



# Essays on the Trade and Macroeconomic dimensions of Global Value Chains

Sebastián Franco Bedoya

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# Essays on the Trade and Macroeconomic dimensions of Global Value Chains

Thèse de doctorat de l'Université Paris-Saclay  
préparée à École Polytechnique

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*In loving memory of my mother, Teresa.  
She could only see the beginning, but  
all this is thanks to her.*



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## Résumé en français

La phase la plus récente de la mondialisation, que constituent les chaînes de valeur mondiales ("CVM"), date du début des années 1990. La naissance de l'Organisation Mondiale du Commerce a abattu de nombreuses barrières commerciales et a conduit à la libéralisation dans des domaines tels que les télécommunications, les services financiers et les technologies de l'information. Cela a suscité l'émergence de nouveaux modèles d'affaires qui se sont appuyés sur de nouvelles opportunités pour développer des avantages comparatifs, avec un flux constant d'investissement, de technologies, de biens intermédiaires et les services aux entreprises. C'est ce qu'on appelle la « chaîne d'approvisionnement internationale ». La principale caractéristique de ce phénomène est l'augmentation du commerce des biens finaux et intermédiaires entre les pays. Les biens intermédiaires ont généré la structure de production du réseau du commerce international et, donc, l'exposition à de nouveaux défis économiques qui ne sont pas saisis et pleinement compris par les statistiques commerciales bilatérales. L'existence du réseau commercial international, liant les pays non seulement du côté de la consommation mais aussi de la production, fait que le contenu à valeur ajoutée du commerce diffère des exportations brutes. C'est précisément la valeur ajoutée qui est le principal objet d'intérêt économique parce qu'elle détermine l'activité économique et le niveau global de l'emploi dans un pays. La question principale est donc de savoir si les changements dans l'organisation du commerce mondial conduisent à une révision de nos intuitions économiques. C'est l'objet de cette thèse, dans laquelle je passe en revue de nombreux sujets et d'hypothèses économiques pressantes et les relie aux schémas de production mondiaux.

Cette thèse couvre les thèmes suivants : l'équation de gravité à valeur ajoutée, le rôle des accords de libre-échange et des technologies de l'information et de la communication captés comme un "effet frontière", et les déséquilibres commerciaux. D'une manière générale, les résultats montrent que (i) les conséquences de négliger la dimension des CVM pour l'élasticité des exportations à valeur ajoutée sont qu'elles ne sont pas constantes dans le temps et inférieures à celles des exportations brutes. Une contribution importante est ici de mettre en place un cadre souple qui lie les changements dans les exportations à valeur ajoutée aux changements dans le flux réel des biens finaux et intermédiaires. Cela facilite la mise en oeuvre d'autres outils qui ont été développés auparavant dans la littérature, comme les taux de change effectif réel (REER) en termes de valeur ajoutée. (ii) les accords de libre-échange augmentent le commerce bilatéral de 54% en moyenne après 10 ans ou plus, autant pour les biens finaux que pour les biens intermédiaires. Le "border effect" (ou "effet frontière") est devenu moins contraignant avec le temps, les échanges de biens finaux ont augmenté de 443% par rapport au commerce intérieur depuis 1970, tandis que la hausse a été de 195% pour les biens intermédiaires. Ils fournissent également la preuve que l'effet des accords de libre-échange sur le commerce s'est renforcé avec le temps. (iii) L'utilisation d'une approche à valeur ajoutée pour étudier les déséquilibres commerciaux montre que nous ne comprenons toujours pas complètement les causes et les conséquences de ces déséquilibres et que les CVM ne font que compliquer davantage les analyses. Par conséquent, je démêle les différentes composantes de la dynamique de la balance commerciale (la performance commerciale et la croissance de la demande) tout en intégrant les liens internationaux du réseau de production entrées-sorties. Enfin, j'explique dans quelle mesure les dévaluations internes sont suffisantes pour com-

penser la rigidité des taux de change intra-Euro.

# Introduction

## The "Short" History of Global Value Chains

Globalization is one of the most prominent and dominant features of the modern-day economy. The changes it has brought have had broad consequences for the way consumers have access to goods and services, and more recently, how firms organize and coordinate production process across countries. [Baldwin \(2016\)](#) describes the process of globalization in several different stages. The first of them dates its start to the early nineteenth century when the Industrial Revolution lowered transportation costs and allowed the separation of production and consumption. This period was the denominated "first unbundling."

The most recent phase of globalization, the emergence of the so-called Global Value Chains (GVCs), is usually dated towards the end of the 1980s and took place in years rather than decades. This time the nature globalization was different. This period not only witnessed how the fall of the Berlin Wall brought down the barriers that had split the post-WWII world, but also the conclusion of the Uruguay Round and the birth of the World Trade Organization. Efforts to bring down many trade barriers expanded trade and led to further liberalization in areas like telecommunications, financial services, and information technologies. The most im-

portant characteristic was that radical advances in information and communication technologies (ICT) allowed to separate production processes across different countries and, what is critical to [Baldwin \(2016\)](#), to move ideas. New business models appeared to build on new opportunities, and comparative advantages became more focused on specific tasks, rather than goods. With new and more open markets, and with the information and communication technologies gaining momentum, the international trade system turned into much more than just a simple exchange of merchandise across borders. It evolved into a constant flow of investment, techniques, goods used in other production processes, and business services. Something that is better understood as an international production network. This complex system is what has been denominated the "Global Supply Chain."

## **Why are GVCs important?**

The fact that nowadays countries not only produce final goods but also demand and supply intermediate inputs implies that they add value at different stages of the production process. Domestic value-added flows through this international production network in different ways, changing the concept of competitiveness. Nowadays, it makes little sense to view a good as 100% domestic or with the label "Made in...". Countries involved in international supply chains have obtained access to new production methods, and cheaper and better inputs, making it possible to take advantage of their and other countries' comparative advantages. The various ways of participating in global value chains increase the already considerable complexity of the system, but more importantly, the emergence of



global value chains has brought challenges for traditional policy-making (Amador and Cabral, 2017). See for instances the accumulation of trade barriers along the supply chain or how national competitiveness depends on other countries through forward and backward linkages.

This thesis bases its analysis in differentiating trade flows in final and intermediate goods. Chapters 1 and 3, additionally, follow a comprehensive value-added approach that identifies the origin and final destination of the value-added trade flows. The primary challenge in pursuing a value-added strategy is the need to model the whole world economy. The use of world input-output tables provide the data for countries representing around the 85 % of the world GDP (depending on the year and database used), and an additional synthetic Rest of the World (ROW) region. Moreover, these databases also allow emphasizing the sectoral dimension of trade.

## **The Scope of this Thesis**

The title of this Ph.D. thesis, "Essays on the Trade and Macroeconomic dimensions of Global Value Chains," emphasizes the purpose and topics covered in this Ph.D. thesis. The nature of the international trade network, linking countries not only on the consumption side but also on production has led to profound changes in the organization of world trade, and in turn, to a revision of our Economic intuitions. In this thesis, I review at least three pressing Macroeconomic and Trade issues by connecting them to the recent global production patterns.

This thesis covers three broad topics. The first of them is the gravity equation for value-added exports. I carry out a tractable derivation

of the gravity equation and show some of its applications. The second is the trade-enhancing effect of Free Trade Agreements and reductions in all factors affecting international trade in comparison to national transactions. The third and last topic is a view of the euro area trade imbalances through the Global Value Chains lenses. To address each of these topics, I make a clear distinction between final and intermediate goods of bilateral trade flows. This distinction is made thanks to the World Input-Output Tables (WIOTs), from different databases, which in turn differentiate these goods by applying the Broad Economic Classification (BEC).

Chapter one derives the sector-level gravity equation for value-added exports. The main contribution is to obtain this gravity equation in a more tractable way than the existing literature. The International supply chain link countries not only on the consumption side but also on production due to the sourcing of intermediate goods (inputs) from abroad. These production linkages not only make the value-added content of trade to differ from gross exports but also that the structural determinants of bilateral value-added flows (e.g., accumulated trade barriers and prices from different countries along the supply chain) are more difficult to be studied. I use the value-added gravity equation to examine issues related to price competitiveness of the domestic economy when trade is not only in final goods but also intermediates. The elasticity of value-added exports to value-added prices and value-added Real Effective Exchange Rates (VA-REERs), with a rich sectoral dimension, are computed by building on the core value-added accounting framework of [Johnson and Noguera \(2012\)](#).

Chapter two, joint work with Erik Frohm, studies the trade-enhancing role of diminished trade barriers, which arguably constituted the primary drivers of the emergence of the Global Value Chains. We simultaneously

address the implementation of Free Trade Agreements and the reduction of all costs reducing international trade flows relative to domestic ones ("border effect"). We use data from the year 1970 to precisely capture the moment in time when the reductions in these trade barriers generate important changes in the international trade system. Results show a prominent role for the border effect in stimulating bilateral trade, with the subsequent strengthening impact of Free Trade Agreements.

Chapter three uses the lenses of Global Value Chains to carry out an analysis of the euro area imbalances. With a multi-sector, multi-country framework, I disentangle the factors driving the evolution of the trade balance to GDP ratio dynamics in the presence of international input-output linkages. I also shed some light on to what extent GVCs affect the effectiveness of internal devaluations. Both, the analysis of the drivers of the imbalances and the effectiveness of economic policies to correct them are of interest to the macroeconomic monitoring schemes that are now in place.

# Chapter 1

## Value-Added Gravity, Elasticities and REERs

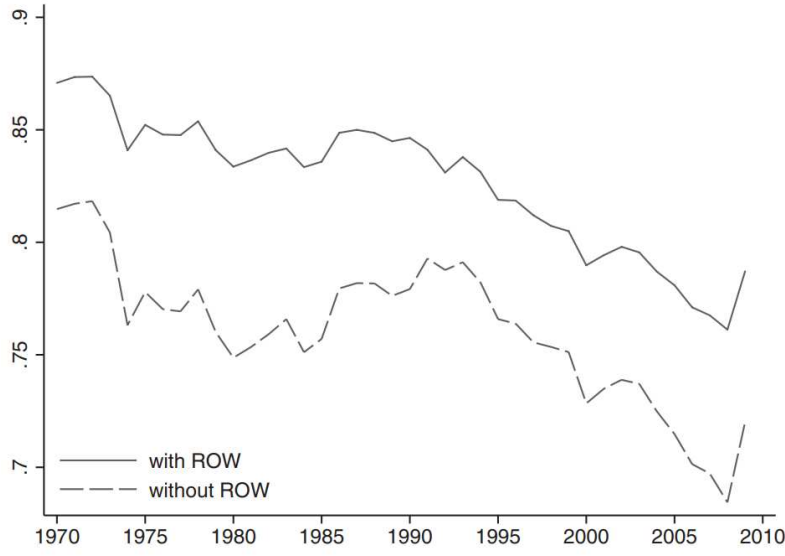
**Abstract:** This chapter derives the value-added gravity equation at the sector level in a more tractable way compared to the existing literature. International supply chains link countries not only on the consumption side but also on production. This not only makes the value-added content of trade to differ from gross exports but also that the structural determinants of bilateral value-added flows are more difficult to be studied. I use the value-added gravity equation for two applications related to price competitiveness in international supply chains: (i) I compute the elasticity of value-added exports to domestic value-added prices. With the use of imported intermediate goods, the importance of domestic prices in determining trade flows (in value-added and gross terms) must be reconsidered. I also explore the implications of neglecting trade in intermediate goods. (ii) I compute value-added Real Effective Exchange Rates (VA-REERs), as in Bems and Johnson (2017), adding a rich sectoral dimension.

*"The main question, therefore, is whether the current situation is different and trade has become less connected to exchange rates, possibly reflecting the changes in the organization of world trade since the trade liberalization that began in the 1990s."*

**IMF (2015)**

## **1.1 Introduction**

Trade in intermediate goods across countries implies that countries export domestic value added not only directly via gross exports of final goods, but also indirectly via intermediate goods that enter in the production process in other countries before being consumed in third countries. This is the denominated input-output structure of trade. Moreover, as [Johnson and Noguera \(2012\)](#) show, with the increase in trade in intermediate goods, the difference between bilateral gross exports and bilateral value-added exports has been growing. Figure (1.1) plots the evolution of the ratio of value added to gross exports (VAX ratio), a measure of the intensity of the input-output structure of trade. This implies that gross trade flows that do not differentiate between trade in final and intermediate goods only have something to say about one stage of the multi-stage production process. The quantification of production linkages is therefore key in answering important empirical questions to international trade and macroeconomics. For instance, the direct and indirect flow of domestic value added along the international supply chain means that the determinants of trade (tariff and non-tariff barriers, and changes in prices) accumulate in the different stages, the so-called 'cascade effect', and they are only partially captured by the use of gross trade flows. Therefore, there is a need for a gravity equation for bilateral value-added exports to properly study



**Source:** Johnson and Noguera (2017).

**Note:** The world value-added to export ratio is  $VAX = \left( \sum_{i \neq j} \sum_s va_{ijt}(s) \right) / \left( \sum_{i \neq j} \sum_s x_{ijt}(s) \right)$ , where  $va$  stands for value-added trade flows,  $x$  for gross trade flows.  $i$  and  $j$  index countries and  $s$  sectors. The solid line includes shipments to and from the rest of the world, and the dashed line excludes them.

Figure 1.1: World value-added to gross exports ratio (1970-2009)

these trade determinants. This chapter derives this gravity equation for bilateral value-added exports, at the sector level, in a more tractable way than what has been done in the literature so far, e.g. Noguera (2012). I then use this equation to study the elasticity of value-added exports to domestic prices, and how changes in prices of the supply chain partners and non-supply chain partners affect the competitiveness of the domestic economy. That is, I computed the denominated value-added real effective exchange rates (VA-REERs).

Noguera (2012) incorporates the global input-output structure into an international trade model to derive an approximate gravity equation for bilateral value-added exports. The first contribution of this chapter is to derive the value-added gravity equation in a more tractable way, significantly reducing the use of matrix algebra and without applying a first-order linear Taylor approximation. The tractability of the value-added

gravity equation and the simplification of its derivation are important in a literature that has been criticized for abstracting from the actual physical flow of goods across countries, giving the impression that countries directly trade value added with each other ([diMauro et al., 2016](#)). Moreover, the relationship between value-added trade flows and gross trade flows is usually not well-defined ([Nagengast and Stehrer, 2016](#)). The tractable gravity equation for value-added exports contributes to overcoming these caveats. It explicitly links changes in value-added trade flows to changes in the actual physical flow of final and intermediate goods. And as I will show later, the gravity equation provides deeper insights regarding the mechanisms at work.

The input-output structure of international trade motivated the value-added accounting framework developed by [Johnson and Noguera \(2012\)](#). Their methodology decomposes final goods output from each country into the amount of value added used, directly and indirectly, from different source countries. I build on this accounting framework to derive the value-added gravity equation. This equation can then be used for different applications. For instance, [Noguera \(2012\)](#) shows that the bilateral trade cost elasticity of value-added exports is about two-thirds of that for gross exports. Bilateral value-added exports depend not only on bilateral trade costs but also on trade costs with third countries through which value-added transits in route from source to destination. [Noguera \(2012\)](#) also shows that the relative importance of these indirect effects varies significantly across countries and types of trade costs and has increased over time alongside the rise in production fragmentation. Instead, I focus on questions related to the price competitiveness of the domestic economy and the so-called "cascade effect" along the international supply chain. This directly relates to the question of whether exchange rates still matter

for trade. The relevance of this issue lies in the fact that the disconnection between exchange rates and trade would complicate policymaking. Weakening, for instance, a key channel for the transmission of monetary policy. Recent studies have found some evidence pointing to this disconnect ([Ollivaud and Schwellnus, 2015](#); [Ahmed, 2015](#)). Others, like [IMF \(2015\)](#), find that exchange rates still matter and that there is little sign of disconnect over time.

The second contribution made in this chapter is to study price competitiveness issues along the international supply chain build on [Johnson and Noguera \(2012\)](#)'s accounting framework. First, I study the evolution of the value-added exports elasticity to domestic prices. That is, I study how changes in domestic value-added prices impact value-added exports, and how their effect has evolved over the 1995-2011 period. The main results are that (i) domestic price changes lead to a sizable redistribution of value-added exports across countries, (ii) the elasticity has decreased (in absolute value) for all countries.<sup>1</sup> These results are important to the extent that they quantify the importance of domestic prices for external competitiveness.

Second, I study the overall price competitiveness of the domestic economy. This is done by "re-building" the value-added Real Effective Exchange Rates (VA-REERs) available in the literature.<sup>2</sup> [Bems and Johnson \(2017\)](#) present an interesting extension of the trade in value-added approach to international macroeconomics by proposing the concept of the VA-REERs. They link the evolution of aggregate value-added exports to the evolution of value-added prices from all countries. Conventional real

---

<sup>1</sup>The only exception is a small increase for Malta.

