from 1 to 4.5.

First of all, we notice that Fontagné's α (set to 4 and represented by the black-dashed line on Figure 2) tends to artificially inflate both low and high quality at the expense of the medium one. In such case, low quality is over represented while the medium quality is under-represented. Thus, we need to set an α that suits better our needs.

We note that no α value allows a perfect division of global trade into three quality segments of identical size. This situation would be represented by the intersection of the three quality curves in one unique point. We then need to set an α that divides roughly each segment to one third of global trade.

[7] The datasets can freely be downloaded on CEPII website section Trade Unit Values (TUV). Data have been accessed January 2019.

Figure 2 - World trade division by quality levels according to different α



Source: Authors' elaboration

It is clear that the greater α, the lower the trade world share given to the medium quality segment. An α too low gives then too much importance to this segment while an α too large under estimate it. The perfect α for us is then between 1.9, point where the low and the medium quality are equal, and 3.4, point where the medium and the high quality are equal. We consider, arbitrarily, that the medium quality segment should correspond to one third of global trade (represented on Figure 2 by the horizontal red-dashed line). **We then set α to 2.5**. With an α at 2.5, the low quality segment represents 42.44% of the global world trade, the medium quality segment 33.11% and the high one 24.45%.

Later, to check robustness of our results, we will use other values for α. We select the values: 1.9, 3.4 and 4, which is the one used by Fontagné in the original paper proposing the methodology. As mentioned above, these different values give different weigh to each quality segment. Table 1 displays, for each α, the precise trade world share for every quality segment.

Table 1 - Quality segment share of world trade for some selected α

Alpha (α)	Low	Medium	High
[1.9]	39,03%	39,20%	21,77%
[2.5]	42,44%	33,11%	24,45%
[3.4]	45,79%	26,92%	27,28%
[4]	47,35%	23,97%	28,68%

Source: Authors' elaboration

1.4.2 Constant market shares: descriptive statistics

As explained in section 1.2.1, we need to compute for each year, product, origin and destination country, a relative unit value, as shown in Equation 1. This relative value is a ratio which compares the unit value of every product traded by a single couple of exporter/importer to the mean price of this very same product imported by the exporter. The relative unit value can be computed using different methodologies. We saw, during the data description, that our databased is the result of merging two different databases. The TUV database informs us about the unit values. It gives one single unit value for each trading flow, namely, the exchange by one "origin" country to a "destination" country of one single good (HS96-6) for one single year (uv_{ijk}). As shown in Equation 1, this unit value is compared to an averaged unit value (uv_{ik}), namely, the unit value average of product i imported by country k during a single year. There are two ways to compute this averaged unit value. We can do a simple mean. In this case, we select one good, one country and one year and we compute the simple mean of the unit values. This method is somehow biased since it does not consider the total traded volume. We then decided to compute a weighted average unit value. This weighted average, is here an average of the unit values of a single imported good, weighted by the total imported trade flow in value of this very good. This latter value being present in the second dataset: HS96-6. Once set this weighted average unit value, the ratio with the unit value (uv_{ijk}/uv_{ik}) can be done and then, the relative value (r_{ijk}) obtained. Once the relative value is estimated, we need to distribute it into different quality shares (low, medium, and high). Let us recall that the quality distribution depends on the value of this ratio. The closer to 0, the greater the attribution to the low quality share. The closer to 1, the greater the attribution to the medium quality share. And finally, the farther above one the greater the attribution to the high quality. In the precedent section we set the smoothing parameter α to 2.5. We know that with our dataset, it corresponds to the following quality attribution of world trade: low quality segment 42.44%, medium 33.11% and high 24.45% (see Table 1).

Before going into the details of the analysis of the export structure of our South American country panel, we illustrate the results of the quality share construction, to control their consistency, by taking two examples: high quality segments in manufacturing and the low quality segment in Textile. This illustration is made by grouping countries by Free Trade Areas (FTA). The FTA used are the following: AFTZ, ALADI, ASEAN 3, CEMAC, CISFTA, ECOWAS, EU28, NAFTA, and the rest of the world ROW. The details of each FTA used is develop in Table 8 - Free Trade Areas - Names and Countries and illustrated in Figure 11 in the Appendix.

Let us now consider the high quality segments in manufacturing for different FTA (Table 2). The high quality segment in manufacturing includes sectors between 25 "Chemical Products" and 96 "Miscellaneous" of the HS-2 rev. 96 nomenclature. We notice that NAFTA shows a marked decrease (a little more than ten points) of its world share in high quality segment passing from 31.93% to 21.42% over the 2000 -2017 period. The 2008 crisis seemed to have had a very large impact for around three following years: 2008, 2009 and 2010. Indeed, NAFTA's share lost about six points between 2007 and 2008 and bounced back to its pre-crisis level of 2007 in only 2015 (21.37% and 21.42%). The high quality share of Europe is relatively stable during the period and remains between 38% and 42%. We notice that NAFTA crisis was beneficial to Europe in 2008 and 2009.

Table 2 - Manufacturing shares in high quality segment by FTA (%)

	2000	2003	2007	2008	2009	2010	2015	2017
NAFTA	31,93%	22,73%	21,37%	15,70%	17,52%	16,44%	21,17%	21,42%
EU28	32,58%	38,09%	37,00%	42,09%	40,79%	39,98%	40,09%	38,67%
ASEAN 3	27,62%	29,40%	30,39%	29,41%	29,06%	33,03%	25,33%	28,63%
ALADI	1,43%	1,34%	1,74%	2,21%	2,28%	2,15%	1,58%	1,58%
CEMAC	0,00%	0,00%	0,05%	0,09%	0,05%	0,08%	0,01%	0,04%
ECOWAS	0,03%	0,11%	0,10%	0,19%	0,12%	0,11%	0,05%	0,07%
AFTZ	0,38%	0,76%	0,91%	1,43%	1,07%	1,05%	0,85%	1,03%
CISFTA	1,28%	1,34%	1,27%	1,52%	1,38%	1,37%	1,27%	1,54%
ROW	4,75%	6,22%	7,16%	7,36%	7,73%	5,80%	9,65%	7,02%

Source: Authors' elaboration

The African free trade areas (CEMAC, ECOWAS and AFTZ) show a very low level of high quality manufactured production. They reach their maximum level thanks to, as Europe, the ongoing crisis in the NAFTA area, but the percentage is really low. These results are coherent with the literature and very similar to the one published by Liu et al.(2018).

Let's now take as an example of the low quality segment of a specific manufacturing sector, the textile industry[8]. Table 3 displays the results for the low quality segment of textile once aggregated by FTA. It is clear that during the early 2000, ASEAN 3 already control most of this market (about 60%), but it is also clear that its growth was steady. In 2017, ASEAN 3 controlled about 80% of this production.

All other FTAs were affected. While ASEAN 3 was wining 20.8 percentage points in 17 years, African FTAs[9] lost more than 36% of their market share to reach 0.30% of world share in 2017. Over this period all other FTA sees a decrease of their share. NAFTA lost about 10 percentage points, the rest of the world about 7 points.