<sup>2</sup>Real effective exchange rates are commonly used to measure country export competitiveness and evaluate the extent of nominal exchange rate misalignments.



effective exchange rates are often calculated from a weighted basket of consumer price indexes, where weights are based on bilateral gross trade flows. However, with the rapid pace of globalization, conventional rates became an inappropriate measure in two respects. First, because real effective exchange rates are used to assess country export competitiveness in the world market, approximating price developments with consumer price indexes (CPI) is not ideal. Consumer price indexes summarize the prices of products whose (direct and indirect) value-added origin is domestic and foreigner. Second, the values of gross trade flows cannot serve as unbiased weights because they do not represent the actual intensity of the input-output structure of trade. The value-added real effective exchange rate overcomes these problems by using gross the domestic product (GDP) deflator to measure price changes, instead of consumer price indexes. VA-REER also bases its weights on value-added bilateral trade flows, instead of gross trade flows. Nevertheless, [Bems and Johnson \(2017\)](#)'s VA-REERs neglect sectoral heterogeneity. [Johnson and Noguera \(2012\)](#) conclude that across countries, export composition drives VAX ratios, with exporters of manufactures having lower ratios. Across sectors, the VAX ratio for manufactures is low relative to services, primarily because services are used as an intermediate to produce manufacturing exports. [Bems and Johnson \(2017\)](#) show that there is an increasing gap between the values of standard REERs and VA-REERs. This difference seems to be mainly accounted by the shift from the CPI index to the GDP deflator, rather than the change in weights from gross to value-added trade flows. Nevertheless, the lack of sectoral heterogeneity raises doubts on the negligible contribution of the weights and the behavior of aggregate GDP deflators. Note that VA-REERs are designed to capture external price competitiveness, but the overall GDP deflator captures both internal and external developments.

Including non-tradable sectors that might not affect the value-added export competitiveness.

Patel et al. (2017) extend Bems and Johnson (2017)'s framework to study how input linkages affect REER measurement in a multi-sector economy. Instead of extending the already complex Bems and Johnson (2017)'s framework, I "re-build" the VA-REERs by using the gravity equation for sectoral value-added exports. Once again, significantly simplifying the derivations and computations. To illustrate this point, note that to derive the sectoral VA-REERs in Patel et al. (2017), extending Bems and Johnson (2017) methodology, it is necessary to stack numerous components in matrices way beyond the matrix algebra applied in Johnson and Noguera (2012). Moreover, note that by building on Johnson and Noguera (2012), I not only keep computations simple but enable the literature to maintain a unified framework to study any issue related to the value-added approach of trade.

The rest of the chapter is organized as follows. Section 2 derives the gravity equation for value-added exports. Section 3 uses the gravity equation to compute the value-added exports elasticity to domestic prices and the value-added REERs with a rich sectoral dimension. Section 4 describes the data. Section 5 presents the results of the value-added exports elasticity and REERs. Finally, section 6 concludes.

## 1.2 Value-Added Trade Gravity

### 1.2.1 Linking Changes in Value-Added to Gross Trade Flows

The first step to derive a value-added gravity equation is to link changes in value-added trade flows to changes in actual trade flows of final and intermediate goods. [Johnson and Noguera \(2012\)](#) put in place an accounting framework that transforms international gross trade flows into bilateral value-added exports. In their accounting framework the global economy consists of  $N$  countries and  $S$  sectors (in each country). This means that there are  $N \times S$  country-sector production entities and  $N$  representative consumers (one per country) in the world economy.<sup>3</sup> Each country-sector supplies a good that can be used both as final good by consumers and as an intermediate good by other country-sectors in production. From [Johnson and Noguera \(2012\)](#)'s accounting framework, we have that value-added exports from the origin country-sector  $o$  to destination country  $d$  are given by:

$$vax_{od} = vr_o \underbrace{\left( \sum_{i=1}^{SN} b_{oi} f_{id} \right)}_{y_{od}} \quad (1.1)$$

As Equation (1.1) shows, value-added exports from country-sector  $o$  to country  $d$ ,  $vax_{od}$ , are the product of the value added to output ratio in country  $o$  (domestic value-added content),  $vr_o$ , and the total value of output from country-sector  $o$  contained in the final goods consumed in country  $d$  from all country-sectors in the world economy,  $y_{od} = \sum_{i=1}^N b_{oi} f_{id}$ .

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<sup>3</sup>This way of using one index for each country-sector, instead of one index for country and one index for sector, alleviates notation complexity. Moreover, it makes the derivations equally tractable when working at the country-sector or the country level.

$b_{oj}$  captures the share of the value of gross output from country-sector  $o$  used directly and indirectly in the production of gross output in country-sector  $i$ , and  $f_{id}$  is the bilateral trade flow of final goods between country-sector  $i$  and country  $d$ . This equation is derived from the  $NS \times N$  matrix  $VAX = VR \times B \times F$  in [Johnson and Noguera \(2012\)](#). Where each entry of the  $NS \times N$  matrix  $F$ ,  $f_{ij}$ , denotes the value of final consumption in country  $j$  from country-sector  $i$ . The  $NS \times NS$  matrix  $B = (I - A)^{-1}$  is the Leontief's inverse and each of entry is denoted by  $b_{oi}$ . Matrix  $A$  is the matrix of global input-output coefficients (use requirements). When these trade flows are expressed as ratios to gross output of the country-sector in each column, the entries  $a_{ij} = \frac{x_{ij}}{y_j}$  provide information on the shares of inputs in total output of the sourcing column-country-sector. The product  $B \times F$  yields a  $NS \times N$  matrix. Each of its entries,  $y_{oj}$ , measures the total value of output from country-sector  $i$  contained in the value of one unit of final consumption in country  $d$ . Then, this product is rescaled with the diagonal matrix of value-added to output ratios,  $vr_o = \frac{va_i}{y_i}$ , in order to reflect how important domestic value added is in each source country-sector.

Nevertheless, note that the value-added accounting framework in equation (1.1) does not explicitly link bilateral value-added exports to the actual physical trade flow of final and intermediate goods. All the intermediate goods trade flows are contained in the  $b$  coefficients. Therefore, it gives the impression that countries directly trade value added with each other ([diMauro et al., 2016](#); [Nagengast and Stehrer, 2016](#)). This apparent abstraction can be overcome (at least in part) by linking changes in value-added exports to changes in bilateral trade flows of final and intermediate goods. Taking logs and the time derivative of equation (1.1) yields the following expression for the change of value-added exports from origin

country  $o$  to destination country  $d$ .<sup>4</sup>

$$\widehat{vax}_{od} = \widehat{vr}_o + \frac{1}{y_{od}} \sum_{i=1}^{NS} b_{oi} \dot{f}_{id} + \frac{1}{y_{od}} \sum_i^{NS} \dot{b}_{oi} f_{id} \quad (1.2)$$

Trade in intermediate goods still does not explicitly appear in Equation (1.2). It is necessary to make explicit that changes in the  $b$  entries of the Leontief inverse matrix are the result of changes in the intermediate inputs demand captured in the global input-output matrix  $A$ . To uncover this link, one needs to compute the time derivative of the Leontief inverse as follows:

$$\frac{dB}{dt} = B \frac{dA}{dt} B \quad (1.3)$$

Note that this step is the only one requiring matrix algebra in this chapter. This expression is derived taking the time derivative the identity matrix  $I = Z^{-1}Z$  and solving for the derivative of the inverse of  $Z$ , such that:<sup>5</sup>

$$\frac{dZ^{-1}Z}{dt} = \frac{dZ^{-1}}{dt}Z + Z^{-1}\frac{dZ}{dt} \rightarrow \frac{dZ^{-1}}{dt} = -Z^{-1}\frac{dZ}{dt}Z^{-1} \quad (1.4)$$

This way it becomes clear that changes in the  $b$  coefficients are the result of changes in the  $a$  coefficients,  $\dot{b}_{oi} = \sum_j^{NS} b_{oi} \dot{a}_{ij} b_{ij}$ . Then, introducing this expression into equation (1.2) yields:

$$\widehat{vax}_{od} = \widehat{vr}_o + \frac{1}{y_{od}} \sum_i^{NS} b_{oi} f_{id} \hat{f}_{id} + \frac{1}{y_{od}} \sum_i^{NS} \sum_j^{NS} b_{oi} a_{ij} \hat{a}_{ij} y_{jd} \quad (1.5)$$

---

<sup>4</sup>I use the notation  $\hat{z} \equiv \log z_t - \log z_{t-1} = \frac{\dot{z}_t}{z_t}$  and  $\dot{z} = \frac{\partial z_t}{\partial t}$  for any variable  $z$ . Note that there is no Taylor expansion as in [Noguera \(2012\)](#).

<sup>5</sup>The time derivative of a matrix is the matrix of the time derivative of each of the entries.

Finally, noting that  $a_{ij} = \frac{x_{ij}}{y_j}$ , and  $\hat{a}_{ij} = \hat{x}_{ij} - \hat{y}_j$ , we obtain the equation linking the change in bilateral value-added exports to changes in the value-added content, in final and in intermediate good trade flows:<sup>6</sup>

$$\widehat{vax}_{od} = \hat{v}r_o + \frac{1}{y_{od}} \sum_i^{NS} b_{oi} f_{id} \hat{f}_{id} + \frac{1}{y_{od}} \sum_i^{NS} \sum_j^{NS} b_{oi} a_{ij} (\hat{x}_{ij} - \hat{y}_j) y_{jd} \quad (1.6)$$

The second term in equation (1.5),  $\frac{1}{y_{od}} \sum_i^{NS} b_{oi} f_{id} \hat{f}_{id}$ , is the weighted average of the  $N \times S$  changes in final goods consumed in country  $d$  from all country-sectors in the world economy. When focusing on bilateral value-added exports, it is important to keep in mind that the destination country  $d$  absorbs value added from country-sector  $o$  both directly and indirectly. Directly when country-sector  $o$  exports final goods to country  $d$ , and indirectly by exporting intermediate goods to third country-sectors and then these country-sectors use the intermediate goods to produce final goods consumed in country  $d$  (captured by  $b$ 's coefficients). This implies that changes in final goods from all countries consumed in country  $d$  will affect the amount of country-sector  $o$ 's value added that is consumed in country  $d$ . This is why in the second term of equation (1.5) the change of country  $d$ ' final goods demand from each country-sector  $i$ ,  $\hat{f}_{id}$ , is weighted by the ratio of country-sector  $o$ 's output required (directly and indirectly) to produce country  $i$ 's final goods,  $b_{oi} f_{id}$ , to the total country-sector  $o$ 's output used to produced final goods consumed in country  $d$ ,  $y_{od}$ . The third term in Equation (1.5),  $\frac{1}{y_{od}} \sum_i^{NS} \sum_j^{NS} b_{oi} a_{ij} (\hat{x}_{ij} - \hat{y}_j) y_{jd}$ , is the change in all  $N \times S \times N \times S$  intermediate goods trade flows (net of changes in output in the destination country sector  $j$ ). This term captures the changes in the

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<sup>6</sup>Note that the value added content (value added to output ratio), and its change, is the same for all bilateral value-added exports from country-sector  $o$  given that it produces output for all destinations with the same value-added content. The change of this ratio depends on the degree of substitutability (or complementarity) between domestic value added and intermediate inputs in the production process.

international input-output structure of trade. Note that changes in bilateral intermediate goods trade flows are net of changes in the output of the country-sector in destination. This is necessary to reflect the importance of inputs in production at each stage of the supply chain.

### 1.2.2 Structural Gravity

The term gravity equation has been used to refer to a variety of different specifications of the determinants of bilateral trade (Head and Mayer, 2014). Among them, the definition of structural gravity is probably the most useful since it corresponds to a large set of models and allows for a more complete calculation of the impacts of trade costs changes. Moreover, it can be estimated at the aggregate or sectoral level. Among the established theories that comply with the structural gravity assumptions, I focus here on the specifications considering bilateral trade costs and prices for final and intermediate goods (and the value added to output ratio). I make standard constant elasticity of substitution (CES) assumptions on the utility and production functions that yield the following equations for the bilateral trade in final and intermediate goods, and value-added content of trade:<sup>7</sup>

$$\hat{f}_{id} = (1 - \sigma) \left( \hat{\tau}_{ij}^f + \hat{p}_i - \hat{P}_{sd}^f \right) + \hat{c}_d \quad (1.7)$$

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<sup>7</sup>I assume the following country-sector production function

$$Y_j = \left( V A_j^{\frac{\gamma-1}{\gamma}} + \left[ \prod_{s=1}^S \left( \sum_{i \in s}^N X_{ij}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1} \alpha_{s,j}} \right]^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}, \text{ and utility function over final goods}$$

$$C_d = \prod_{s=1}^S \left( \sum_{i \in s}^N F_{id}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \pi_{sd}}.$$

$$\widehat{x}_{ij} = (1 - \rho) \left( \widehat{\tau}_{ij}^x + \widehat{p}_i - \widehat{P}_j^x \right) + \widehat{x}_j \quad (1.8)$$

$$\widehat{v}r_o = \widehat{v}a_o - \widehat{y}_o = (1 - \gamma) (\widehat{p}_o^{va} - \widehat{p}_o) \quad (1.9)$$

In equations (1.7) and (1.8), changes in bilateral trade in final and intermediate goods depend on changes in trade costs ( $\widehat{\tau}_{ij}^f$  and  $\widehat{\tau}_{ij}^x$ , potentially different for the two types of goods), the gross price of country-sector of origin ( $\widehat{p}_i$ ), the sectoral consumer prices index in destination country  $\widehat{P}_{sd}^f$  and the sectoral producer price index  $\widehat{P}_j^x$  respectively. Finally, these equations depend on total demand in destination for final goods  $\widehat{c}_d$ , and input bundle in the sourcing country-sector  $\widehat{x}_j$  respectively. The change in the value-added content of trade depends on the domestic value-added price,  $\widehat{p}_o^{va}$ , and the output prices,  $\widehat{p}_o$ . Substituting equations (1.7), (1.8) and (1.9) into equation (1.6) yields the structural gravity equation for value-added exports that allows to study all the determinants of value-added trade:

$$\begin{aligned} \widehat{vax}_{od} = & (1 - \gamma) \left( \widehat{p}_o^{va} - \widehat{P}_o^x \right) \\ & + \frac{1}{y_{od}} \sum_i^{NS} b_{oi} \left[ (1 - \sigma) \left( \widehat{\tau}_{ij}^f + \widehat{p}_i - \widehat{P}_{sd}^f \right) + \widehat{c}_d \right] \\ & + \frac{1}{y_{od}} \sum_i^{NS} \sum_j^{NS} b_{oi} a_{ij} \left[ (1 - \rho) \left( \widehat{\tau}_{ij}^x + \widehat{p}_i - \widehat{P}_j^x \right) \right] y_{jd} \end{aligned} \quad (1.10)$$

In the rest of this chapter, the gravity equation for bilateral value-added exports in equation (1.10) is used to study issues related to the domestic price-competitiveness along the international supply chain.



## 1.3 Value-Added Elasticities and REERs

This section uses the gravity equation for value-added exports derived before to compute the elasticity of value-added exports to domestic prices and to "re-build" the VA-REERs available in the literature, with a rich sectoral dimension. But first, it is necessary to address the issue of price spillovers along international supply chains.

### 1.3.1 Price Spillovers in International Supply Chains

In the international production network, price changes accumulate along the supply chain, generating the so-called "cascade effects". Therefore, forward and backward linkages change the concept of competitiveness ([Bems and Johnson, 2017](#)). An increase (decrease) in the value-added price of country-sector  $i$  might drag down (up) the exports of another country-sector  $j$  if  $i$  is using  $j$ 's intermediates in production. This means that it is not straightforward to identify competitors and trade partners when goods contain value added from different countries. Therefore, in the modern international production network, the price-competitiveness analysis must focus on how changes in the value-added price from all countries affects the gross trade prices. This is only possible by keeping track of the input-output structure of trade. I follow [Bems and Johnson \(2017\)](#), who establish that under marginal cost pricing or constant mark-ups over marginal cost, changes in the gross price of a final or intermediate good are given by:<sup>8</sup>

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<sup>8</sup>The key assumption is the full pass-through of marginal cost changes into prices. Nevertheless, note that there is partial pass-through of nominal exchange rate changes due to the imported intermediate goods.

$$\hat{p}_o = \sum_{i=1}^{NS} b_{io} \frac{va_i}{y_i} \hat{p}_i^{va} \quad (1.11)$$

Equation (1.11) states that changes in value-added prices from all country-sectors in the world economy impact the gross price of country sector  $o$  to the extent that country-sector  $i$  uses, directly and indirectly (as summarized on the  $b$  coefficients), value added from each of them. From equation (1.11), changes in price indexes change be computed accordingly.

### 1.3.2 Value-Added Elasticities

The value-added exports elasticity of country  $c$  to domestic value-added prices,  $\frac{\partial \log va_x_c}{\partial \{\log p_i^{va}\}_{i \in c}^S}$ , is the change in aggregate value added (across the  $S$  domestic sectors) as a result of a 1% change in all domestic sectors  $o \in c$  prices,  $\{\hat{p}_i^{va} = 1\}_{o \in c}^S$ .<sup>9</sup> By using the gravity equation for value-added exports, defined in equation (1.14), and aggregating bilateral sectoral elasticities,  $\widehat{va}_{od} \left( \{\hat{p}_o^{va} = 1\}_{o \in c}^S \right)$ , one obtains the following expression:

$$\frac{\partial \log va_x_c}{\partial \{\log p_p^{va}\}_{o \in c}^S} = \widehat{va}_c \left( \{\hat{p}_o^{va} = 1\}_{o \in c}^S \right) = \sum_{o \in c}^S \sum_{d \neq c}^N \frac{va_{od}}{\sum_{o \in c}^S \sum_{d \neq c}^N va_{od}} \widehat{va}_{od} \left( \{\hat{p}_o^{va} = 1\}_{o \in c}^S \right) \quad (1.12)$$

Note that this simple derivation yields an equation that captures all the complex dynamics of the input-output structure of trade. As an example of this complexity, note that two country-sectors (of different countries) can trade intermediate goods with each other. Therefore, the importance of domestic value-added prices is larger than the simple value-added share in production. This kind of effects is fully captured in equation

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<sup>9</sup>Note that it is defined as an aggregate shock that affects each sector to the same extent.

(1.12), through equation (1.10).

### 1.3.3 Value-Added Real Effective Exchange Rates (REERs)

Country  $c$ 's value-added real effective exchange rate,  $REER_c^{va}$ , is defined as the change in aggregate value-added exports as a consequence of the actual change of value-added prices in all the  $N \times S$  country-sectors in the world economy,  $\{\widehat{p}_i^{va}\}_{i=1}^{NS}$ .<sup>10</sup> By using the gravity equation for value-added exports defined in equation (1.14), and aggregating changes in bilateral sectoral value-added exports,  $\widehat{vax}_{od} \left( \{\widehat{p}_i^{va}\}_{i=1}^{NS} \right)$ , one obtains the following expression for the country-level VA-REER:

$$REER_c^{va} = \widehat{vax}_c \left( \{\widehat{p}_i^{va}\}_{i=1}^{NS} \right) = \sum_{i \in c} \sum_{d \neq c}^S \frac{vax_{od}}{\sum_{o \in c}^S \sum_{d \neq c}^N vax_{od}} \widehat{vax}_{od} \left( \{\widehat{p}_i^{va}\}_{i=1}^{NS} \right) \quad (1.13)$$

When using country-level data, equation (1.13) yields the same indicator as in Bems and Johnson (2017). Nevertheless, the use of sector-level data makes the indicator more precise. Rather than taking logs of the expression in equation (1.13) (to obtain an index-like expression), I report the percentage change in value-added exports induced by changes in value-added prices in all country-sectors in the world economy.

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<sup>10</sup>Note that for the value-added exports elasticity to domestic prices an homogeneous value-added prices shock (of 1%) was introduced. For the VA-REER the actual and heterogeneous changes in value-added prices across sectors have to be considered.

### 1.3.4 CES Parameters

The value-added export elasticities to domestic value-added prices and the VA-REERs depend on the value assigned to the elasticities of substitution in consumption ( $\sigma$ ), and production ( $\rho$  and  $\gamma$ ). I follow a similar approach to the one in [Bems and Johnson \(2017\)](#). As a benchmark, I assume that consumption and production elasticities are equal,  $\sigma = \rho = 4$ . I later relax this assumption by studying the country-level value-added exports elasticities for different values of  $\rho$ . I also set  $\gamma = 1$ . As [Bems and Johnson \(2017\)](#) explain, the value of  $\gamma$  is less important, and in fact, results are robust to alternative choices for this parameter.

### 1.3.5 Nominal vs Real Terms

Note that equation (1.14) was derived in nominal terms. The VA-REER are usually derived in real (or quantity) terms. When that is done in the literature, see for instance [Bems and Johnson \(2017\)](#), changes in quantities are weighted with the same nominal weights used in this chapter. That procedure is better understood as a Laspeyres index.<sup>11</sup> Therefore, the value-added gravity equation defined in "real terms" has the following expression:

$$\begin{aligned} \widehat{VAX}_{od} = & -\gamma \left( \widehat{p}_o^{va} - \widehat{P}_o^x \right) \\ & + \frac{1}{y_{od}} \sum_i^{NS} b_{oi} \left[ -\sigma \left( \widehat{\tau}_{ij}^f + \widehat{p}_i - \widehat{P}_{sd}^f \right) + \widehat{C}_d \right] \\ & + \frac{1}{y_{od}} \sum_i^{NS} \sum_j^{NS} b_{oi} a_{ij} \left[ -\rho \left( \widehat{\tau}_{ij}^x + \widehat{p}_i - \widehat{P}_j^x \right) \right] y_{jd} \end{aligned} \quad (1.14)$$

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<sup>11</sup>Note that this is not made explicit in [Bems and Johnson \(2017\)](#).

Where  $\widehat{F}_{id} = -\sigma \left( \widehat{\tau}_{ij}^f + \widehat{p}_i - \widehat{P}_{sd}^f \right) + \widehat{C}_d$  is the change in quantities of the bilateral trade of final goods. Analogously,  $\widehat{X}_{ij} = -\rho \left( \widehat{\tau}_{ij}^x + \widehat{p}_i - \widehat{P}_j^x \right) + \widehat{X}_j$  is the change in intermediate good quantities. Note that capital letters denote quantities and lower-case letter denote nominal values. Finally, note that  $\widehat{VAX}_{od} = \widehat{vax}_{od}$ . But while  $\widehat{vax}_{od}$  relates to the set of parameters  $\sigma = \rho = 5$  and  $\gamma = 1$ ,  $\widehat{VAX}_{od}$  relates to the set of parameters  $\sigma = \rho = 4$  and  $\gamma = 0$ .

## 1.4 Data

The framework presented in this chapter requires the use of bilateral trade flows between all pair of countries in the world economy. Moreover, it is necessary to differentiate between trade in final and intermediate goods at the bilateral level. The World Input-Output Database (WIOD) provides this information in its World Input-Output Tables (WIOTs). I use the 2013 WIOD [see [Timmer et al. \(2015\)](#) for the details]. The 2013 version covers the 1995-2011 period with 40 countries and 35 sectors. The literature has stressed that value-added approach needs to incorporate the sectoral dimension ([Johnson and Noguera, 2012](#)). Different sectors within a country participate in international production sharing at different stages. In all my computations I use the data in full detail, at the sector level, and then aggregate up to the aggregate country-level of value-added exports.

Finally, the computation of VA-REERs requires the use of sectoral value-added prices in all countries. For this, I use the sector-level value-added deflator available in the Social and Economic Accounts of the WIOD.

## 1.5 Results: Value-Added Elasticities and REERs

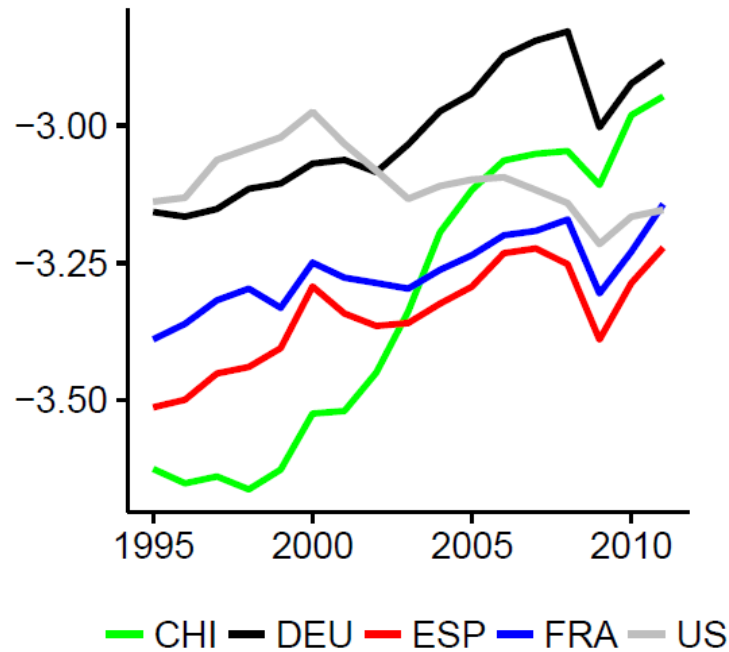
This section presents the results the value-added exports elasticity to domestic value-added prices and VA-REERs. I focus on the 1995-2011 period.

### 1.5.1 Value-Added Elasticities

#### Evolution over the 1995-2011 Period

Figure (1.2) shows the evolution of the value-added exports elasticity to domestic value-added prices over the period 1995-2010 for Germany, France, the US, China and Spain. The main important insights from this figure are that: (i) there has been a decreasing trend in the absolute value of this elasticity. This trend tracks the increasing share of imported intermediate goods that have been documented in the literature ([Johnson and Noguera, 2012](#)). When the share of value added in production falls, the impact of domestic value-added price changes on gross output prices also falls. (ii) China and the US show a different behavior to Germany, France, and Spain. While China started the period with the largest elasticity among these countries, around its ascension to the World Trade Organization in the year 2000, its elasticity started to follow the same trend and end the period close to the German level. On the other hand, the US elasticity slightly increased (in absolute value) over the period. But the US had a small elasticity in 1995 and a comparable one in 2011 to the rest of selected countries. (iii) The value-added exports elasticity to domestic prices also shows a cyclical behavior, at least to severe shocks like the Great Trade Collapse that followed the 2008-2009 financial and economic

crisis.<sup>12</sup> But the sudden increase in this elasticity for the five countries was reversed by the end of the end of the sample.<sup>13</sup>



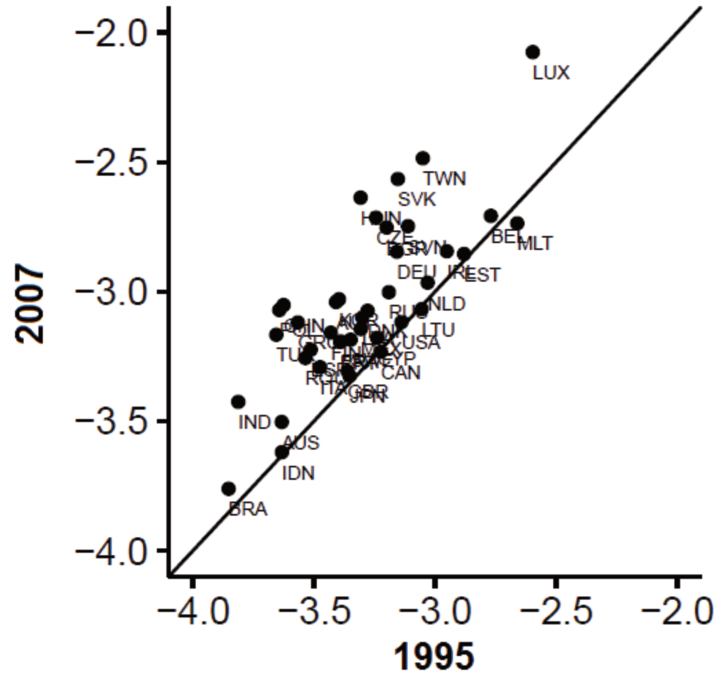
**Note:** computed with  $\sigma = \rho = 5$  and  $\gamma = 1$ .

Figure 1.2: VAX elasticity to domestic prices for selected countries (1995-2011)

Given that the 2008-2009 economic and financial crisis distorts the analysis, I make an international comparison across all countries available in the World Input-Output Database (WIOD) for the years 1995 and 2007 in figure (1.3). It shows heterogeneous levels across countries, both in 1995 and 2007. It also shows a high correlation between the initial and final levels. Finally, only Malta seems to have experienced a small increase in the absolute value of this elasticity.

<sup>12</sup>For details on the Great Trade Collapse see for instance [Bussiere et al. \(2013\)](#).

<sup>13</sup>For Germany the elasticity was still larger (n absolute value) in the year 2011, but close the pre-crisis level.



**Note:** computed with  $\sigma = \rho = 5$  and  $\gamma = 1$  in nominal terms.

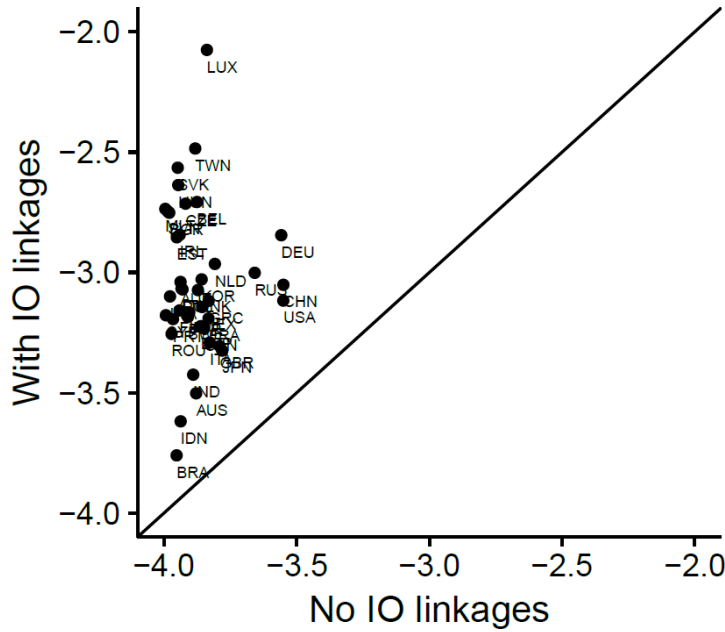
Figure 1.3: Value-Added Elasticity (1995-2007)

### The Role of Input-Output Linkages

To gain further insights on the role of international production linkages, I carry out two exercises. First, figure (1.4) shows the implications of neglecting trade in intermediate goods. That is, of considering all international trade flows to be in final goods. The result is that the value-added export elasticity for all countries is compressed towards the lowest possible value ( $1 - \sigma = 4$  when  $\sigma = 5$ ). The non-IO elasticity also shows that for countries with a relatively large proportion of international trade (over domestic trade flows) like Germany, the US, and China, the elasticity moves towards a level of 3.5.

Second, instead of focusing on using a benchmark set of parameters  $\sigma$ ,  $\rho$ . In figure (1.5), I uncover the role of international production linkages by allowing the production elasticity  $\rho$  to vary, while keeping the consumption



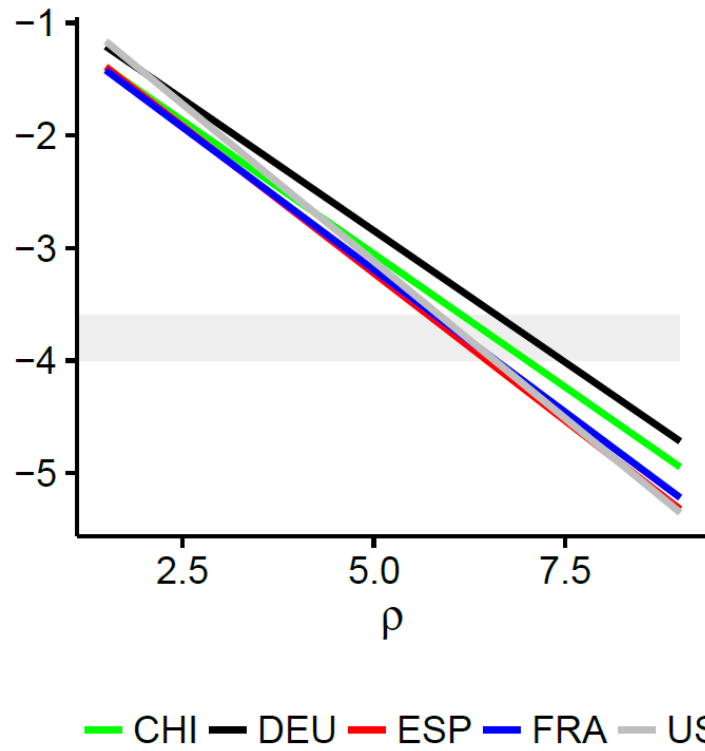


**Note:** computed with  $\sigma = \rho = 5$  and  $\gamma = 1$  in nominal terms. The input-output structure of trade is shut down by only allowing sectors to source from them selves. This is necessary to be able to use the same model to carry out the computations.