[8] Sectors between 50 to 63 of the HS rev. 96 nomenclature

[9] African FTAs are: CEMAC, ECOWAS and AFTZ

Table 3 - Textile shares in low quality segment by FTA (%)

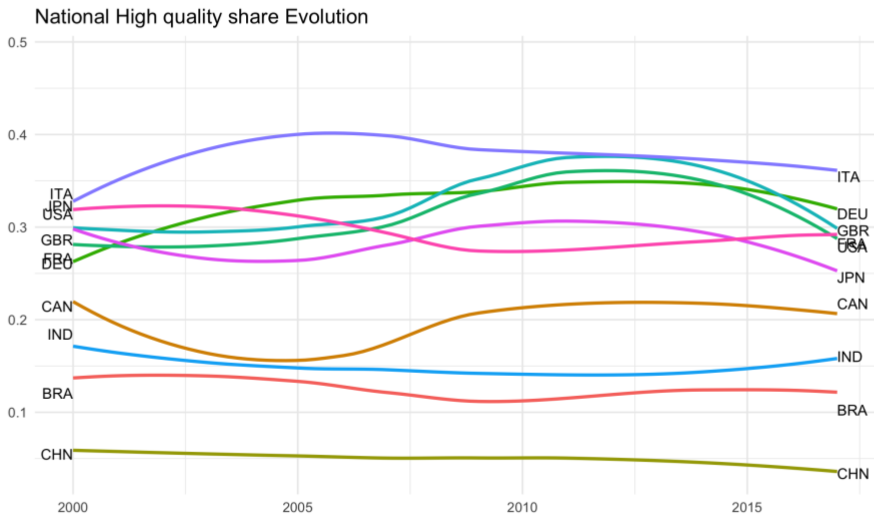
	2000	2003	2007	2008	2009	2010	2015	2017
NAFTA	14,26%	9,28%	5,42%	5,72%	3,68%	4,13%	2,64%	3,93%
EU28	4,26%	3,28%	2,82%	2,39%	2,07%	1,64%	2,39%	2,00%
ASEAN 3	59,24%	58,20%	68,10%	68,03%	76,01%	83,17%	78,75%	79,31%
ALADI	1,08%	1,34%	0,99%	0,98%	0,76%	0,93%	0,90%	0,50%
CEMAC	0,07%	0,00%	0,00%	0,03%	0,03%	0,03%	0,00%	0,03%
ECOWAS	0,01%	0,08%	0,04%	0,17%	0,04%	0,14%	0,26%	0,01%
AFTZ	0,40%	0,94%	0,98%	1,09%	0,81%	0,83%	0,30%	0,26%
CISFTA	0,99%	1,37%	0,94%	0,83%	0,65%	0,66%	0,58%	0,70%
ROW	19,71%	25,51%	20,72%	20,76%	15,96%	8,46%	14,17%	13,27%

Source: Authors' elaboration

2 The export structure of selected countries and groups of countries

Let us now give an overview of the global trade situation, with a focus on our panel of South American countries. Using the results obtained in the precedent section, we illustrate on Figure 3 and Figure 4 the share of high quality exports by country for a selection of countries.

Figure 3 - High quality share evolution - countries with top 10 GDPs

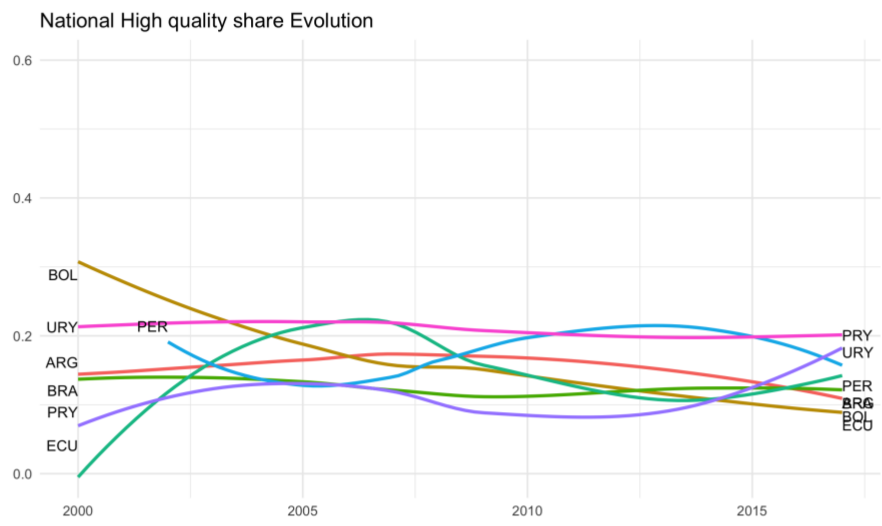


Source: Authors' elaboration based on our dataset

In order to have a reference point, we display, on Figure 3, the high quality share of the main world economies for the period 2000-2017. We observe a relative stability, despite some small fluctuations. Figure 3 clearly shows that there is no reversal of situation. Developed country remain grouped between 30 and 40% of high quality good. India and Brazil draw a straight line between 15 and 20% while China remains around about 7%.

These developments can be a little surprising since we would have expected an upgrading of China's production. Chinese quality shift should mostly be done between the low quality level to the medium one, not displayed in this graph. This particular situation will be analysed in Figure 5.

Figure 4 - High quality share evolution - panel of South American countries

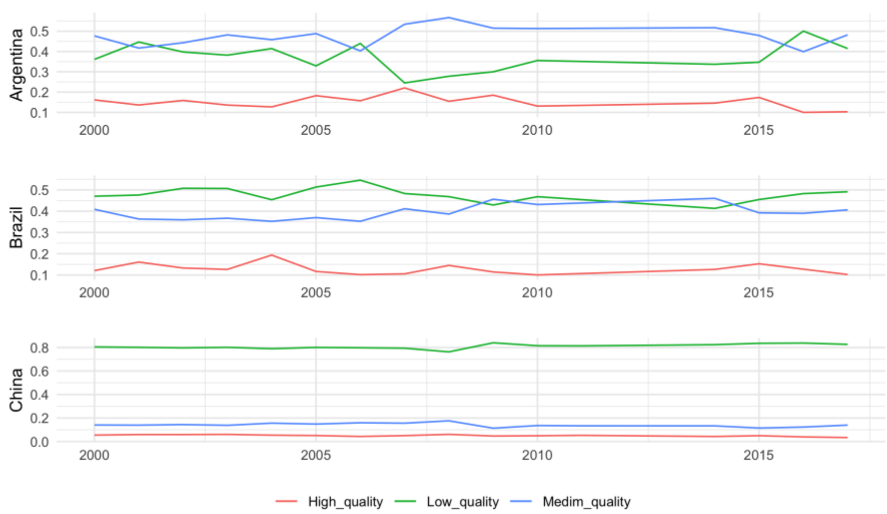


Source: Authors' elaboration based on our dataset

Let's now do the same analysis on our panel of South American countries. We observe, on Figure 4, a stability similar to the one seen previously with the other countries. Nevertheless, results are here much more concentrated and the quality level seems to be much lower: between ten and twenty percent, or just above for the highest values.

We notice an exception to this stability. Bolivia sees its curve following a regular decreasing trend. Bolivia share of high quality manufactured product export drop from about 40% in 2000 to about 10% in 2017. It went, over the period, from the top position of our panel to the very last one.