Figure 1.4: VA elasticities with and without the IO structure active (2007)

elasticity  $\sigma$  constant. The main idea is to look for the production elasticity  $\rho$  value that makes the value-added elasticity enter into the range when all trade flows are considered to be in final goods (4). Figure (1.5) shows that broadly speaking (there are not large differences across countries), the production elasticity  $\rho$  that would make the value-added exports elasticity equal in both cases is around  $\rho = 7$ . Note that this goes against the commonly held view that production chains are inflexible, such that producers find it difficult (if not impossible) to substitute across suppliers at least in the short run (Bems and Johnson, 2017).<sup>14</sup>

<sup>14</sup>See Bems and Johnson (2017) for a more detail discussion on this issue. Nevertheless, a more precise estimation of elasticity parameters is required to have clear conclusions.



**Note:** computed with  $\sigma = 5$  and  $\gamma = 1$  in nominal terms. The dark area signals the range of value-added elasticities when the input-output structure of trade is neglected.

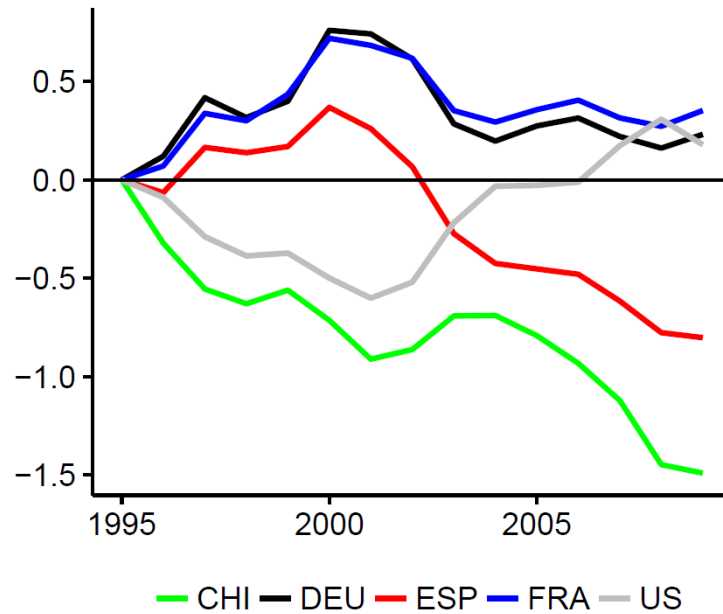
Figure 1.5: VA elasticities depending on the production elasticity

### 1.5.2 Value-Added Real Effective Exchange Rates (VA-REERs)

Real effective exchange rates are tools used to track the price competitiveness developments of countries in international markets. Nevertheless, as [Bems and Johnson \(2017\)](#) explain, the validity of stated REERs has been undermined by the emergence of international supply chains. In this chapter, I have explained how to obtain VA-REER that consider the international production network, a rich sectoral dimension and are easily derived from the gravity equation for value-added exports.<sup>15</sup> The idea

<sup>15</sup>[Patel et al. \(2017\)](#) present a more complex way to derive these VA-REERs that incorporate the sectoral dimension.

with this is to keep the value-added approach as close as possible to the work of [Johnson and Noguera \(2012\)](#) and offer deeper insights.



**Note:** computed with  $\sigma = 5$  and  $\gamma = 1$  in nominal terms.

Figure 1.6: Values-Added real effective exchange rates (VA-REERs)

Figure (1.6) plots the evolution of the VA-REERs for China, the US, Germany, France, and Spain. The results show that: (i) Spain, but mostly China lost price competitiveness during this period. Germany and France seem to have had a similar positive evolution in terms of price competitiveness. And by the end of the period, the US also experienced a similar positive evolution as Germany and France, but after a long period on the negative side. Note that the evolution of the VA-REERs is determined by the evolution of the domestic value-added prices at the sector level in each economy (in domestic currency) and the evolution of the nominal exchange rates. Therefore, figure (1.7) disentangles the contribution of nominal exchange rates and sectoral value-added prices (in domestic currency) to the evolution of the VA-REERs. This figure shows that, as

expected the evolution of the three euro countries considered is similar.<sup>16</sup> The nominal exchange rate can explain the initial divergence, and later convergence, between the US and Germany-France. The contribution of domestic value-added prices (in relative terms to the rest of the world) added a significant and positive contribution to the competitiveness of Germany, France, and the US. For Spain and China, this contribution was negative and comparable for the two countries.

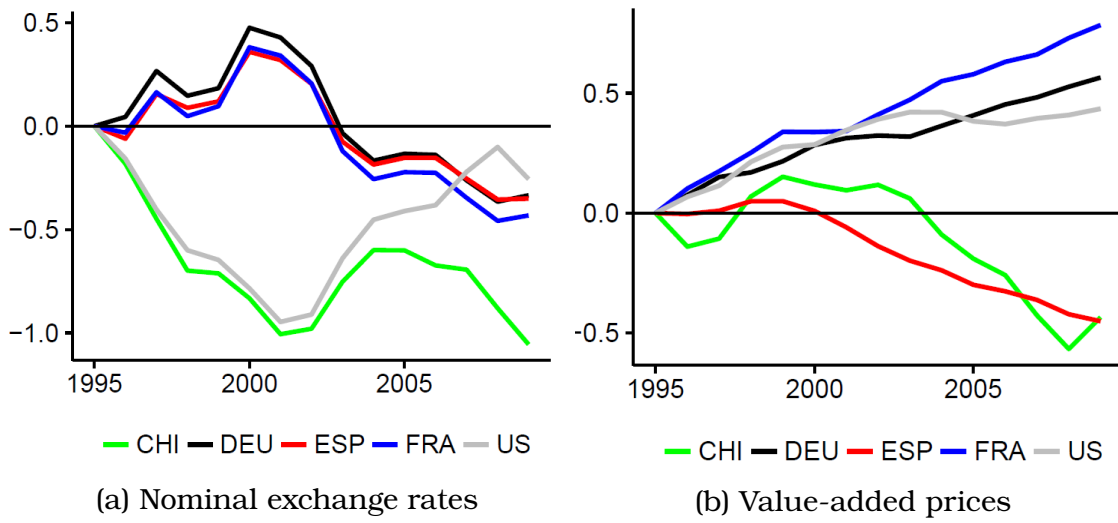


Figure 1.7: Decomposition of the VA-REERs in exchange rates and value-added prices

## 1.6 Concluding Remarks

The international production network links countries on both the consumption and production sides. This generates spillovers across borders that are not captured by models that neglect trade in intermediate goods.

The supply chain that combines value-added from different countries into

<sup>16</sup>The evolution of the three euro countries considered is similar. Nevertheless, it is not the same. This is due two things: (i) nominal exchange rates among euro countries continued to be adjusted until 1999, and (ii) the post-1999 small fluctuations show that destination composition and the degree of pass-through of the nominal exchange rate changes is heterogeneous across euro countries, but with a limited impact on the overall competitiveness.

final goods, changes the nature of international competitiveness and the role of domestic prices. This chapter derived the gravity equation for value-added exports in a more tractable way than what was done in the literature before, e.g. [Noguera \(2012\)](#). This gravity equation allows studying the determinants of trade in value-added terms, those determinants that accumulate along the supply chain. This chapter focuses on two applications of this gravity equation: the value-added exports elasticity to domestic value-added prices, studying the implications of neglecting this dimension, and the VA-REER under the same conceptual methodology initiated by [Johnson and Noguera \(2012\)](#)'s accounting framework. The tractability of the derivations comes from linking changes in value-added exports to changes in the actual physical trade flow of final and intermediate goods.

Results show that the continuous evolution of the international production network, due to changes in intermediate trade flows, implies that the value-added exports elasticity to domestic prices is not constant over time. It has been following a decreasing trend (in absolute value) over the 1995-2011 period for most countries. A decreasing trend that was only momentarily interrupted by the Great Trade Collapse. Abstracting from the input-output structure of trade neglects this evolution and the economic policy implications. The more tractable use of value-added real effective exchange rates, disentangling the role of nominal exchange rates and value-added prices in a rich sectoral framework, should allow an easier adoption by international organizations, who are interested in the role of international price spillovers.

## Chapter 2

# Impact of FTAs and reduced "Border Effect" on finals and intermediates

*Joint work with Erik FROHM (Sveriges Riksbank)*<sup>1</sup>

**Abstract:** This chapter studies the trade-enhancing role of diminished trade barriers. We do it from two dimensions: (i) the implementation of Free Trade Agreements, and (ii) the reduction of the "border effect" (all costs reducing international trade flows relative to domestic ones). Our results show that the lowering of trade barriers since 1970 have significantly expanded trade in the manufacturing sector: FTAs are estimated to increase bilateral trade by 54% after 10 or more years, for both final goods and intermediate inputs. The border effect has also become less binding over time. Its reduction is estimated to have increased international trade in final goods by 443%, relative to domestic trade since 1970, while the rise has been 195% for intermediate inputs. We also find further evidence that the trade effect of the average FTAs has strengthened over time.

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*"Globalisation accelerated again from around 1990, when the ICT revolution radically lowered the cost of moving ideas. ... GVCs involve the international separation of factories. ICT made it possible to coordinate complex activities at distance."*

**"The Great Convergence", Richard Baldwin, 2016.**

## 2.1 Introduction

The most recent wave of globalization (second unbundling) dates from around 1990 ([Baldwin, 2016](#)). It is characterized by a sharp increase in Free Trade Agreements (FTAs) in force and rapid advances in information and communication technology (ICT). Although several studies have documented the important role of FTAs for boosting international trade, the potentially different effect on trade in final and intermediate goods and the role of reduced border effects have been less documented.<sup>2</sup> The latter can be thought of as an additional factor that makes trade appear "home biased". Such bias is usually considered to embody a host of factors, such as preferences. It has been also understood as the inherent costs of moving a good or service across a border. We further explain these trade barriers and use the "border effect" concept to refer to the bundle of trade barriers that reduced international trade flows compared to intra-national flows. Our main contribution in this chapter is that we jointly consider the introduction of FTAs and other reductions in trade barriers, and their impact on trade both in final goods and intermediate inputs.

To provide a precise estimate of the effect of changes in the border effect and an evaluation of the trade impact of FTAs, we apply the most up-to-

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<sup>2</sup>[Bergstrand et al. \(2015\)](#) is a recent study which has documented a weaker border effect from early 1990 to 2011. They do not consider the potentially different effect on final and intermediate goods.

date and theory-consistent empirical gravity methods.<sup>3</sup> First, this chapter quantifies the trade effect of the reduction in both barriers (FTAs and the border effect). Second, we look at their differential impact on trade in final goods and intermediate inputs respectively. It turns out that the reduction of the "border effect" plays a key role in enabling trade over time and it is important to be taken into consideration when estimating the trade effect of FTAs. Third, we use our methodology to track the evolution of the FTAs effect and investigate the trade effect of specific economic institutional arrangements such as the European Union (EU).

A key ingredient in our analysis is trade data on final goods and intermediate inputs covering a long period of time. Working with final and intermediate goods data allow us to make inference on the pattern of trade in these goods, and in turn for the expansion of global value chains. We use [Johnson and Noguera 2017](#)'s input-output tables since the differentiation of the two goods (finals versus intermediates) is natural in these tables. Moreover, the long panel dimension of this data (covering the period 1970-2009) is essential to capture the factors driving the second wave of globalization.

Our findings suggest that: (i) the reduction in trade barriers brought by FTAs, and the diminished role of the border effect, significantly stimulated manufacturing goods trade: FTAs are estimated to increase bilateral trade by 54% after 10 or more years, for both final and intermediate goods once the border effect is included. (ii) the decline in the border effect have on the other hand had a greater impact on international trade (relative to domestic trade flows) in final goods, rather than intermediate inputs,

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<sup>3</sup>We use a PPML estimation with high dimensional fixed effects (exporter-time, importer-time, and country-pair) to control for all confounding factors. The estimation strategy is carefully explained later in the chapter.



from 1970-2009. However, this differential effect disappears in the 2000s when the reduction of the border effect has a broadly similar impact on intermediate inputs as final goods. (iii) and finally, we find further evidence that the trade effect of FTAs has strengthened over time. We try to further understand this patterns by disentangling the European Union (EU) effect from an average FTA. The deep economic integration of the European Union has brought additional trade benefits beyond regular FTAs for its members, and the costs of leaving the Union are (rightly) anticipated to be large. We estimate the trade-enhancing effect of the EU to be more than double compared to an average FTA.

The rest of the chapter is structured as follows: Section II motivates our research questions and outlines some facts about trade in final and intermediate goods, FTAs, and the border effect. Section III introduces the structural framework that we use and derive our empirical approach. Section IV outlines the data used, and Section V presents our results. Section VI discusses the results and Section VII concludes.

## **2.2 Motivation**

### **2.2.1 Global Analysis of Trade in Intermediate and Final Goods**

Thanks to trade in intermediate inputs and the expansion of global value chains, the international trade system is now organized in regional and global production networks, where goods embed value added from different economies. Countries involved in international supply chains have obtained access to new production methods, and cheaper and better in-

puts, making it possible to take advantage of their and other countries' comparative advantages via the international division of labor. The various ways of participating in global value chains increase the already great complexity of international trade, and make it even more difficult than ever before to characterize a product as truly "Made in ...". As [Amador and Cabral \(2017\)](#) explains, the emergence of global value chains has brought important challenges for traditional economic policy-making, relating to for example the impact of changes in tariffs or back-tracking of FTAs ([Blanchard, 2010](#)).

Due to the emergence of GVCs and the fact that trade in intermediate goods increased sharply, there is a widely held notion that trade in intermediate goods has been growing at a faster pace than in final goods. Nevertheless, figure (2.1) shows that bilateral trade in gross final goods in the manufacturing sector has not lagged behind between 1970 and 2009. This characteristic is robust to an analysis in different sub-periods. The density distribution of changes in the final to intermediate goods ratio in manufacturing, if any, shows a balanced growth for the two goods or larger for final goods. This is not in contrast to the well-known expansion of global value chains. That gross exports of final goods have grown more substantially in value terms than intermediate inputs reflect several potential explanations: (i) bilateral gross final goods exports embody a larger portion of gross imports of intermediate inputs from earlier steps of the supply chain than bilateral trade in intermediate inputs. (ii) Policy-makers have the incentive to imposed lower tariffs on intermediate goods. This is since higher trade barriers in intermediate goods impact domestic competitiveness. In fact, the average level of trade frictions faced by intermediates has been lower than that for final goods. (iii) Moreover, the average fall in intermediate goods trade costs was smaller than for

final goods.<sup>4</sup> Finally, note that the "effective" emergence of GVCs only requires an increase in the bilateral trade of intermediate goods in absolute value, rather than in relative terms to final goods. The trade literature has made advances in documenting the value-added content of trade since the emergence of the global value chains. [Johnson and Noguera \(2017\)](#) find that the ratio of value-added to gross exports fell by roughly 10 percentage points worldwide, with the ratio declining nearly 20 percentage points in manufacturing and with fast-growing countries seeing larger declines. Moreover, they find that regional trade agreements and the changing effect of distance might have played a dominant role in explaining these facts.