Figure 5 - All quality shares evolution - Argentina, Brazil & China

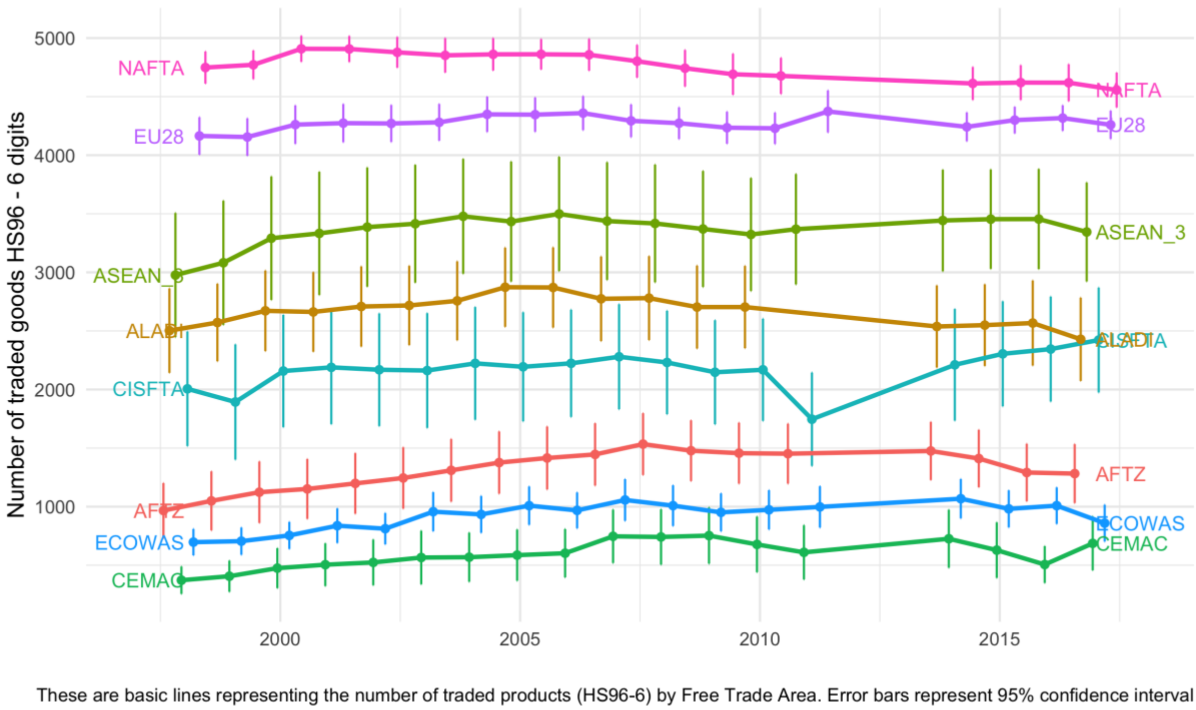


Source: Authors' elaboration based on our dataset

The other countries are between, roughly 15% and 25% such as their very big neighbour Brazil. We notice a similar trend of Brazil and Argentina. We plotted on Figure 5 the evolution of all, low, medium and high quality shares, for the two countries of interest for the chapter, Brazil and Argentina, and we compare them to China. The specific choice of these countries is done on purpose. They are indeed the countries on which will focus the competition analysis of section below. We observe on this graph that China has a very regular trend in term of quality exported. Its exports are largely dominated by the low quality ones which represent about 80% of the total exports. The medium quality share of exports strictly dominates the high quality one.

The case of Brazil and Argentina is slightly different. We saw previously that the high quality share is about 15% over the period. This share is always strictly dominated by the two other shares in both cases. Argentina's exports are essentially of medium quality. Nevertheless, we observe that the low quality share can become, very occasionally, lightly dominant. Looking at the Brazilian exports, we observe the very opposite. Low quality exports represent most of its exports, with occasionally a very light dominance of medium quality. That said, it is clear that in none of these Argentinian or Brazilian cases, we observe a clear preeminence of one quality share as it was the case with China.

Figure 6 – Country products diversity of exports, regrouped by FTA



Source: Authors' elaboration based on HS96

Let's now consider the extensive margin of trade. The extensive margin refers to the product diversity: the number of different products (HS96-6) traded by a country. This number is interesting because it is completely independent of the quantity traded. As shown in Figure 6, Europe 28 and NAFTA[10] are the area with the most diversified patterns of exported products. The dispersion of products is, on this graph, represented by the vertical error bars around each line (95% confidence interval). We observe that the dispersion is more important in Europe than in North America. This can be explained on two grounds. The first one is the size of these area in terms of number of country participating. The probability to have a high dispersion increases with the quantity of countries constituting the free trade area. The second one is the difference of development level between European countries.

These areas are followed by ASEAN 3[10] and the south American countries of ALADI[10]. Then the former Soviet Union countries (CISFTA[10]) followed by the three African free trade areas (CEMAC[10], ECOWAS[10]

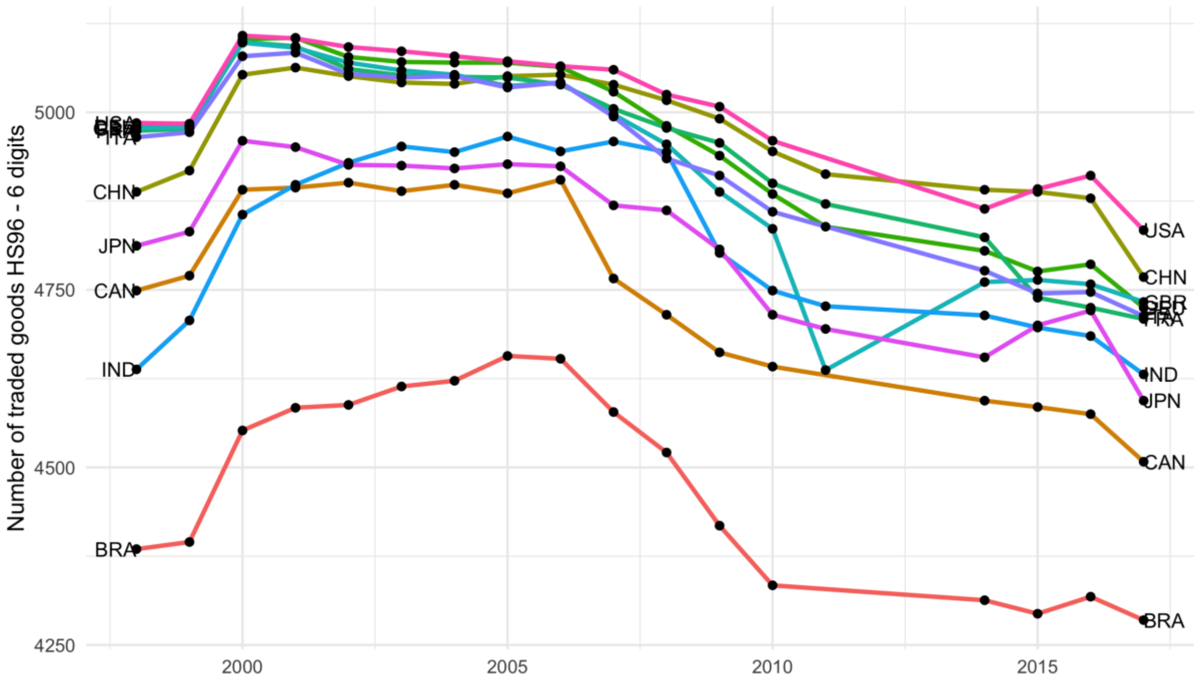
[10] The details of the free trade areas used is develop in Table 8 - Free Trade Areas - Names and Countries and illustrated in Figure 11

and AFTZ[10]). We can underline that for these last groups the dispersion is important. This dispersion, measured by the standard deviation, illustrates the difference in terms of trade diversity between countries in a very same trade area. In other words, it means that in a specific trade area some countries trade an important variety of good while others do not.

Looking at the product diversity by country, we observe that, in 2017, 12 of the 20 main diversified exporters, in terms of goods HS96-6, were from EU28. The fact that 60% of these mains diversified exporters are Europeans is a sign of the importance of the intra-community trade. To confirm it we can underline the presence of Turkey in our top 20 (19th). Turkey is one of the EU's main partners and is member of the European Union–Turkey Customs Union. We also note the presence in this ranking, of Canada and the United States of America, both members of NAFTA. All detailed figures relative to this 2017 Top 20 diversified exporters are available on Table 9 in the Appendix.

Let's now perform an analysis similar to the one done in Figure 6, but at a country level, with a selected number of countries. Once again, in order to have a reference point, we do, firstly, the analysis for the ten main world economies in terms GDP. Secondly, we compare our graphical analysis with our panel of South American countries. Figure 7 suggests that all countries have a remarkable product diversity. For instance, in 1998 none of them was exporting less than 4300 different products. In 2000, we can observe that, with the exception of Brazil, which trades "only" slightly more than 4500 different products, all the other economies trade at least 4850 products. In this same year, for some countries, this figure can go up to 5111. This figure is the maximum number of product present in our dataset. Indeed, the harmonised system revision 96, contains 5111 different categories at a 6-digits-depth. In other words, in 2000, all these countries enjoy a very large product diversity, and some of them, the maximum one.