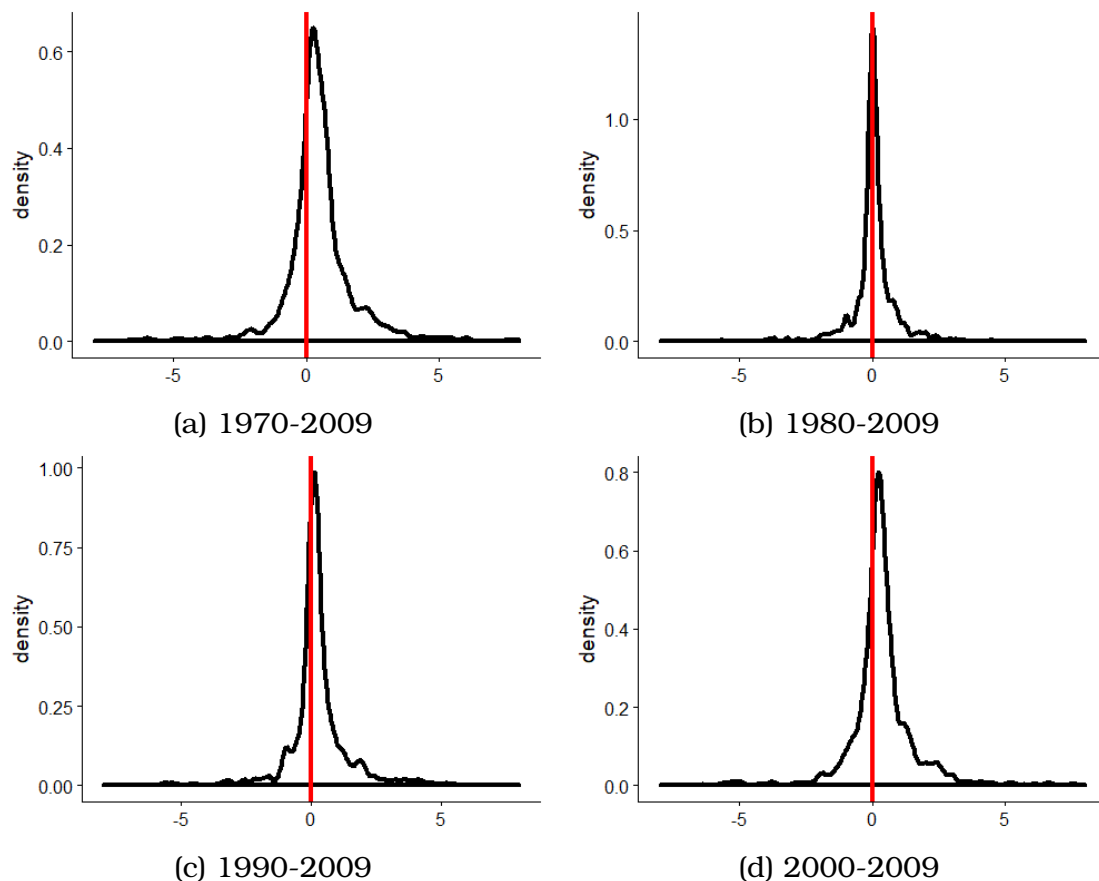
We contribute along these dimensions by quantitatively estimating the FTAs' effect on bilateral trade flows of gross final and intermediate goods. We study whether the FTAs effect has strengthened over time and whether there has been a different effect on either type of goods. We also estimate the effect and timing of the reduction of other trade barriers included in the concept of the "border effect" (ICT revolution, air cargo, container, etc.). With this deep analysis, we manage to characterize the reduction in technological and policy-related trade barriers that had an impact on international trade flows and eventually made possible and governed the fragmentation of production across countries.

### **2.2.2 Free Trade Agreements**

The world witnessed a rapid increase in the number of countries engaging in FTAs, with the aim of facilitating cross-border trade and expanding economic activity over the past decades. Between the mid-1980s and the

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<sup>4</sup>[Antras and Chor \(2018\)](#) obtain these proximate measures using a Head-Reis index over the period 1995-2011.



**Source:** World Input-Output tables from Johnson and Noguera (2017). See the data section for details.  
**Note:** these figures plot, in different time periods, the distribution of changes in the finals to intermediates ratio of all bilateral manufacturing trade flows. Therefore, positive values imply that bilateral trade in final goods have grown more than in intermediate goods. Domestic trade flows were excluded and for all graphs no more than 7% of the observations were dropped due to zero trade flows impeding to compute the final to intermediate goods ratio.

Figure 2.1: Distribution of the change in the final to intermediate goods ratio

mid-1990s, governments in developing nations reversed decades of opposition to freer trade and investment and lower tariffs. The world economy witnessed a rash of regional trade agreements signed (Baldwin, 2016). The new trade agreements included bilateral investment treaties (BITs) governing interactions between private foreign investors and host governments. For the most part, the provisions in these agreements constrain the developing nation's sovereignty. The number of new BITs exploded in the late 1980s and early 1990s, and it reduced significantly once most of the BITs that could have been signed between economically significant nations have

already been signed. These agreements are deep in the sense that they affect matters deep inside national borders beyond tariff cutting. Nevertheless, it was not until recently that economists could actually claim reliable empirical support for the positive effect of FTAs. In a meta-analysis, [Cipollina and Salvatici \(2010\)](#) find a range of estimates between 12 percent and 285 percent. Using a more robust estimation method, [Baier and Bergstrand \(2007\)](#) showed that the quantitative estimates of the average effect of an FTA on bilateral trade are positive, strong (around 100 percent) and significant. They considered the fact that trade policy is not an exogenous variable and addressed the endogeneity of FTAs. They study different econometric approaches aiming to control for the endogeneity of FTAs and concluded that a panel approach controlling for country-pair specific factors yields the most reliable empirical results. Several studies followed [Baier and Bergstrand \(2007\)](#), see [Bergstrand et al. \(2015\)](#) for a more detail literature review.

But FTAs might even play an even more important role more recently than in previous decades. They establish rules governing commerce at and behind the border, and thus embody both tariffs and non-tariff barriers ([Blanchard et al., 2016](#)). In the age of international supply chains, the production processes that are needed to bring a product to life spans many countries and crosses multiple borders multiple times. This led to deep economic integration across countries and made the economic system more vulnerable to potential disruptions in international trade. Now that the probability of some FTAs being renegotiated has significantly increased (see for instance the cases of NAFTA and "Brexit"), it is important to keep in mind that a potential elimination of a trade agreement would not simply take countries back to the pre-agreement situation. Instead, it would perpetuate shocks along the production network that are difficult

to quantify. What is clear is that in the era of global value chains, if intermediate inputs are "less accessible", it may not only take some time to adjust to the new scenario (due low substitution of inputs), it can be the case that certain tasks cannot be performed any more ([Blanchard et al., 2016](#)).

### **2.2.3 The "Border Effect": Much more than crossing a border**

Other trade barriers were also reduced and boosted international trade and made production fragmentation feasible. One way to think about such "other" trade barriers is the concept of a "border effect", often called "home bias", that has been used in the literature at least since [McCallum \(1995\)](#)'s work on the trade effect of the US-Canada border between provinces on both sides. [Anderson and van Wincoop \(2003\)](#) uses the notion that international border dummies embed international trade costs relative to intra-national trade costs in gravity equations with international and intra-national trade flows. Building on that idea, [Bergstrand et al. \(2015\)](#) argue that FTA estimates may be biased upward because they may be capturing the effects of general globalization trends, and propose to include domestic sales to explicitly control for their effects in the gravity model by introducing a set of globalization dummies. The idea is that there are unobservable fixed and variable export costs [see for instance [Melitz \(2003\)](#)] that are declining over time. Such a reduction in export cost would stimulate trade and the omission of such variables could lead to upward bias in the estimates of FTAs under the approach in [Baier and Bergstrand \(2007\)](#). On the way to addressing our research questions, we will have the opportunity to review this bias later in this chapter.

[Bergstrand et al. \(2015\)](#) conclude that the cost of an international border (in terms of trade flows) has declined on average by 25.3 percent from 1990 to 2002. This chapter has something to say about the evolution of the border effect over a longer period. But more importantly, we also distinguish between the effect of these trade cost on trade in final goods and intermediate inputs. These goods are different in nature, and subject to different trade costs. For example, trade costs cumulate in final goods as they consist of intermediate inputs which travel across many borders in the age of global value chains. These goods must bear the full burden of trade costs added in previous steps in production.<sup>5</sup> But at the bilateral level, it is not straightforward to think that trade barriers should be more bidding for either type of good. Distinguishing between final goods and intermediate inputs allows us to put the trade costs analysis in a historical perspective and better understand the emergence of the global value chains.

According to [Baldwin \(2016\)](#), it was a bundle of technological advances that enabled the expansion of global value chains and offers a deep motivation and timing for the declining trade costs: the ICT revolution was based on low computing and data storage costs, advances in the transmission of information, and the reorganization of production with new working methods and workplace organizations. This made it easier, cheaper, faster, and safer to coordinate separate complex activities spatially. These revolutions took place between 1985 and 1995. The ICT revolution, however, was not the only disruptive change during this time. The development of air cargo both stimulated - and was stimulated - by the development of international production networks. It really expanded in the

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<sup>5</sup>[Rouzet and Miroudot \(2013\)](#) show that tariffs and other trade costs cumulate and that even small trade costs can have adverse consequences when inputs are part of complex value chains that finally constitute final products.

mid-1980s.<sup>6</sup> Finally, one should not forget about the strong reduction in transportation costs due of the introduction of the container in the 1960s, that grew in importance in the 1970s and 1980s.

The timing of these technological advances will prove to be consistent with the sharp reduction of the border effect according to our empirical results.

## **2.3 Framework and empirical approach**

We derive our empirical approach from a structural gravity equation able to capture the different trade barriers we are interested in. The effect of FTAs and the border effect is studied with a PPML estimator that properly maintains the structural approach of the gravity equation and uses a high dimensional set of fixed effects that controls for the potential confounding factors that could bias the results. Also, the inclusion of the large set of fixed effects will make possible to track the evolution of the effect on trade of FTAs over time.

### **2.3.1 Framework: Structural Gravity**

Structural gravity models are widely used in the trade literature. [Head and Mayer \(2014\)](#) show the gravity equation is consistent with a very large number of theoretical foundations. To guide our analysis, we extend the gravity equation to account for different kinds of trade barriers and their differential effect on trade in final goods and intermediate in-

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<sup>6</sup>The key here is not the cost. Air shipments have been getting cheaper, but the speed is associated with certainty and this matters. When things go wrong in an international production network, air cargo allows the offshoring firms to fix it in days.



puts. Therefore, the bilateral exports between country  $i$  and  $j$  in good  $k \in \{final, input\}$ ,  $X_{ij}^k$ , is determined in the following expression:

$$X_{ij}^k = \frac{b_{ij}^{k-1} (\tau_{ij,FTA}^k w_i^k)^{-\sigma^k}}{P_j^k} E_j^k \quad (2.1)$$

where  $E_j^k$  is the total expenditure in good  $k \in \{final, input\}$  in destination country  $j$ .<sup>7</sup>  $P_j^k$  is the importer price-level, while  $w_i$  represent the exporter's wage and any comparative advantage factor.<sup>8</sup> Regarding the trade barriers, the term  $\tau_{ij}^{k-\sigma}$  represents the trade costs that are altered by an FTA. It includes not only tariff but also non-tariff measures that can hamper international trade. The trade cost terms  $b_{ij}^{k-1}$  includes all kinds of trade frictions (not related with tariff and non-tariff measures that are imposed on traded goods in the destination) that reduce international trade in comparison to intra-national flows. This is the border effect. Reductions in both trade cost terms,  $\tau_{ij}^{k-\sigma}$  and  $b_{ij}^{k-1}$ , are expected to have a positive effect on trade. Note that the good type dimension,  $k \in \{final, input\}$ , is considered because all terms are potentially different for each type of good.

## 2.3.2 Empirical approach

### Free Trade Agreements

We estimate the structural gravity equation as follows:

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<sup>7</sup>Note that it is important to distinguish between final and intermediate goods when controlling for this total expenditure in destination (Baldwin and Taglioni, 2014). While for final goods it is related to total final demand at the sector level, for intermediate goods it is related to the total expenditure on intermediate goods, also at the sector level.

<sup>8</sup>These terms represent inward and outward multilateral resistances in a general equilibrium framework, as in Anderson and van Wincoop (2003).

$$X_{ij,t} = \exp \left( \sum_{s=0}^{10+} \beta_{fta,t-s} FTA_{ij,t-s} + \eta_{i,t} + \psi_{j,t} + \vec{\gamma}_{ij} \right) + \varepsilon_{ij,t} \quad (2.2)$$

where  $X_{ij,t}$  is the bilateral exports from country  $i$  to country  $j$  at time  $t$ .<sup>9</sup>  $FTA_{ij,t-s}$  is an indicator that takes the value one if a country-pair has a FTA, or stronger economic integration agreement, in place in a given year  $t$ . We include up to ten lags ( $s = 10+$ ) of the FTA indicator to capture the dynamics of this effect, with the  $\beta_{fta,t-10+}$  coefficient capturing the "long-term effect" (after 10 or more years).<sup>10</sup> We also use a rich set of fixed effects that control for many confounding factors that can bias the FTA-coefficient: importer-time fixed effects,  $\psi_{j,t}$ , which captures the time-varying expenditure term in the destination trading partner ( $E_j^k$ ); while the exporter-time,  $\eta_{i,t}$ , captures the time-varying comparative advantage term of the origin country ( $w_i$ ).<sup>11</sup> These fixed effects also absorb any price deflator index and exchange rate fluctuations over time ( $P_j^k$ ).<sup>12</sup>

Finally, the country-pair fixed effects,  $\vec{\gamma}_{ij}$ , control for the potential endogeneity of FTAs that arises from the fact that country pairs signing FTAs might be more likely to trade in the first place.<sup>13</sup> These country-pair fixed effects are directional, that is, they control for potentially asymmetric country-pair factors. Moreover, the fact that we are able to include all

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<sup>9</sup>We omit the sector index since we focus on the manufacturing sector.

<sup>10</sup>Typically, FTAs are phased in over 5 to 10 years (Baier and Bergstrand, 2007). The lagged effects on bilateral trade flows also stem from the fact that trade responds slowly to terms-of-trade changes.

<sup>11</sup>These importer-time and exporter-time fixed effects capture the multilateral resistance terms of a general equilibrium framework, as in Anderson and van Wincoop (2003).

<sup>12</sup>Baldwin and Taglioni (2014) discuss in detail the mistakes to be avoided in gravity equation estimations, like implications of inappropriate deflation of nominal trade values. Their most preferred econometric specification is one with non-deflated trade values. As they explain, in addition to accounting for the multilateral resistances in a dynamic setting, fixed effects also eliminate any problems arising from the incorrect deflation of trade.

<sup>13</sup>The main contribution made by Baier and Bergstrand (2007) was to show that not including the country-pair fixed effect bias the FTA coefficient towards zero.

these fixed effects eliminates concerns about potentially autocorrelated errors in a panel regression. Note that after the inclusion of these fixed effects, the only variability that we use stems from the country-pair time-varying factors like the effect of the introduction FTAs.

We estimate Equation (2.2) with a Poisson-Pseudo Maximum Likelihood (PPML) estimator. It allows for zero trade flows across countries and avoids inconsistent estimations as a consequence of the log-linearizing the error term [see [Silva and Tenreyro \(2006\)](#)].<sup>14</sup> The use of high dimensional fixed effects specification in the PPML estimation is possible thanks to the algorithm developed by [Zylkin \(2017\)](#).

There is one last potential econometric issue that needs to be considered. The literature estimating FTAs' effect has usually followed the argument made by [Cheng and J.Wall \(2005\)](#) that "fixed-effects estimations are sometimes criticized when applied to data pooled over consecutive years on the grounds that dependent and independent variables cannot fully adjust in a single year's time". To avoid this critique, [Baier and Bergstrand \(2007\)](#) use 5-year intervals, [Anderson and Yotov \(2016\)](#) use 4-year intervals, and [Trefler \(1993\)](#) uses 3-year intervals. We use consecutive years data to guarantee the precision of all our estimations. Nevertheless, to make our results comparable and to make sure that such an econometric issue does not affect our results, we also report all our results using 5-year intervals data. We show that relaxing the constraint of using year interval data (limiting the number of observations we can use) does not

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<sup>14</sup>The log-linearization of zeros is infeasible, and the expected value of the log-linearized error will, in general, depend on the covariates, and hence OLS will be inconsistent. Using robust or clustered standard errors affect the estimated standard errors, but will have no effect at all on the estimates of the parameters. Therefore, the log-linear model will generally be invalid with or without the robust or clustered standard errors. PPML, on the other hand, delivers estimates of the parameters that are consistent under general conditions. See [Silva and Tenreyro \(2006\)](#) for more details.

affect our results. It is very likely that [Cheng and J.Wall \(2005\)](#)'s argument was justified when the econometric specifications did not include lags.<sup>15</sup>

## Trade in final goods and intermediates

The emergence of global value chains in the past decades has been characterized by the increasing importance of trade in intermediate inputs. [Caliendo and Parro \(2015\)](#), building on the work of [Eaton and Kortum \(2002\)](#), is an example of a structural gravity model which incorporates trade in intermediate inputs in the evaluation of the welfare effects of tariff changes. In our case, we are interested in the overall effect of FTAs, both tariff and non-tariff measures. As will be explained in more detail in the data section, we use international input-output tables that naturally differentiate between trade in final goods and intermediate inputs.

In order to carry out the analysis, we estimate Equation (2.2) using data for each type of trade. This is required to test the significant differences of the effects for both final goods and intermediate inputs. Therefore, we use data for both types of goods in the same estimation by extending our econometric approach and interacting the FTA variable with a dummy for a given type of good (intermediates in our case), as follows:

$$X_{ij,t}^k = \exp \left( \sum_{s=0}^{10+} \beta_{fta,t-s} FTA_{ij,t-s} + \sum_{s=0}^{10+} \beta_{fta-input,t-s} FTA_{ij,t-s} * Input_{ij,t} \right. \\ \left. + \eta_{i,t}^k + \psi_{j,t}^k + \vec{\gamma}_{ij}^k \right) + \epsilon_{ij,t}^k \quad (2.3)$$

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<sup>15</sup>Remember that we allow the FTA variable to have a lagged effect of up to 10 years, similar to the more recent contributions to the literature.