Figure 7 - Number of traded products by country - countries with top 10 GDPs



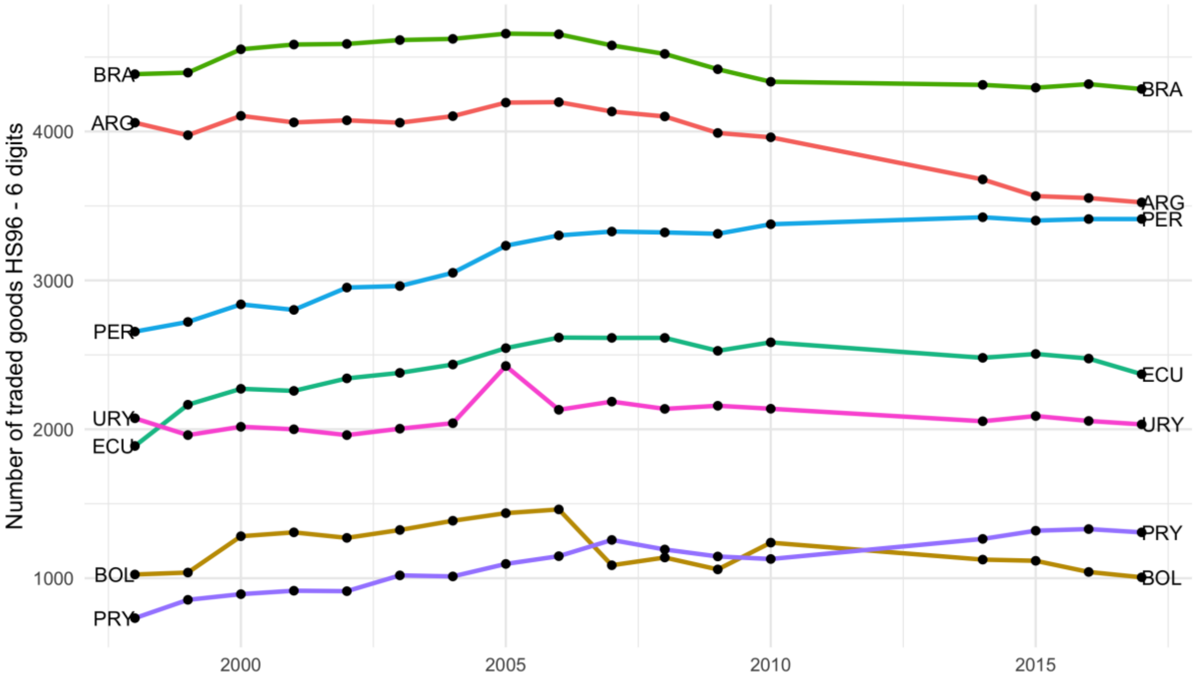
Source: Authors' elaboration based on HS96

However, the turn of the century, was also a turn of this upward trend. With the exception of Brazil which enjoyed a slow increase of its diversity, the period 2000-2008 shows a stagnation or slow decrease of product diversity for all countries. After this date we observe for all countries a slow, but constant, decrease of product diversity. This is probably due to a post-crisis strategy of business refocusing.

Confining our analysis to the south American panel, we see a very different picture. First, with the only exception of Argentina, we do not observe the clear upwards trend observed for the main world economies. Second, the diversity level is far below that of the leader countries. For instance, Argentina, clearly dominates all others, but remains, at its maximum level, 12% under Brazil by far the less diversified country of our previous panel.

Argentina and Peru have a fairly large product diversity (definitely over 3500 products), even if still lower with respect to the top world economies. In contrast, the other countries of our panel do not have very diversified exports. Ecuador and Uruguay export around (or a little more) two thousand different products. Bolivia and Paraguay are just above one thousand in 2017. The land-locked situation of these two countries can partially explain their export difficulties. It is nevertheless a very low level.

Figure 8 - Number of traded products by country – panel of South American countries



Source: Authors' elaboration based on HS96

This export concentration may not be good for an economy, because it makes it more vulnerable to idiosyncratic shocks. This is particularly true for raw material producers where exports are dominated by one or two main products and the rest represent a low percentage of total exports[11].

To get a better understanding of the described patterns, we single out, for each country, the 2017 ten main products exported. The specification of all products by country are detailed in Table 10, Table 11, Table 12, Table 13, Table 14, and Table 15 page 101 and following.

Two peculiarities emerge from this exercise. First, manufacturing is nearly always under-represented and in some cases almost absent. Agro-food-industry dominates exports in those countries, where a

[11] For instance, the three main exports of Bolivia in 2017 represented more than 55% of total exports (*Natural Gas, In The Gaseous State* (30.93%) *Zinc Ores And Concentrates* (14.20%), and *Gold in unwrought forms* (10.10%)), while the three main exports of Paraguay represented more than 56% of total exports (*Soya beans* (24.99%), *Electrical energy* (23.02%), and *Soya-bean oil-cake* (8.56%))

large share of the top exports refers to this sector. 8/10 in Argentina, 3/10 in Bolivia, 7/10 in Ecuador, 3/10 in Peru, 9/10 in Paraguay and Uruguay. The metal or mineral sector is also very important, not only for the number of specialization sectors but also for its weight and size. Focusing on the number we have 1/10 in Argentina, 7/10 in Bolivia, 3/10 in Ecuador, and 7/10 in Peru. The only pure manufacturing sectors appearing are *Motor Vehicles For The Transport Of Goods* (870421) for Argentina, *Ignition Wiring Sets And Other Wiring Sets [...]* (854430) for Paraguay, and *Wool Tops And Other Combed Wool* (510529) for Uruguay.

It is important to note that one individual product, soybean (120100), is present in the top 10 exports of three countries. In Paraguay where it is the first main export, representing 32% of total exports. In Uruguay it represents 7.6% of total exports and in Argentina 4.8%. This product is also important for Brazil (11.19%). Bolivia is the tenth world producer before Uruguay (See Table 4 for details). In the case of Bolivia, however, soybean is not exported in its raw form, but after transformation in oil cakes of soya beans (230400 - 5.3%) (which is also main Argentine export), or Soybean oil crude (150710 - 2.5%). Soybean is then an important resource for these countries as well as being an important intermediate inputs in several value chains, regional and global (see Bianchi and Szpak (2017) or Heron et al. (2018)) The importance of soybeans for export and for value chains is one of the reasons why we will focus the constant market share analysis on this product in the following section.

Second, every year, for each country, exports are largely dominated by a single product: *Oilcake of soya beans* in Argentina, *Natural Gas, In The Gaseous State* in Bolivia, *Petroleum Oils And Oils From Bituminous Mineral[...]* in Ecuador, *Copper Ores And Concentrates* in Peru, *Soybeans* in Paraguay and *Meat Of Bovine Animals, Boneless, Frozen* in Uruguay.

In summary, South American countries face them a double difficulty: they have a poor diversification in quantity, i.e. few goods are exported, and as far as quality is concerned, the goods exported seem to be very similar. Their economies are then really subject to price competition (which will less compelling if their economies were more diversified and then more resilient (Hill et al., 2008)). Note however that for these economies, the unit value of their main exports are relatively stable and did not, especially during these last years, vary often more than one percent from one year to another. In the following we are going to concentrate on soybean, which from this descriptive analysis comes out as a very interesting product, both for its importance in total exports and for its use as intermediate inputs in different value chains (livestock rations, food-processing, but also biofuels). Furthermore, the cultivation of soybeans rises an important issue, which is related to having sustainable value chains: soybean is one of the main drivers of commodity-driven forest loss and has been « accused » of being on of the causes of deforestation in South America[12].

3 A focus on soybeans

3.1 A peculiar product

Soybean is an oleaginous annual plant, a specie of legume (family *Fabaceae*) native to East Asia. Numerous varieties of this plant exist, with different characteristics in terms of nutrients. It is widely produced mostly for its edible bean, which has several uses. “Born” in China, its culture has long been exclusive to this country. It has gradually spread to other countries to become one of the main crops in the United States, Brazil, Argentina, India, China and South Korea.

[12] This topic, which is very important and interesting is however outside the scope of our analysis. It is discussed in many recent papers, see for instance Czaplicki Cabezas et al. (2019).

In its report of may 2019: *World Agricultural Production*[13], the United States Department of Agriculture (USDA) estimates soybean world production at 362.08 Millions of tonnes[14]. A little less than 35% (123.66M tonnes) of this world production was produced by USA. Brazil (1170M tonnes - 32%) and Argentina (56M tonnes - 16%) complete the podium of the first three world producers. We note that China (15.90M tonnes - 4.4%), India (11.50M tonnes - 3.2%), respectively 4th and 5th producers, are far below the three first ones. The five first producers represent 83% of global production, while the next three are much below and represent only 10%.

At a world level in 2018 the production of soybeans covered an area of 125 Million hectares.

Often the debate on soybean is related to genetically-modified organisms (GMOs)[15]. In 1996, only two years after the first GM food was approved by the Food and Drug Administration in the US, Argentina officially approved the cultivation of this herbicide-tolerant soybean for growing commercially. In the same year, 375 000 acres were cultivated with this GMO soybean. It is equivalent to about 217 000 football fields. It is hard to say how much of the total world production is genetically modified soybean. We can estimate it between 70% and 80%. Indeed, in 2012 it already represented 70% of world production (Le Monde and AFP 2012). Transgenic soybean crop is widely adopted in the United States and Argentina. It has also been developing rapidly in Brazil, in the last few years. Transgenic varieties are most often resistant to herbicides, especially glyphosate.

Most of the production is intended for feeding farm animals (soybean meal). Nevertheless, an important part is "directly" consumed by human (soy milk, yoghurt, tofu, etc.).

According to the nomenclature of the Harmonized System revision 96 with six digits' depth, as mentioned before, Soybean has the number 120100, named Soybeans in the group of Vegetable Products. We will refer to this HS96-6 120100 in the analysis.

3.2 A peculiar market

Let us first consider the soybeans market from the consumer side. We know that, originally, soybean come from East Asia, and have two main uses: "direct" human consumption via products like soy milk, tofu etc... The second one is a more "indirect" human consumption: feeding farm animals, with the animals being, at the end, often becoming food themselves. Due to cultural habits, direct consumption is mainly developed in East Asian countries, the main market. Consumption is still fairly low in Europe (He and Chen 2013). South America enjoys a particular position in this market. Indeed "soy protein has been used in several Latin American countries, including Mexico, in various feeding programs; the purpose has been to improve the nutritional status of the population due to its high nutritional value and its relatively low cost that it maintained for some time" (Torres y Torres and Tovar-Palacio, 2009, p246).

[13] For more detail please see the full report of may 2019 (USDA 2019, table 11, p24).

[14] Metric tons. More generally, units used in this document all refer to metric system units.

[15] It is in 1994 that the first genetically modified food was approved by Food and Drug Administration. (FDA) (James and Krattiger 1996). Officially: tomato CGN-89564-2, it is better known worldwide by its, now famous, commercial name: Flavr Savr™. Developed by Calgene, the aim was to obtain a longer shelf life by inserting an antisense gene delaying ripening. This first authorisation opened the door to new plants. During the following year 1995, a wave of genetically-modified (cash) crops were approved. We can mention, for instance, the canola with modified oil composition, the cotton resistant to the herbicide bromoxynil, Bt cotton, Bt maize, virus-resistant squash, other delayed ripening tomatoes and, of course, the glyphosate-tolerant soybeans. This later was commercialised with the name Roundup Ready™. In 1996, only one year after its lunch, it enjoyed an impressively large acreage of 1 million acres. This success being mainly due to its herbicide resistance.

Indirect consumption is important in countries that use it for food farming. For instance, European countries tend to use soybeans to feed animals.

Figure 9 - Soybeans Importers Through Time

(a) 1998

(b) 2002

(c) 2010

(d) 2017

Source: Authors' elaboration based on HS96

Figure 9 depicts the volume of soybean import by country for four different years: 1998, 2002, 2010 and 2017. Figure 9 panel a shows that, in 1998, China, the country that is identified as an historical consumer, imports less than countries like Japan (first importer), Netherlands[16], Spain, Germany or Mexico). The entry of China into the World Trade Organization (WTO) as a full member on December 11th 2001 radically change the import market. One year after its entering in WTO, China, enjoying a free access also to the soybeans market, start importing a relevant part of soybean global flows. As illustrated on Figure 9 panel b, Japan, Netherlands, Spain, Germany and Mexico are still, in 2002, important importers but at a much lower level. We also observe a clear dispersion of the quantities traded. In 2010, Figure 9 panel c, China imports are as important than those of traditional importers. These "traditional" importers are no longer visible on the map. This trend is confirmed by Figure 9 panel d, which shows that the importance of China on this market continues to grow (contraction of legend). Soybean market in China is then an enormous and growing market. It represents incredible opportunities for producers and country exporters.

The production market of soybean is very concentrated. As mentioned above, the five main actors produce more than 90% of world production. Table 4 summarises some key statistics for the main producers of soybeans in 2018 (USDA, 2019).

[16] Due to the presence of important ports and multinationals

Table 4 - Soybean Production Details (2018)

	AREA	YIELD	PRODUCTIO N	WORLD SHARE
UNITED STATES	35.7	3.47	123.7	34.15%
BRAZIL	36.1	3.24	117.0	32.31%
ARGENTINA	17.1	3.27	56.0	15.47%
CHINA	8.4	1.89	15.9	4.39%
INDIA	11.0	1.05	11.5	3.18%
PARAGUAY	3.3	2.73	9.0	2.49%
CANADA	2.6	2.86	7.1	2.02%
UKRAINE	1.7	2.58	4.5	1.23%
RUSSIA	2.7	1.47	4.0	1.11%
BOLIVIA	1.4	1.93	2.7	0.75%
URUGUAY	1.0	2.00	2.0	0.55%
WORLD	125.69	2.88	362.08	

Area: production surface in million hectares

Yield: production in metric tons per hectare

Production: production in million metric tons

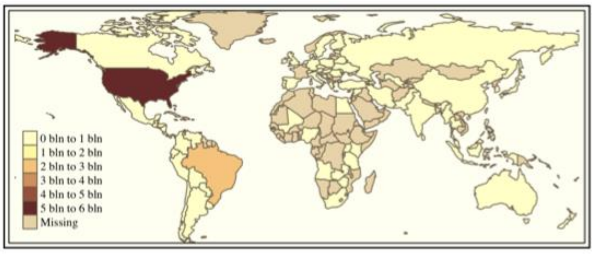
The three main producers clearly dominate the production market. First, in terms of quantity produced. Second, and this point is interesting, in terms of tons per hectare. Indeed, the United States have a yield of 3.47 tonnes per hectare and is very closely followed by Brazil (3.27) and Argentina (3.24). In terms of yield, the US seem to be the most productive, closely followed by Brazil and Argentina, and are 3 times more productive than India and 1.8 times than China. The intensive use by these countries of genetically-modified organism may explain, at least in part, these differences.

The situation from the production point of view of the market is then, in 2018, very clear.

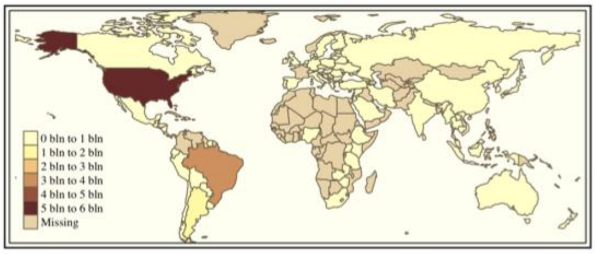
Figure 10 represents the volume of soybean export by country for four differenced selected years: 1998, 2002, 2010 and 2017. We wonder whether China entry into the WTO had a direct impact on soybeans exporters. To answer this question, it is interesting to carefully analyse potential differences between 1998 (Figure 10 panel a) and 2002 (Figure 10 panel b). The effect on this side of the market is not that evident. We can nonetheless see a clear trend for our main three producers. Brazil tends to increase its importance. And so do Argentina and the United States.