Note that Equation (2.3) expand the set of fixed effects accordingly to the observation unit, that now is bilateral trade flows in a given good and year. All fixed effects are also allowed to vary by good type (finals or intermediate) identified by  $k$ . Therefore, the origin-time fixed effects become origin-type-time effects, the destination-time fixed effects become destination-type-time effects, and pair-specific terms become origin-destination-type specific. This is particularly important for the destination-time fixed effect that captures the total expenditure in the destination, and it is expected to be different for final and intermediate goods (Baldwin and Taglioni, 2014).

### **The "Border Effect" and use of intra-national trade**

On top of using bilateral international trade data, we also use domestic trade flows. Fally (2015) explains that the gravity model is micro-consistent to the extent that domestic and international trade flows sum up to output for each source country and sum up to expenditures for each destination country. Otherwise, the multilateral resistance indexes implied by the fixed-effects with Poisson-Pseudo Maximum Likelihood (PPML) would not satisfy the structural gravity constraints based on actual output and expenditures. In other words, the equivalence between structural gravity and gravity with fixed-effects and a PPML-estimator would not hold.

In addition, Bergstrand et al. (2015) argue that estimations of the FTA-effect may be biased upward due to inadequate control for time-varying exogenous unobservable changes in bilateral export costs. Fixed export costs are especially important considering their prominence in the “New New” trade theory [see for instance Melitz (2003)]. Bergstrand et al. (2015)

find evidence of this bias and report a declining effect of “international borders” on world trade.

But the motivation for also including intra-national trade data is stronger in our case. It is not only about being consistent with the theoretical foundations of the gravity equation and controlling for time-varying exogenous unobservable changes in bilateral export costs. We use it as identification strategy to estimate the potentially different effect of the reduction of trade barriers (other than those altered by FTAs) on final goods and intermediate inputs. To make this point clear, we review our econometric specification to consider both FTAs and the border effect:<sup>16</sup>

$$\begin{aligned}
X_{ij,t}^k = \exp & \left( \sum_{s=0}^{10+} \beta_{fta,t-s} FTA_{ij,t-s} + \sum_{s=0}^{10+} \beta_{fta-input,t-s} FTA_{ij,t-s} * Input_{ij,t} \right. \\
& + \sum_{t \neq t_0}^T \beta_{b,t} B_{i \neq j,t} + \sum_{t \neq t_0}^T \beta_{b,t} B_{i \neq j,t} * Input \\
& \left. + \eta_{i,t}^k + \psi_{j,t}^k + \vec{\gamma}_{ij}^k \right) + \epsilon_{ij,t}^k
\end{aligned} \tag{2.4}$$

First, note that in Equation (2.4) we include a set of  $T - 1$  (time iteration) terms of a border dummy that takes the value one if the bilateral trade flow is between different countries and for a given year.<sup>17</sup>  $T$  is the total number of years available in the sample and the border dummy itself is not included in the regression because it is a non-time-varying characteristic captured by the country-pair fixed effects. All the  $B_{ij,t}$  terms account for average (across all pairs of different countries) changes in unobservable bilateral (fixed and variable) export costs, that are not associated with

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<sup>16</sup>Intra-national trade flow data is naturally available in international input-output tables used for global value chains analysis. See the data section for more details.

<sup>17</sup>The border dummy for the first year of the sample is always omitted.

FTAs.

Also note that with the inclusion of intra-national trade flows, international trade barriers' effects are measured relative to intra-national trade flows. This leads us to wonder about the nature of the trade barriers included in the border effect, and what factors could have led to its change. ICT advances are arguably behind the fragmentation of production across countries by allowing to move ideas across countries, leading to an increasing importance of intermediate goods in international trade. Nevertheless, [Baldwin \(2016\)](#) does not consider the potentially different effect of ICT advances on trade in final and intermediate goods.

While exported final goods are produced or designed to be consumed, intermediate goods are designed to be part of further production processes that might require certain specificities and more importantly, a certain degree of coordination between the different stages of production. Therefore, we conjecture that while we should expect a positive effect of a reduction in the border effect on both types of trade, final goods could have benefited more from the same reductions at the bilateral level. As explained in the motivation section, this is not in contradiction with the well-known expansion of global value chains, since the effect of FTAs and the border effect reduction is expected to be positive for both final goods and intermediate inputs.

To capture the potential different effect from reduction in trade frictions on final goods and intermediate inputs, we also include the  $T - 1$  interaction of the border-time dummies with a intermediate good dummy,  $Input_{i \neq j}$ , as we did with the FTA indicator to capture the other potentially different effect on intermediate goods from FTAs.

## 2.4 Data

### 2.4.1 Trade Flows in Final and Intermediate Goods

Differentiating between final and intermediate goods demands the use of specific data. This delineation is something natural in the international input-output tables that have been made available by different sources (see for instance initiatives like WIOD, OECD-TiVA and EORA). Unfortunately, the time coverage of the input-output tables mentioned often starts in the mid-1990s and is thus too limited to capture the long-term factors we are interested in. Therefore, we need input-output tables covering a longer period. Fortunately, [Johnson and Noguera \(2017\)](#) have constructed a database of input-output tables covering the 1970-2009 period. Their data construction effort is distinguished from related work in that they provide a long historical perspective on the rise of global supply chains by covering a long period and with broad a country scope, 43 countries reduced to 37 after dropping Check Republic, Estonia, Russia, Slovakia and Slovenia.<sup>18</sup> This sample size is the same used in studies like [Bergstrand et al. \(2015\)](#), with the difference that they cover the period 1990-2002 and we focus on the period 1970-2009. Given that we build on the existent literature, we also replicate several results in the literature before proceeding to address our research questions for comparability and consistency.

Note that the long and comprehensive panel dimension of this data is key for our purpose of identifying the timing of the reductions in trade barriers that have been driving the emergence of Global Value Chains.<sup>19</sup> The Input-Output tables also track trade between as well as within coun-

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<sup>18</sup>These countries are dropped due to not being covered over the whole period. The RoW region is also dropped.

<sup>19</sup>Remember that we focus on trade in the manufacturing sector.



tries, so that we have access to both international and intra-national trade flows, which is essential to estimate structural gravity equations and to examine the specific border effects we interested in.

### **2.4.2 Economic Integration Agreements**

We use data on economic integration agreements assembled by Scott Baier and Jeffrey Bergstrand, covering the 1960-2009 period.<sup>20</sup> This database is designed to allow users to quickly sort, file, and use information regarding the economic integration of bilateral country pairings. Table (2.1) shows the Economic Integration Agreements classification. We follow the literature in the way to define a FTA for comparison purposes. Therefore, a FTA is defined as an economic integration agreement in which trade barriers are eliminated (or substantially so) among members, and where non-members are treated differently. Our FTA indicator, therefore, takes the value one if a country pair has a FTA or stronger economic agreement, similar to the literature.<sup>21</sup> Also note that since our trade data ends in 2009, only FTA's that been in place 10 or more years before 2009 are included. The literature has shown that Preferential trade agreements have a less significant (if any) effect on bilateral trade.

Later in this chapter, when exploring the evolution of the trade effect of FTAs, we will disentangle the intra-EU effect from the average FTA. Therefore, it is important to remember that most agreements in categories 4, 5 and 6 are those among EU members.

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<sup>20</sup>This database is available in "<https://www3.nd.edu/~jbergstr/#Links>". We use the September 2015 revision.

<sup>21</sup>See [Baier and Bergstrand \(2007\)](#) and the subsequent literature.

Table 2.1: Economic Integration Agreements

IIA Ranking	Type of Agreement	Type of Agreement	Definition
1	NR-PTA	Non Reciprocal Preferential Trade Arrangement	Preferential terms and customs concessions given by developed nations to developing countries
2	PTA	Preferential Trade Arrangement	Preferential terms to members vs non-members
3	FTA	Free Trade Areas	Trade barriers eliminated (or substantially so) among members; treat non-members differently
4	CU	Customs Union	Same as FTA; but treat non-members the same
5	CM	Common Market	Same as CU; but also includes free movement of labor/capital
6	EUN	Economic union	Same as CM, but also monetary and Fiscal Policy coordination; further harmonization of taxes/regulation/monetary system

## 2.5 Results

### 2.5.1 FTAs and trade in final goods and intermediates

We start by presenting our empirical estimates for the trade-enhancing effect of FTAs in Table (2.2). Column 1-3 show the results from the estimation considering total trade flows (adding trade in final goods and inputs). Columns 4 to 7 show the results using data for both final and intermediate goods, which doubles the sample size. For each of the two specifications, we first omit the intra-national trade flows, then introduce them, but without controlling for the border effect. Lastly, we control for the border effect. Also note that we include lagged effects of the FTAs of up to 10 years, with the 10-year lag indicating 10 years or more after the introduction of the FTA between the country pair. This is the main object of interest regarding FTAs.

The results point to large gains to international trade from FTA's: a 54% [ $e^{0.434} - 1$ ] increase in bilateral trade over 10 years in our preferred specification in column 7. There are only minor differences between the estimation with total trade and the one with trade in final and intermediate goods as seen in columns 3 and 7. Nevertheless, the estimation differentiating trade in final and intermediate goods yield some additional

	(1) Total	(2) Total	(3) Total	(4) Both	(5) Both	(6) Both	(7) Both
FTA lag 0	0.083** (0.033)	0.440*** (0.075)	0.174*** (0.067)	0.071 (0.045)	0.554*** (0.096)	0.277*** (0.085)	0.193** (0.080)
FTA lag 1	0.129*** (0.036)	0.544*** (0.101)	0.236*** (0.087)	0.119** (0.051)	0.645*** (0.113)	0.325*** (0.096)	0.238** (0.098)
FTA lag 2	0.140*** (0.040)	0.607*** (0.108)	0.254** (0.103)	0.141*** (0.055)	0.741*** (0.114)	0.374*** (0.106)	0.263** (0.109)
FTA lag 3	0.185*** (0.039)	0.686*** (0.107)	0.294*** (0.096)	0.181*** (0.054)	0.837*** (0.113)	0.431*** (0.099)	0.311*** (0.103)
FTA lag 4	0.206*** (0.040)	0.761*** (0.106)	0.350*** (0.092)	0.203*** (0.055)	0.933*** (0.111)	0.509*** (0.094)	0.372*** (0.097)
FTA lag 5	0.223*** (0.043)	0.839*** (0.107)	0.389*** (0.098)	0.226*** (0.057)	1.023*** (0.104)	0.559*** (0.091)	0.408*** (0.094)
FTA lag 6	0.244*** (0.044)	0.910*** (0.115)	0.409*** (0.105)	0.250*** (0.058)	1.097*** (0.110)	0.585*** (0.096)	0.440*** (0.101)
FTA lag 7	0.261*** (0.046)	0.914*** (0.104)	0.394*** (0.098)	0.265*** (0.060)	1.112*** (0.102)	0.582*** (0.092)	0.425*** (0.096)
FTA lag 8	0.265*** (0.049)	0.979*** (0.096)	0.411*** (0.098)	0.251*** (0.065)	1.182*** (0.094)	0.603*** (0.092)	0.432*** (0.096)
FTA lag 9	0.288*** (0.051)	1.024*** (0.094)	0.427*** (0.097)	0.272*** (0.069)	1.220*** (0.090)	0.612*** (0.090)	0.430*** (0.099)
FTA lag 10 +	0.312*** (0.055)	1.248*** (0.123)	0.385*** (0.129)	0.292*** (0.071)	1.531*** (0.119)	0.667*** (0.121)	0.434*** (0.131)
Input FTA lag 0				0.009 (0.036)	-0.191*** (0.041)	-0.183*** (0.035)	-0.035 (0.030)
Input FTA lag 1				-0.003 (0.040)	-0.180*** (0.035)	-0.173*** (0.026)	-0.019 (0.033)
Input FTA lag 2				-0.022 (0.040)	-0.243*** (0.034)	-0.236*** (0.022)	-0.039 (0.033)
Input FTA lag 3				-0.016 (0.042)	-0.270*** (0.035)	-0.264*** (0.024)	-0.051 (0.033)
Input FTA lag 4				-0.023 (0.044)	-0.308*** (0.034)	-0.303*** (0.023)	-0.059* (0.031)
Input FTA lag 5				-0.038 (0.046)	-0.331*** (0.032)	-0.330*** (0.023)	-0.060* (0.033)
Input FTA lag 6				-0.046 (0.046)	-0.341*** (0.037)	-0.343*** (0.026)	-0.084** (0.035)
Input FTA lag 7				-0.045 (0.048)	-0.355*** (0.034)	-0.359*** (0.026)	-0.080** (0.037)
Input FTA lag 8				-0.011 (0.049)	-0.361*** (0.033)	-0.367*** (0.025)	-0.062 (0.041)
Input FTA lag 9				-0.014 (0.051)	-0.349*** (0.035)	-0.356*** (0.028)	-0.030 (0.045)
Input FTA lag 10 +				0.004 (0.052)	-0.485*** (0.046)	-0.516*** (0.037)	-0.099* (0.052)
Observations	47520	49000	49000	95040	98000	98000	98000
Domestic trade flows	No	Yes	Yes	No	Yes	Yes	Yes
Control for border		No	Yes		No	Yes	Yes
Control for border-inputs					No	No	Yes

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses.

Table 2.2: FTA's Effect on bilateral trade (1970-2009)

interesting results: (i) the FTA effect is larger when one also considers intra-national trade flows. This clarifies the need to include the domestic flows in gravity equations.

When intra-national trade flows are considered, but we do not control for the border effect, the FTA-effect is 362% [ $e^{1.531} - 1$ ] increase in bilateral trade. (ii) Once one controls for the border effect, the coefficient returns to a more feasible level of 95% [ $e^{0.667} - 1$ ], pointing towards the fact that FTAs and other factors embodied in the border effect also affect international trade and are correlated with the FTAs. If one does not control for the border effect, the impact of FTAs is overestimated. [Bergstrand et al. \(2015\)](#) show these same results, but without reporting the impact of FTAs without including the intra-national trade flows. We think this is important because it is not about an overestimation of the effect as [Bergstrand et al. \(2015\)](#) conclude, but about the need to properly control for the border effect once the intra-national flows are included. Moreover, our estimations differentiate the trade in final and intermediate goods and yield these and other unique results reported later in this chapter. (iii) Finally, it turns out that one needs to control for a different border effect for final goods and intermediate inputs (comparing columns 6 and 7). With such different border effects, the FTA impact is further reduced to the 54% [ $e^{0.434} - 1$ ] increase in bilateral trade we find most plausible. This shows that the different factors that are affecting international and intra-national trade are also having a different effect for the two types of goods (finals and intermediates), whereas the effect of FTAs is not different for final goods and intermediate inputs when we use the whole 1970-2009 sample.

### **2.5.2 The evolution of the FTA-effect**

So far, we have used the whole data-set covering the period from 1970 to 2009. One can intuitively think that the effect of FTAs has changed over time. For instance, the 1980s turned out to be particularly important

for trade liberalization initiatives and that the depth and content of FTAs might be different in more recent agreements and had a greater trade effect. To study this possibility, we "roll" the estimations by dropping the starting year of the sample and keeping the end year always in 2009. This means that we identify the effect of only those FTAs signed after the starting year. Table (2.3) shows the results for the estimations with starting years between 1970 until 1997. We see two important results: (i) The FTA-effect seems to have been strengthened over time. In 1970, the effect is 54% [ $e^{0.434} - 1$ ] as mentioned before, and it gradually increases up to an effect of 97% [ $e^{0.678} - 1$ ]. This is in line with the idea that new FTAs have evolved by deepening trade integration.<sup>22</sup> Additionally, it seems that there is a significantly smaller effect of FTA on trade in intermediate goods towards the end of the sample (the mid-1990s).

### 2.5.3 Reduced border effects

As we saw previously, reductions in the border effect are correlated with FTAs. This means that when we introduce intra-national trade flows in the estimation as theory indicates, one needs to control for whether the trade flows are between different countries or within the same country. Zylkin (2017) estimates the effect of the NAFTA free trade agreement between the United States, Mexico, and Canada. He does not differentiate between trade in final and intermediate goods but anticipates that symmetric reduction in tariffs could (paradoxically) show up in the data as promoting more trade in final goods than in intermediate inputs. The logic is that the final goods include more value than the intermediates

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<sup>22</sup>Note that the FTA's effect is estimated only with the new FTAs signed after the starting year. They are comparable thanks to the high dimensional fixed effects included. See the empirical approach section for more details.