The following section will focus on the producer side to understand what are the dynamics and trends between producers and how productivity evolves

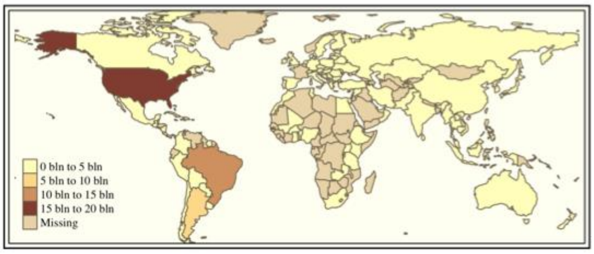
Figure 10 - Soybeans Exporters Through Time



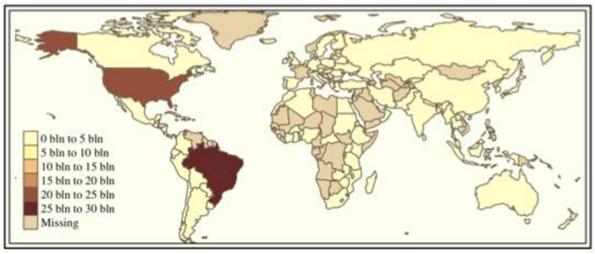
(a) 1998



(b) 2002



(c) 2010



(d) 2017

Source: Authors' elaboration on HS96

3.3 Competition and crowding-out effect

In 2017, Asia accounts for 80% of soybean imports, Europe 12%, North America 4.2%. At the same time, South America and Africa represent only 2% and 1.8% respectively. At a country level, China clearly dominates the market and alone accounts for 63% of world imports (for the amount of $36.6B). China imports soybeans mainly from Brazil (56%-$20.3B), United States (34%- $12.5B), Argentina (6.6%-$2.41B) and Uruguay (1.4%-$497M). It does not seem to import from Paraguay and Bolivia, other important producers (as seen in Table 4), enjoying a yield rate of about two tons per hectare[17].

In 2017, Brazil was exporting 89% ($23.1B) of its soybean to Asia, and about 10% to Europe. Chinese market represents 79% of its total soybean exports. The situation is similar in Argentina and United States. Respectively 88% and 80% of their exports is done to Asia (79% and 57% only to China).

We notice that potential market variation can impact these economies in a variety of ways. It depends of each country situation and economic structure. Our panel of South American countries all enjoy very concentrated export in quantity. These countries are therefore very sensitive to market variations in terms of both quantity and price. In 2017, soybean represents 12% ($25.8B) of total Brazilian export. During this same year, it was about 4.8% ($2.82B) for the Argentinian one’s and 1.8% ($22B) for the United States, which exports are highly diversified in terms of number of products and varieties. Therefore, even if the export volume in dollar seems similar between Brazil and United States, it is clear

[17] The fact that Bolivia and Paraguay do not directly export to China could be linked to the fact that they are landlocked and that the neighbouring countries are able to exploit this situation. This is in line with the geography models of trade.

that Brazil is more sensitive to market change. Soybeans represent a very important part of its total less diversified exports, and a change in international market can affect Brazil more. Argentina is somehow in between. Of course the trade volume is about nine time lower, but soybeans still represents a substantial part of its also less diversified exports. It also to be remembered that its yield per hectare is greater that its big neighbour, and about 15% greater than the world average.

Looking at the evolution of export flow to China over time, we first notice a clear time pattern with an important constant increase from 2000 to 2017. For instance, Argentina multiplied its export in value by 4.5 times and United States about 12 times. The most impressive increase is probably the Brazilian one. This grew from $340M in 2000 to $20.3B of soybean export: an increase of about 60 times. It then became the first world exporter of soybean while, in 2000, it was only exporting about one third of United States exports[18]. In 2017, it exported 60% more. This tends to confirm what was seen earlier during the analysis of Table 4.

We have now a precise idea of the economic context of the soybean market, we can enter into the analysis of the competition between Argentina and Brazil. Table 5 displays some key information for our analysis. First, it informs us about the value of a country (origin) soybean export to China for a selection of years. This table is confined to the 3 main world exporters: Argentina (arg), Brazil (bra) and the United States of America (usa). We then see on Table 5 columns *QS low*, *QS med* and *QS high* the quality distribution of soybean, according to Fontagné's methodology for an α set to 2.5. We remember that, by construction, the quality level is set according through a price discrimination process as seen in equation 1 and Figure 1. The column "Competitivity" of Table 5, corresponds to the first part of Equation 4. We can define it as a mixture of competitiveness effect and industry reallocation. It is indeed hard to say if a gain in a micro market share, at a product level, is due to a pure gain of productivity done by the national industry "winning against its competitors", or if it is due to the reallocation in the country of production capitals or facilities. Competitivity is measured through a period of time. The figure in the row year indicated the Competitivity evolution between this year and the precedent one. 2000 being our first year, it is also our reference year for the 2000-2007 period. The column "Structural" of Table 5 corresponds to the second part of Equation 4 described in the methodological section, namely the indirect competition effects.

Table 5 suggests that United States is mostly producing low quality soybeans: 83% of its soybean exports in 2000 and 84% in 2017 were on this low quality segment. Argentina and Brazil are more centred on medium quality, respectively about 60% to 70% and high quality for the rest. Brazil is then competing with Argentina in both medium and high quality segment. Brazil competes with the United States, such as Argentina, only on the medium quality segment. It is, indeed, the only segment where the three countries compete.

Looking at the competition effect (column "competitivity" of Table 5), we observe that only Brazil always has positive coefficient. Argentina is always negative and the United States enjoys a positive one only once in 2010.

[18] Note that these years were those in which Brazil was growing fast and was part of the BRICS (Brazil, Russia, India and China) group. The same years saw the crisis hit very strongly the US economy.

Table 5 - Soybean - export to China – 3 main exporters

Year	Origin	Flow Value	QS low	QS med	QS high	Competitivity	Structural
2017	bra	20 337 489 091	0.00	0.61	0.39	0.006599	0.008420
2017	usa	12 450 785 821	0.84	0.16	0.00	-0.004183	0.005155
2017	arg	2 414 590 332	0.00	0.84	0.16	-0.003205	0.001000
2010	usa	11 118 800 640	0.76	0.24	0.00	0.001139	0.004287
2010	bra	7 139 254 944	0.00	0.88	0.12	0.000420	0.002753
2010	arg	4 121 131 782	0.02	0.98	0.00	-0.001720	0.001589
2007	usa	4 200 483 599	0.24	0.76	0.00	-0.001865	0.000949
2007	bra	2 858 116 447	0.00	0.75	0.25	0.001953	0.000646
2007	arg	2 664 457 654	0.00	0.65	0.35	-0.000021	0.000602
2000	usa	1 050 357 016	0.83	0.17	0.00		
2000	arg	531 233 299	0.00	0.67	0.33		
2000	bra	340 255 868	0.00	0.60	0.40		

Source: Authors' elaboration based on our dataset

The structural effect is positive for all three countries (Table 5 column "structural"). The economic structural conditions favoured the development of this product suggesting that world demand is then growing.

Let us now investigate whether there was any displacement of soybean exports of one country in a particular market (China). The analysis performed, confined to Brazil and Argentina for the Chinese destination market, is reported in Table 6.

Table 6 - Part micro share change of ARG export to CHN due to BRA COE (α=2.5)

	$\Delta M_{js}^{t+1,t}$	$\Delta M_{js_{low}}^{t+1,t}$	$\Delta M_{js_{med}}^{t+1,t}$	$\Delta M_{js_{high}}^{t+1,t}$
Period 2000 - 2007	-0,0325	.	-0,0603	0,0120
Period 2007 - 2010	-0,0329	.	-0,0306	-0,5679
Period 2010 - 2017	-0,0804	.	-0,1418	0,0435
Period 2000 - 2017	-0,1410	.	-0,2599	-0,5097

Source: Authors' elaboration based on our dataset

Table 6 allows shows by period and by quality level if Brazil soybean exports are crowding-out Argentine ones. First, as expected, we notice that these countries do not compete on the low quality segment of this product export ($\Delta M_{js_{low}}^{t+1,t}$). It follows from the fact that these two countries are never at the same time present on this quality segment. If we look at the medium quality segment ($\Delta M_{js_{med}}^{t+1,t}$), it is clear that Brazil is crowding-out Argentina's exports of soybeans, for the overall period as well as for every single sub-period. The same trend can be observed at a "general" level ($\Delta M_{js}^{t+1,t}$) where no quality division is done. But, the story is different if we focus on the high quality segment ($\Delta M_{js_{high}}^{t+1,t}$). This quality segment sees Brazil crowding-out Argentina's export over the period 2000-2017. However, Argentina displaced Brazilian exports during the periods 2000-2007 and 2010-2017. This means that the fight for market shares in the high quality level does not have a clear "winner", while for the medium quality level Brazil is crowding out Argentina. For high quality soybeans, therefore, competition is still open. This conclusion is somehow surprising if we consider the growth difference of these two countries soybean export to China.

To control the robustness of these results we re-did the same computation but with other level of α, smoothing parameter which influence the quality share repartition. As seen in section 1.4.1, four different level of α can interest us. The first one [1.9] gives the same importance to the low and medium quality shares (about 39%). The second α, [2.5], was used above during our precedent analysis. The third α, [3.4], gives the same importance to the medium and high quality shares (about 27%). The last one is the Fontagné et al.(2008)'s and Liu et al. (2018)'s α, set to [4]. This last one overweight low (47%) and high quality (27%) at the expense of the medium one (24%).

Table 7 - Part micro share change of ARG export to CHN due to BRA COE – different α

	Alpha (α) = [1.9]		Alpha (α) = [3.4]		Alpha (α) = [4]	
	$\Delta M_{js_{med}}^{t+1,t}$	$\Delta M_{js_{high}}^{t+1,t}$	$\Delta M_{js_{med}}^{t+1,t}$	$\Delta M_{js_{high}}^{t+1,t}$	$\Delta M_{js_{med}}^{t+1,t}$	$\Delta M_{js_{high}}^{t+1,t}$
PERIOD 2000 - 2007	-0,0531	0,0163	-0,0711	0,0058	-0,0784	0,0018
PERIOD 2007 - 2010	-0,0321	-0,5701	-0,0272	-0,5646	-0,0244	-0,5624
PERIOD 2010 - 2017	-0,1282	0,0426	-0,1601	0,0450	-0,1706	0,0459
PERIOD 2000 - 2017	-0,2323	-0,5085	-0,2983	-0,5114	-0,3212	-0,5125

Source: Authors' elaboration based on our dataset

As we can see on Table 7, results are similar to the one obtained above with α set to [2.5].

Conclusion

In this chapter, we have focused on an important non-price competition factor: quality and we have analysed the production and exports of a number of South American countries comparing them with main aggregations of countries in the world, described in terms of areas where goods are not subject to tariffs or other obstacles: free trade areas. We highlighted that the high quality share of exports is relatively stable (between 15% and 20%) for the panel of South American countries over the period 2000-2017. Looking in more detail at the cases of Argentina and Brazil, we have seen that the quality levels of exports, medium and low, were fairly comparable for these two countries. Although Argentina tends to have a slight dominance of medium quality exports while Brazil has a slight dominance of low quality exports. From the analysis of the extensive margin for the panel of South American countries exports, we singled out a product which is very relevant for these countries: soybeans. This product is consumed as final good, notably in Asia and particularly in China but is also an intermediate product in several different value chains. Soybean is a very important product for the Argentinean and Brazilian economies and its value chain represent 2.6% of total employment in Argentina and 1.6% in Brazil

(Bianchi and Szpak 2017). We have therefore carried out an analysis of the evolution of the direct competition effect (competitiveness) between Argentina and Brazil over the period 2000-2017, using the constant market share analysis (Fontagné et al., 2008; Liu et al., 2018) to divide the product into quality groups: low, medium and high. We have done robustness checks by using different parameters to divide soybeans in the different quality groups. The analysis indicates that what seemed to be Brazil's total domination over Argentina reflected a partial truth. Argentina is competitive when it comes to high quality, even though Brazil has a much higher growth rate in the production of this product in recent years. Results are robust to the use of different parameters.

References

Batista, Jorge Chami. 2008. "Competition between Brazil and Other Exporting Countries in the US Import Market: A New Extension of Constant-Market-Shares Analysis." *Applied Economics* 40(19):2477–87.

Berthou, Antoine, and Charlotte Emlinger. 2011. "The Trade Unit Values Database." *CEPII* (WP No 2011-10):33.

Bianchi, Eduardo, and Carolina Szpak. 2017. "Soybean Prices, Economic Growth and Poverty in Argentina and Brazil." *UNCTAD-FAO* 49.

Czaplicki Cabezas, Stasiek, Helen Bellfield, Guillaume Lafortune, Charlotte Streck, and Barbara Hermann. 2019. *More Sustainability in the Soy Supply Chain: How Can EU Actors Support Zero Deforestation and SDG Efforts?* Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ).

Deaton, Angus. 1988. "Quality, Quantity, and Spatial Variation of Price." *The American Economic Review* 78(3):418–30.

Fagerberg, Jan, and Gunnar Sollie. 1987. "The Method of Constant Market Shares Analysis Reconsidered." *Applied Economics* 19(12):1571–83.

Fontagne, Lionel, Guillaume Gaulier, and Soledad Zignago. 2008. "Specialisation Across Varieties Within Products and North-South Competition." *Economic Policy* 23(53):52–91.

He, Fen-Jin, and Jin-Qiang Chen. 2013. "Consumption of Soybean, Soy Foods, Soy Isoflavones and Breast Cancer Incidence: Differences between Chinese Women and Women in Western Countries and Possible Mechanisms." *Food Science and Human Wellness* 2(3–4):146–61.

Heron, Tony, Patricia Prado, and Chris West. 2018. "Global Value Chains and the Governance of 'Embedded' Food Commodities: The Case of Soy." *Global Policy* 9:29–37.

Hill, Edward, Howard Wial, and Harold Wolman. 2008. "Exploring Regional Economic Resilience." *University of California, Institute of Urban and Regional Development (IURD)* (Working Paper, No. 2008,04):22.

James, Clive, and Anatole F. Krattiger. 1996. "Global Review of the Field Testing and Commercialization of Transgenic Plants: 1986 to 1995 The First Decade of Crop Biotechnology." *The International Service for the Acquisition of Agri-Biotech Applications (ISAAA)* (1):44.

Le Monde, and AFP. 2012. "70 % de la production mondiale de soja est OGM." May 24.

Liu, Yan, Xunpeng Shi, and James Laurenceson. 2018. "Are China's Exports Crowding Out or Being Crowded Out? Evidence from Japan's Imports." *China & World Economy* 26(4):1–23.

Paulsen, Marvin R. 2008. "Measurement and Maintenance of Soybean Quality." Pp. 151–92 in *Soybeans*. Elsevier.

Torres y Torres, Nimbe, and Armando R. Tovar-Palacio. 2009. "La historia del uso de la soya en México, su valor nutricional y su efecto en la salud." *Salud Pública de México* 51(3):246–54.

Turzi, Mariano. 2011. "The Soybean Republic." *Yale Journal of International Affairs* Spring-Summer:59–68.

United Nations, ed. 1992. *Handbook of the International Comparison Programme*. New York: United Nations.

USDA. 2019. *World Agricultural Production*. *Circular Series*. WAP 5-19. United States Department of Agriculture.

Zhu, Zhenying, Shangbing Chen, Xueyou Wu, Changrui Xing, and Jian Yuan. 2018. "Determination of Soybean Routine Quality Parameters Using Near-Infrared Spectroscopy." *Food Science & Nutrition* 6(4):1109–18.

Appendix

Table 8 - Free Trade Areas - Names and Countries

NAFTA	North American Free Trade Agreement	Canada, Mexico, United States
ASEAN	Association of Southeast Asian Nations	Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei Darussalam, Vietnam, Laos, Myanmar, Cambodia
ALADI	Latin American Integration Association	Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Ecuador, Mexico, Paraguay, Panama, Peru, Uruguay, Venezuela
CISFTA	Commonwealth of Independent States Free Trade Area	Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine and Uzbekistan
CEMAC	Central Africa Economic and Monetary Community	Cameroon, Central African Republic, Republic of the Congo, Gabon, Equatorial Guinea, Chad
ECOWAS	Economic Community of West African States	Benin, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, and Burkina Faso (which joined as Upper Volta), Cape Verde
AFTZ	African Free Trade Zone	Angola, Botswana, Burundi, Comoros, Djibouti, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Lesotho, Libya, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, Swaziland, South Africa, Sudan, Tanzania, Uganda, Zambia, and Zimbabwe