	(1) 1970	(2) 1973	(3) 1976	(4) 1979	(5) 1982	(6) 1985	(7) 1988	(8) 1991	(9) 1994	(10) 1997
FTA lag 0	0.193** (0.080)	0.205*** (0.078)	0.217*** (0.076)	0.222*** (0.076)	0.220*** (0.070)	0.228*** (0.055)	0.308*** (0.030)	0.170*** (0.030)	0.277*** (0.047)	0.105* (0.061)
FTA lag 1	0.238** (0.098)	0.254*** (0.098)	0.266*** (0.096)	0.272*** (0.095)	0.272*** (0.090)	0.281*** (0.074)	0.367*** (0.032)	0.271*** (0.040)	0.320*** (0.052)	0.226** (0.108)
FTA lag 2	0.263** (0.109)	0.272** (0.109)	0.284*** (0.108)	0.290*** (0.107)	0.290*** (0.102)	0.299*** (0.087)	0.389*** (0.044)	0.324*** (0.042)	0.351*** (0.054)	0.265*** (0.094)
FTA lag 3	0.311*** (0.103)	0.319*** (0.102)	0.331*** (0.101)	0.336*** (0.100)	0.337*** (0.095)	0.346*** (0.080)	0.436*** (0.042)	0.354*** (0.045)	0.361*** (0.070)	0.347*** (0.107)
FTA lag 4	0.372*** (0.097)	0.377*** (0.095)	0.390*** (0.094)	0.395*** (0.093)	0.397*** (0.089)	0.405*** (0.074)	0.514*** (0.039)	0.416*** (0.045)	0.374*** (0.066)	0.347*** (0.106)
FTA lag 5	0.408*** (0.094)	0.417*** (0.095)	0.429*** (0.094)	0.435*** (0.093)	0.435*** (0.089)	0.444*** (0.075)	0.547*** (0.042)	0.446*** (0.045)	0.382*** (0.078)	0.428*** (0.144)
FTA lag 6	0.440*** (0.101)	0.451*** (0.100)	0.464*** (0.098)	0.469*** (0.098)	0.469*** (0.094)	0.478*** (0.081)	0.584*** (0.049)	0.504*** (0.044)	0.394*** (0.080)	0.399*** (0.151)
FTA lag 7	0.425*** (0.096)	0.440*** (0.095)	0.452*** (0.094)	0.458*** (0.094)	0.460*** (0.091)	0.469*** (0.079)	0.564*** (0.057)	0.481*** (0.051)	0.473*** (0.088)	0.515*** (0.163)
FTA lag 8	0.432*** (0.096)	0.447*** (0.096)	0.460*** (0.095)	0.465*** (0.096)	0.467*** (0.093)	0.476*** (0.084)	0.562*** (0.069)	0.481*** (0.066)	0.536*** (0.101)	0.529*** (0.189)
FTA lag 9	0.430*** (0.099)	0.438*** (0.098)	0.451*** (0.097)	0.457*** (0.099)	0.459*** (0.097)	0.468*** (0.089)	0.550*** (0.077)	0.475*** (0.078)	0.529*** (0.110)	0.612*** (0.211)
FTA lag 10 +	0.434*** (0.131)	0.424*** (0.134)	0.437*** (0.134)	0.445*** (0.135)	0.456*** (0.134)	0.469*** (0.125)	0.473*** (0.100)	0.496*** (0.105)	0.536*** (0.115)	0.678*** (0.216)
Input FTA lag 0	-0.035 (0.030)	-0.032 (0.032)	-0.045 (0.032)	-0.049 (0.031)	-0.048 (0.030)	-0.043 (0.027)	-0.024 (0.031)	-0.124*** (0.025)	-0.162*** (0.040)	-0.107* (0.061)
Input FTA lag 1	-0.019 (0.033)	-0.015 (0.034)	-0.025 (0.034)	-0.029 (0.033)	-0.026 (0.032)	-0.021 (0.029)	-0.001 (0.032)	-0.091*** (0.029)	-0.194*** (0.050)	-0.250** (0.107)
Input FTA lag 2	-0.039 (0.033)	-0.033 (0.033)	-0.042 (0.033)	-0.046 (0.033)	-0.043 (0.033)	-0.038 (0.032)	-0.017 (0.033)	-0.087** (0.034)	-0.242*** (0.057)	-0.284*** (0.097)
Input FTA lag 3	-0.051 (0.033)	-0.047 (0.034)	-0.057* (0.034)	-0.061* (0.034)	-0.058* (0.034)	-0.051 (0.034)	-0.039 (0.035)	-0.105*** (0.040)	-0.245*** (0.072)	-0.289*** (0.105)
Input FTA lag 4	-0.059* (0.031)	-0.055* (0.032)	-0.064** (0.032)	-0.068** (0.032)	-0.065** (0.033)	-0.057* (0.034)	-0.053 (0.035)	-0.117*** (0.038)	-0.254*** (0.063)	-0.355*** (0.092)
Input FTA lag 5	-0.060* (0.033)	-0.055* (0.033)	-0.064* (0.033)	-0.068** (0.034)	-0.064* (0.036)	-0.057 (0.041)	-0.048 (0.042)	-0.072 (0.044)	-0.230*** (0.081)	-0.418*** (0.134)
Input FTA lag 6	-0.084** (0.035)	-0.084** (0.036)	-0.093** (0.036)	-0.097*** (0.037)	-0.092** (0.039)	-0.084* (0.045)	-0.084* (0.047)	-0.090** (0.046)	-0.214*** (0.078)	-0.350*** (0.127)
Input FTA lag 7	-0.080** (0.037)	-0.077** (0.038)	-0.085** (0.038)	-0.088** (0.039)	-0.084** (0.041)	-0.077* (0.046)	-0.070 (0.050)	-0.091* (0.049)	-0.234*** (0.085)	-0.402*** (0.137)
Input FTA lag 8	-0.062 (0.041)	-0.059 (0.042)	-0.066 (0.043)	-0.069 (0.044)	-0.064 (0.046)	-0.057 (0.053)	-0.051 (0.058)	-0.066 (0.060)	-0.269*** (0.087)	-0.387*** (0.147)
Input FTA lag 9	-0.030 (0.045)	-0.024 (0.046)	-0.031 (0.047)	-0.035 (0.048)	-0.030 (0.051)	-0.022 (0.057)	-0.012 (0.065)	-0.036 (0.071)	-0.279*** (0.097)	-0.409** (0.171)
Input FTA lag 10 +	-0.099* (0.052)	-0.101* (0.053)	-0.110** (0.054)	-0.114** (0.055)	-0.112* (0.057)	-0.104* (0.063)	-0.051 (0.066)	-0.051 (0.067)	-0.250** (0.105)	-0.465*** (0.180)
Observations	98000	90650	83300	75950	68600	61250	53900	46550	39200	31850

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses. The year in each column denotes the starting year in the sample.

Table 2.3: The FTA's effect evolution

that are used in their production. Any innovation or policy action that reduces trade costs would, therefore, have a larger impact on trade in final goods, than the intermediate inputs.

This naturally poses the question whether the evolution of the border effect since 1970 has had a differential effect on these different types of goods over time. Figure (2.2) plots our estimates and show a continuous stimulation of international trade in relation to intra-national over time.

This means that trade barriers, other than those relating to FTAs, have been continuously reduced. From around 1985 we observe a stronger effect on final goods than on intermediate inputs. By the end of the sample in 2009, international final goods trade is estimated to have expanded by a 443% [ $e^{1.692} - 1$ ] relative to domestic trade flows due to the decreasing border effect, while the rise of intermediate inputs is 195% [ $e^{1.083} - 1$ ].

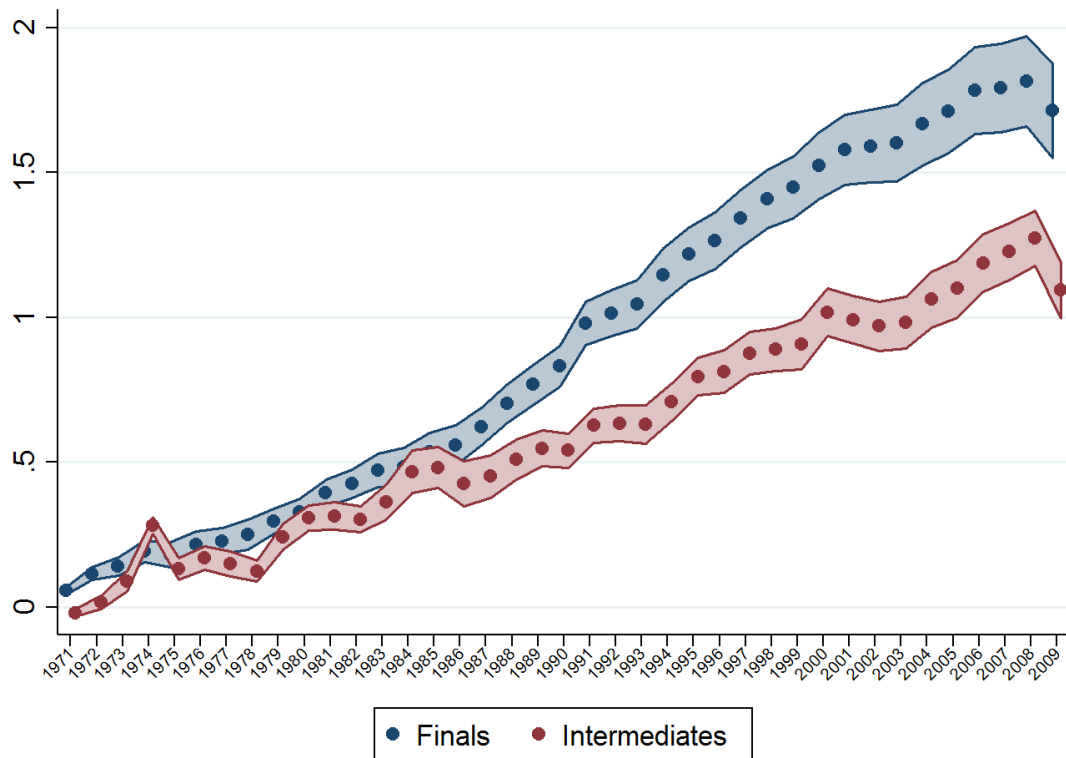
This is arguably related to the fact that final goods and intermediates inputs are different in nature. While final goods are produced to be consumed, intermediates are designed to be further processed in subsequent production processes. Therefore, intermediate inputs require more coordination in production and are thus less impacted by reduced trade costs than final goods that bear the full cost of previous steps in production.<sup>23</sup> The differential impact of lower trade costs on final goods and intermediate inputs is also found by [Antras and Chor \(2018\)](#). It is not inconsistent with the emergence of international supply chains, since these results show that intermediate goods have been increasingly traded, generating production linkages across countries. It could instead be that final goods consist of an increasingly complex chain of intermediate inputs.

Figure (2.2) graphically illustrates the impact of the decreasing border effect on final and intermediate goods when estimated in different regressions. It gives a clear idea of the different effect. Nevertheless, it does not precisely show the period in which these differences take place. Figure (2.3) therefore plots the impact of the reduced border effect on intermediate goods obtained from the regression using trade in final goods and intermediate inputs in the same estimation. From this figure, we see

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<sup>23</sup>[Rouzet and Miroudot \(2013\)](#) show that tariffs and other trade costs cumulate and that even small trade costs can have adverse consequences when inputs are part of complex value chains that finally constitute final products.

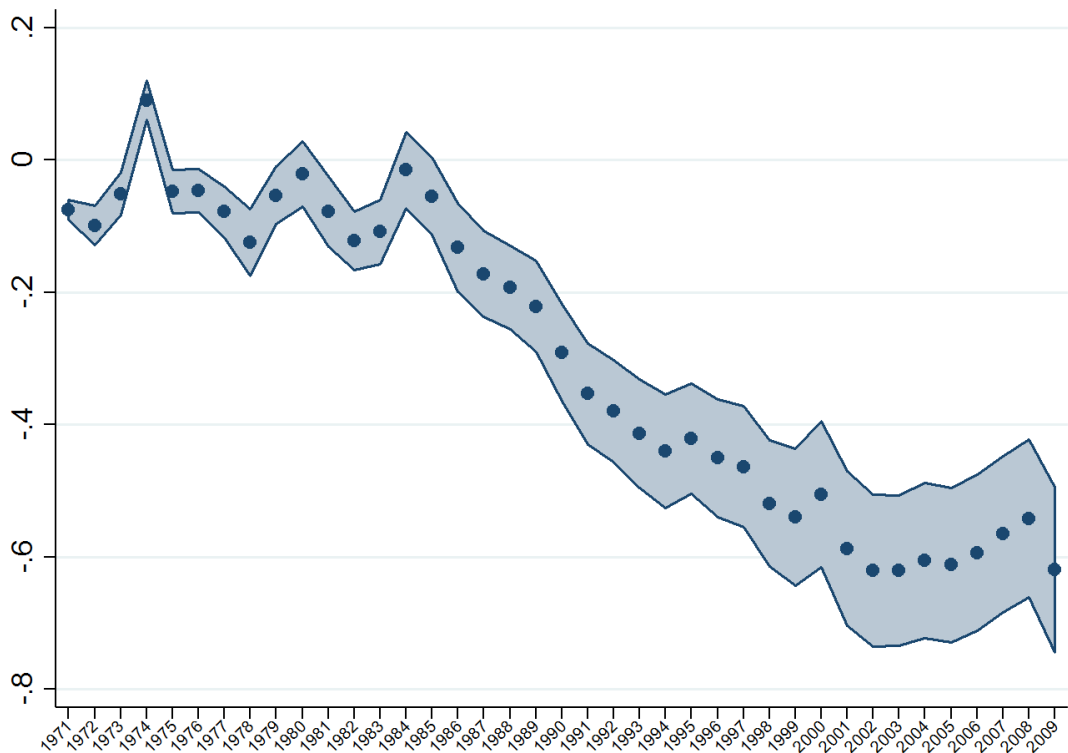
Figure 2.2: Border effect for final and intermediate goods



that the evolution of the border effect is not different until the mid-1980s when it starts to be greater for the final goods. From then and until the beginning of the 2000s, the reduction of trade frictions stimulated final goods much more strongly. From the beginning of the 2000s and onward, the reduction in the border effect has once again affected final goods and intermediate inputs to the same extent. As it was explained before in this chapter, it is particularly interesting that this different border effect coincides with the Information and Communication (ICT) revolution that allowed the emergence of global value chains. We will further discuss this issue later.



Figure 2.3: Different Border effect for finals and intermediates



#### 2.5.4 Getting into the Strengthened Effect of FTAs

We previously found evidence that the trade of effect of the average FTA has strengthened over time. To get further insights into this trend, we focus on the intra-EU effect. The reason for this is that the European Union has pursued deeper integration since its first steps and it could be the main driver of the observed evolution. The year 1986 was a particularly important year for initiatives liberalizing trade. Europe both deepened and widened its pan-European economic integration within the European Union (EU). Spain and Portugal were admitted as new members and the EU embarked on the reduction of many other economic barriers in the context of the Single Market program [see for instance [Mongelli et al. \(2005\)](#) on the different stages of integration]. Now that EU-membership is being renegotiated in the context of 'Brexit', it is interesting to see what

the average trade effect of joining the EU might be.

We apply our general methodology to capture the potentially different trade effect of the European Union (EU) compared to the average FTA-effect. We define a dummy variable for the EU in the same way as the FTA variable. It takes value 1 when the bilateral trade flow is between two EU countries. This variable thus captures the additional effect of the EU on bilateral intra-EU trade.

The results capture several important insights: (i) The EU has a larger effect on bilateral trade, beyond that of the average FTA effect. (ii) By 1994 however, the difference between the EU's effect and the average FTA-effect has become smaller. At the same time, the effect of average FTAs has increased strongly, meaning that the total EU-effect has also increased over time. The previous result of a larger effect of FTAs on trade in intermediate goods towards the end of the sample is also present in these results. Nevertheless, for the intra-EU trade, this difference is already significant since the beginning of the 1970s.

	(1) 1970	(2) 1973	(3) 1976	(4) 1979	(5) 1982	(6) 1985	(7) 1988	(8) 1991	(9) 1994
FTA lag 10 +	0.270** (0.122)	0.266** (0.123)	0.277** (0.122)	0.282** (0.122)	0.292** (0.120)	0.312*** (0.112)	0.323*** (0.084)	0.393*** (0.095)	0.565*** (0.117)
Input FTA lag 10 +	-0.086* (0.049)	-0.096* (0.050)	-0.108** (0.051)	-0.118** (0.053)	-0.129** (0.056)	-0.141** (0.065)	-0.107 (0.075)	-0.100 (0.077)	-0.284*** (0.108)
EU lag 10 +	0.354*** (0.071)	0.340*** (0.071)	0.335*** (0.069)	0.335*** (0.068)	0.335*** (0.066)	0.327*** (0.066)	0.246*** (0.065)	0.262*** (0.058)	0.285*** (0.062)
Input EU lag 10 +	-0.215*** (0.045)	-0.232*** (0.048)	-0.234*** (0.048)	-0.241*** (0.049)	-0.254*** (0.050)	-0.260*** (0.052)	-0.249*** (0.051)	-0.277*** (0.047)	-0.339*** (0.043)
Observations	90800	83990	77180	70370	63560	56750	49940	43130	36320

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses. The year in each column denotes the starting year in the sample. Out of the 40 lags included in the estimations, only the long-run effect of FTAs (10+ lag) is report due to space constraints.