Figure 11 - Free Trade Area Map

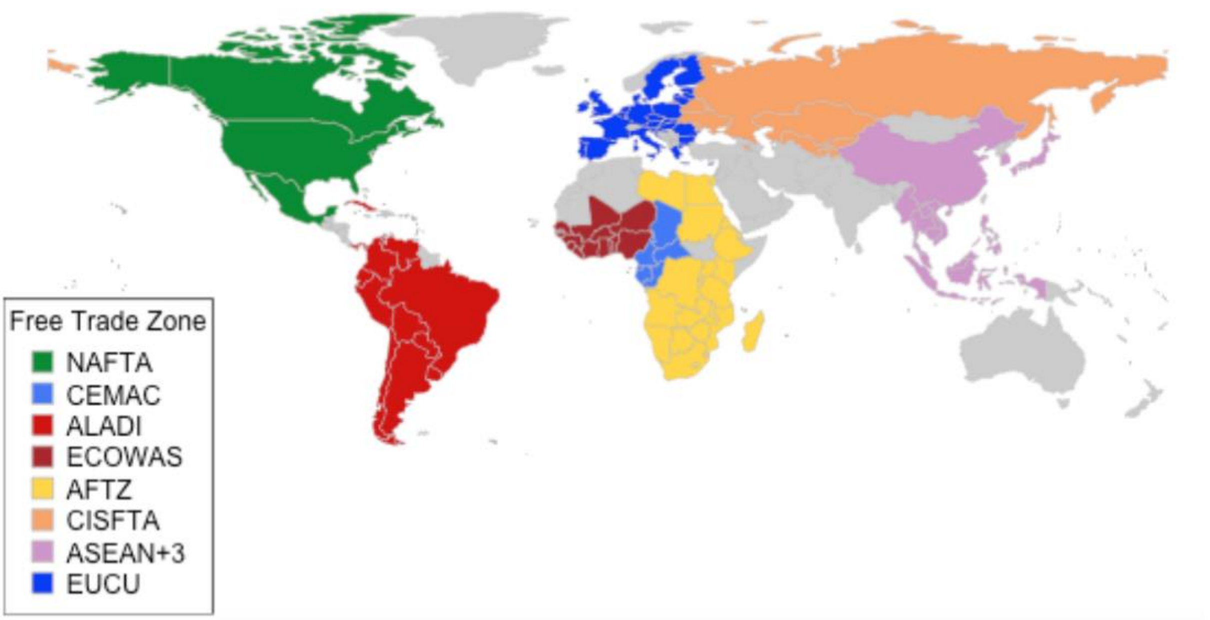


Table 9 - Top 20 main product diversified exporters in 2017

COUNTRY	# HS96-6	FTA
AUT	4586	EU28
BLX	4693	EU28
CAN	4508	NAFTA
CHN	4768	ASEAN_3
CZE	4567	EU28
DEU	4725	EU28
ESP	4684	EU28
FRA	4709	EU28
GBR	4733	EU28
IND	4631	ROW
ITA	4713	EU28
JPN	4594	ASEAN_3
KOR	4516	ASEAN_3
NLD	4683	EU28
POL	4610	EU28
PRT	4515	EU28
RUS	4520	CISFTA
SWE	4497	EU28
TUR	4482	ROW
USA	4834	NAFTA

Source: Authors' elaboration based on HS96

Table 10 - Argentina main exports in 2017

#HS 96	PRODUCT NAME	GROUP
#020130	Meat Of Bovine Animals, Boneless, Fresh Or Chilled	Animal Products
#030613	Shrimps And Prawns, Frozen	Animal Products
#100190	Wheat (Including Spelt) And Meslin, Unmilled, N...	Vegetable Products
#100590	Maize (Not Including Sweet Corn) Unmilled, Exce...	Vegetable Products
#120100	Soybeans	Vegetable Products
#150710	Soybean Oil, Crude, Whether Or Not Degummed	Animal and Vegetable...
#220421	Wine Of Fresh Grapes (Other Than Sparkling Wine...	Foodstuffs
#230400	Oilcake of soya beans	Foodstuffs
#710812	Gold (Including Gold Plated With Platinum), Non...	Precious Metals
#870421	Motor Vehicles For The Transport Of Goods, N.E.S.	Transportation

Table 11 - Bolivia main exports in 2017

#HS 96	PRODUCT NAME	GROUP
#080122	Brazil Nuts, Fresh Or Dried, Whether Or Not She...	Vegetable Products
#150710	Soybean Oil, Crude, Whether Or Not Degummed	Animal and Vegetable...
#230400	Oilcake of soya beans	Foodstuffs
#260700	Lead Ores And Concentrates	Mineral Products
#260800	Zinc Ores And Concentrates	Mineral Products
#261610	Silver Ores And Concentrates	Mineral Products
#271121	Natural Gas, In The Gaseous State	Mineral Products
#710691	Silver (Including Gold And Platinum Plated Silv...	Precious Metals
#710812	Gold (Including Gold Plated With Platinum), Non...	Precious Metals
#800110	Tin, Unwrought (Not Alloyed)	Metals

Table 12 - Ecuador main exports in 2017

#HS 96	PRODUCT NAME	GROUP
#030613	Shrimps And Prawns, Frozen	Animal Products
#060310	Cut Flowers And Flower Buds Suitable For Bouque...	Vegetable Products
#080300	Bananas (Including Plantains), Fresh Or Dried	Vegetable Products
#151110	Palm Oil, Crude	Animal and Vegetable...
#160414	Tunas, Skipjack And Bonito (Sarda App.) Whole O...	Foodstuffs
#180100	Cocoa Beans, Whole Or Broken, Raw Or Roasted	Foodstuffs
#210111	Extracts, Essences And Concentrates Of Coffee A...	Foodstuffs
#270900	Petroleum Oils And Oils From Bituminous Mineral...	Mineral Products
#271000	line Including Aviation (Except Jet) Fuel	Mineral Products
#710812	Gold (Including Gold Plated With Platinum), Non...	Precious Metals

Table 13 - Paraguay main exports in 2017

#HS 96	PRODUCT NAME	GROUP
#020130	Meat Of Bovine Animals, Boneless, Fresh Or Chilled	Animal Products
#020230	Meat Of Bovine Animals, Boneless, Frozen	Animal Products
#100190	Wheat (Including Spelt) And Meslin, Unmilled, N...	Vegetable Products

#100590	Maize (Not Including Sweet Corn) Unmilled, Exce...	Vegetable Products
#100630	Rice, Semi	Vegetable Products
#120100	Soybeans	Vegetable Products
#150710	Soybean Oil, Crude, Whether Or Not Degummed	Animal and Vegetable...
#230400	Oilcake of soya beans	Foodstuffs
#410422	Bovine Leather N.E.S. And Equine Leather (Witho...	Animal Hides
#854430	Ignition Wiring Sets And Other Wiring Sets Of A...	Machines

Table 14 - Peru main exports in 2017

#HS 96	PRODUCT NAME	GROUP
#080610	Grapes, Fresh	Vegetable Products
#090111	Coffee, Not Roasted, Not Decaffeinated	Vegetable Products
#230120	Flours, Meals And Pellets Of Fish Or Of Crustac...	Foodstuffs
#260300	Copper Ores And Concentrates	Mineral Products
#260700	Lead Ores And Concentrates	Mineral Products
#260800	Zinc Ores And Concentrates	Mineral Products
#271000	line Including Aviation (Except Jet) Fuel	Mineral Products
#271111	Natural Gas, Liquefied	Mineral Products
#710812	Gold (Including Gold Plated With Platinum), Non...	Precious Metals
#740311	Refined Copper	Metals

Table 15 - Uruguay main exports in 2017

#HS 96	PRODUCT NAME	GROUP
#010290	Bovine Animals, Other Than Purebred Breeding An...	Animal Products
#020130	Meat Of Bovine Animals, Boneless, Fresh Or Chilled	Animal Products
#020220	Meat Of Bovine Animals With Bone In, Frozen	Animal Products
#020230	Meat Of Bovine Animals, Boneless, Frozen	Animal Products
#040221	Milk And Cream, In Solid Form, Of A Fat Content...	Animal Products
#100630	Rice, Semi	Vegetable Products
#110710	Malt, Whether Or Not Roasted (Including Malt Fl...	Vegetable Products
#120100	Soybeans	Vegetable Products

#410431	Bovine Leather N.E.S. And Equine Leather (Witho...	Animal Hides
#510529	Wool Tops And Other Combed Wool	Textiles