Table 2.4: European Union effect on trade in finals and intermediates

## 2.6 Robustness Checks

### 2.6.1 The Role of the HDFEs in Estimating the FTA Effect

Since the contribution of [Baier and Bergstrand \(2007\)](#) the literature estimates the FTA effect on bilateral trade includes country-pair fixed effects. They used a log-linear OLS, but after [Silva and Tenreyro \(2006\)](#)'s work, the PPML estimator became the benchmark, as we explained before. Nevertheless, for large samples, computational issues have limited the choice of the estimator, forcing researchers to use the log-linear OLS or the PPML without country-pair fixed effects. More recently, [Larch et al. \(2017\)](#) have addressed this gap, unveiling an iterative PPML estimator, which flexibly accounts for multilateral resistance, pair-specific heterogeneity, and correlated errors. This has open the door to the use of High-Dimensional Fixed Effects in PPML. This implies that more robust and unbiased estimate can be obtained. Nevertheless, this might raise the question of whether there is an "overfitting problem".<sup>24</sup> In PPML there is not an equivalent way to obtain a measure of the goodness of fit of a model as the  $R^2$  in OLS, and that is why it is not usually reported in the literature using the PPML estimator. Although, there exists a pseudo- $R^2$  for PPML computed as the square of the correlation between the dependable variable and the fitted values. Introducing the different set of fixed effects one by one and reporting this pseudo- $R^2$  provides two important insights: (i) an approximation of the goodness of fit of the model, (ii) an approximation to an analysis of variance (ANOVA). Nevertheless, rather than allowing to par-

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<sup>24</sup>Note that the only set of fixed effects that is not included is the country-pair-time since it the dimension at which the FTA effect is estimated.

tition the observed variance in the dependent variable into the different explanatory variables and fixed effects, we can only compute the pseudo- $R^2$  when the different sets of variables are included in the estimation. Results are reported in table (2.5).

So far we have estimated the FTA effect on trade with asymmetric country-pair fixed effects. Therefore, one basic exercise we can do to reduce the number of fixed effects included is to estimate this effect with symmetric country-pair fixed effects. This cuts the number of country-pair fixed effects roughly in half. An over-fitting bias in fixed effects estimations generally creates a problem by yielding standard errors that are too small. Given that the degree of precision is roughly the same (see columns 1 and 2), we conclude that it is unlikely to be an over-fitting issue in our estimates.

### **2.6.2 More Robust Standard Errors**

Note that so far in this chapter, results have been reported with standard errors clustered by exporter and importer, in line with the literature. Nevertheless, we think it is also important to consider the potential correlation of errors across time. There, we now cluster errors by exporter-importer-year. Table (2.6) reports the same results as in table (2.2), showing that our results are robust to this specification. If any, table (2.6) shows that the differential effect of FTAs in trade in intermediate goods emerges at the end of the period.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FTA lag 0	0.193** (0.080)	0.190** (0.079)	0.394 (0.276)			0.554*** (0.096)	0.749* (0.390)
FTA lag 1	0.238** (0.098)	0.242** (0.096)	0.420 (0.263)			0.645*** (0.113)	0.915** (0.385)
FTA lag 2	0.263** (0.109)	0.268** (0.107)	0.465* (0.257)			0.741*** (0.114)	0.995*** (0.378)
FTA lag 3	0.311*** (0.103)	0.316*** (0.101)	0.526** (0.255)			0.837*** (0.113)	1.067*** (0.379)
FTA lag 4	0.372*** (0.097)	0.376*** (0.095)	0.600** (0.251)			0.933*** (0.111)	1.159*** (0.390)
FTA lag 5	0.408*** (0.094)	0.413*** (0.093)	0.694*** (0.246)			1.023*** (0.104)	1.264*** (0.396)
FTA lag 6	0.440*** (0.101)	0.445*** (0.099)	0.721*** (0.244)			1.097*** (0.110)	1.360*** (0.390)
FTA lag 7	0.425*** (0.096)	0.433*** (0.095)	0.701*** (0.240)			1.112*** (0.102)	1.369*** (0.384)
FTA lag 8	0.432*** (0.097)	0.438*** (0.095)	0.676*** (0.240)			1.181*** (0.094)	1.467*** (0.387)
FTA lag 9	0.430*** (0.099)	0.436*** (0.098)	0.648*** (0.230)			1.220*** (0.090)	1.521*** (0.383)
FTA lag 10+	0.435*** (0.131)	0.440*** (0.129)	0.168* (0.093)			1.531*** (0.119)	2.303*** (0.131)
Input FTA lag 0	-0.035 (0.030)	-0.030 (0.028)	-0.058 (0.405)			-0.191*** (0.041)	-0.203 (0.559)
Input FTA lag 1	-0.019 (0.033)	-0.020 (0.031)	-0.069 (0.384)			-0.180*** (0.035)	-0.246 (0.550)
Input FTA lag 2	-0.039 (0.033)	-0.041 (0.031)	-0.124 (0.377)			-0.243*** (0.034)	-0.298 (0.540)
Input FTA lag 3	-0.051 (0.033)	-0.054* (0.032)	-0.107 (0.369)			-0.270*** (0.035)	-0.273 (0.543)
Input FTA lag 4	-0.059* (0.031)	-0.062* (0.032)	-0.134 (0.365)			-0.308*** (0.034)	-0.326 (0.562)
Input FTA lag 5	-0.060* (0.033)	-0.065* (0.035)	-0.144 (0.359)			-0.331*** (0.032)	-0.341 (0.564)
Input FTA lag 6	-0.085** (0.035)	-0.091** (0.037)	-0.140 (0.355)			-0.340*** (0.037)	-0.356 (0.554)
Input FTA lag 7	-0.080** (0.037)	-0.088** (0.039)	-0.151 (0.349)			-0.355*** (0.034)	-0.345 (0.540)
Input FTA lag 8	-0.062 (0.041)	-0.069 (0.043)	-0.149 (0.351)			-0.361*** (0.033)	-0.343 (0.541)
Input FTA lag 9	-0.030 (0.045)	-0.038 (0.047)	-0.150 (0.339)			-0.348*** (0.035)	-0.354 (0.536)
Input FTA lag 10+	-0.099* (0.052)	-0.104** (0.053)	-0.385*** (0.133)			-0.485*** (0.046)	-0.475** (0.190)
Pair FEs	Asym	Sym	No	Asym	No	Asym	No
Borders	Yes	Yes	Yes	Yes	Yes	No	No
Observations	98000	98000	98000	98000	98000	98000	98000
pseudo- $R^2$	1.000	1.000	0.991	1.000	0.991	0.999	0.356

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses. The pseudo- $R^2$  is reported as 1 when pseudo- $R^2 > 0.999$

Table 2.5: The role of HDFEs and pseudo- $R^2$  (1970-2009)

	(1) 1970	(2) 1973	(3) 1976	(4) 1979	(5) 1982	(6) 1985	(7) 1988	(8) 1991	(9) 1994	(10) 1997
FTA lag 0	0.193* (0.100)	0.205** (0.099)	0.217** (0.100)	0.222** (0.102)	0.220** (0.105)	0.228** (0.111)	0.309*** (0.117)	0.169 (0.119)	0.281*** (0.098)	0.105* (0.060)
FTA lag 1	0.238** (0.103)	0.254** (0.100)	0.266*** (0.100)	0.272*** (0.102)	0.272*** (0.104)	0.281*** (0.104)	0.367*** (0.099)	0.271** (0.131)	0.323*** (0.052)	0.225*** (0.034)
FTA lag 2	0.263** (0.110)	0.272** (0.108)	0.284*** (0.108)	0.290*** (0.109)	0.290*** (0.109)	0.299*** (0.106)	0.389*** (0.084)	0.324*** (0.114)	0.355*** (0.048)	0.265*** (0.034)
FTA lag 3	0.311*** (0.104)	0.319*** (0.100)	0.330*** (0.099)	0.336*** (0.099)	0.337*** (0.097)	0.346*** (0.090)	0.437*** (0.081)	0.354*** (0.110)	0.364*** (0.048)	0.347*** (0.021)
FTA lag 4	0.372*** (0.099)	0.377*** (0.095)	0.390*** (0.094)	0.395*** (0.094)	0.397*** (0.093)	0.405*** (0.087)	0.514*** (0.073)	0.415*** (0.102)	0.377*** (0.034)	0.347*** (0.028)
FTA lag 5	0.408*** (0.103)	0.417*** (0.101)	0.429*** (0.100)	0.435*** (0.101)	0.435*** (0.101)	0.444*** (0.098)	0.547*** (0.085)	0.446*** (0.098)	0.385*** (0.032)	0.428*** (0.037)
FTA lag 6	0.440*** (0.110)	0.451*** (0.107)	0.464*** (0.106)	0.469*** (0.108)	0.469*** (0.108)	0.478*** (0.105)	0.585*** (0.080)	0.504*** (0.079)	0.398*** (0.056)	0.399*** (0.062)
FTA lag 7	0.425*** (0.112)	0.440*** (0.108)	0.452*** (0.108)	0.458*** (0.110)	0.460*** (0.110)	0.469*** (0.107)	0.564*** (0.084)	0.480*** (0.061)	0.477*** (0.069)	0.514*** (0.106)
FTA lag 8	0.432*** (0.117)	0.447*** (0.113)	0.460*** (0.113)	0.465*** (0.115)	0.467*** (0.113)	0.476*** (0.108)	0.562*** (0.093)	0.480*** (0.067)	0.540*** (0.085)	0.529*** (0.156)
FTA lag 9	0.430*** (0.124)	0.438*** (0.120)	0.451*** (0.121)	0.457*** (0.122)	0.459*** (0.120)	0.468*** (0.115)	0.550*** (0.099)	0.475*** (0.069)	0.533*** (0.075)	0.612*** (0.158)
FTA lag 10+	0.435** (0.184)	0.424** (0.182)	0.437** (0.182)	0.445** (0.182)	0.456** (0.179)	0.469*** (0.168)	0.473*** (0.139)	0.495*** (0.106)	0.541*** (0.094)	0.678*** (0.184)
Input FTA lag 0	-0.035 (0.050)	-0.032 (0.051)	-0.045 (0.052)	-0.049 (0.052)	-0.048 (0.052)	-0.044 (0.055)	-0.025 (0.072)	-0.124* (0.065)	-0.165*** (0.057)	-0.101** (0.049)
Input FTA lag 1	-0.019 (0.050)	-0.015 (0.051)	-0.025 (0.052)	-0.029 (0.052)	-0.026 (0.052)	-0.021 (0.053)	-0.001 (0.068)	-0.091 (0.066)	-0.197*** (0.038)	-0.244*** (0.042)
Input FTA lag 2	-0.039 (0.049)	-0.033 (0.048)	-0.041 (0.048)	-0.046 (0.049)	-0.043 (0.050)	-0.038 (0.051)	-0.018 (0.061)	-0.087 (0.066)	-0.246*** (0.055)	-0.278*** (0.096)
Input FTA lag 3	-0.051 (0.049)	-0.047 (0.050)	-0.056 (0.050)	-0.061 (0.051)	-0.058 (0.052)	-0.052 (0.053)	-0.040 (0.055)	-0.105 (0.072)	-0.249*** (0.074)	-0.283*** (0.042)
Input FTA lag 4	-0.059 (0.052)	-0.055 (0.054)	-0.064 (0.055)	-0.068 (0.056)	-0.065 (0.058)	-0.058 (0.060)	-0.054 (0.056)	-0.117* (0.071)	-0.257*** (0.048)	-0.349*** (0.057)
Input FTA lag 5	-0.060 (0.052)	-0.055 (0.055)	-0.064 (0.056)	-0.068 (0.058)	-0.064 (0.061)	-0.058 (0.064)	-0.049 (0.050)	-0.072 (0.072)	-0.233** (0.095)	-0.412*** (0.022)
Input FTA lag 6	-0.085 (0.058)	-0.084 (0.063)	-0.093 (0.064)	-0.097 (0.066)	-0.092 (0.070)	-0.085 (0.074)	-0.084 (0.062)	-0.090 (0.076)	-0.217*** (0.070)	-0.343*** (0.043)
Input FTA lag 7	-0.080 (0.056)	-0.077 (0.063)	-0.085 (0.063)	-0.088 (0.065)	-0.084 (0.068)	-0.077 (0.071)	-0.070 (0.060)	-0.091 (0.078)	-0.237*** (0.091)	-0.396*** (0.102)
Input FTA lag 8	-0.062 (0.052)	-0.059 (0.057)	-0.066 (0.058)	-0.069 (0.060)	-0.064 (0.062)	-0.057 (0.063)	-0.051 (0.049)	-0.066 (0.070)	-0.272*** (0.087)	-0.381** (0.153)
Input FTA lag 9	-0.030 (0.051)	-0.024 (0.054)	-0.031 (0.054)	-0.035 (0.055)	-0.030 (0.055)	-0.022 (0.056)	-0.012 (0.042)	-0.036 (0.063)	-0.283*** (0.082)	-0.403** (0.163)
Input FTA lag 10+	-0.099 (0.071)	-0.101 (0.071)	-0.110 (0.070)	-0.114 (0.072)	-0.112 (0.070)	-0.105 (0.069)	-0.051 (0.059)	-0.050 (0.069)	-0.254*** (0.077)	-0.458** (0.198)
Observations	98000	90650	83300	75950	68600	61250	53900	46550	39200	31850

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer-year, are reported in parentheses. The year in each column denotes the starting year in the sample.

Table 2.6: FTA effect on trade with more robust standard errors

### **2.6.3 Working with Data in 5-Year Intervals**

The literature estimating the impact of FTA's has followed the recommendation of [Cheng and J.Wall \(2005\)](#) to use data in intervals of 3 to 5 years. To make sure that our results are comparable with those in the literature, we report the previous results using 5-year intervals data. Table (2.7) reports the results for the full sample 1970-2009, in which the intra-national trade flows and the control for border effect as progressively introduced, and the result for the rolling starting year respectively. Table (2.8) reports the "rolling" estimation on the initial year of the sample. Finally, table (2.9) reports the results disentangling the intra-EU trade effect from the average FTA.

We find that our results hold and maintain our conclusions. Moreover, when using 5-year intervals the interpretation of the coefficients is less precise due to the time-windows. Therefore, we think there is no clear reason to drop a large number of observations now that efficient PPML algorithms are available.

## **2.7 Discussion**

### **2.7.1 The Border Effect and the ICT Revolution**

The ability to send ideas down cables for almost nothing to almost anywhere triggered a host of reformations in work practices, management practices, and relationships among firms and their suppliers and customers ([Baldwin, 2016](#)). Working methods and product designs shifted to make production more modular and thus easier to coordinate at distance.

	(1) Total	(2) Total	(3) Total	(4) Both	(5) Both	(6) Both	(7) Both
FTA lag 0	0.071* (0.042)	0.514*** (0.101)	0.191** (0.084)	0.072 (0.058)	0.668*** (0.130)	0.337*** (0.110)	0.200* (0.103)
FTA lag 5	0.185*** (0.055)	0.937*** (0.131)	0.406*** (0.116)	0.201*** (0.072)	1.174*** (0.133)	0.632*** (0.117)	0.414*** (0.119)
FTA lag 10 +	0.154** (0.070)	1.077*** (0.131)	0.288** (0.139)	0.110 (0.090)	1.394*** (0.134)	0.604*** (0.135)	0.327** (0.148)
Input FTA lag 0				-0.001 (0.047)	-0.264*** (0.054)	-0.262*** (0.049)	-0.022 (0.041)
Input FTA lag 5				-0.061 (0.055)	-0.435*** (0.033)	-0.439*** (0.023)	-0.053 (0.039)
Input FTA lag 10 +				0.037 (0.067)	-0.556*** (0.046)	-0.586*** (0.037)	-0.090 (0.059)
Observations	8784	9080	9080	17568	18160	18160	18160
pseudo- $R^2$	0.996	0.999	1.000	0.996	0.999	1.000	1.000
Domestic trade flows	No	Yes	Yes	No	Yes	Yes	Yes
Control for border		No	Yes		No	Yes	Yes
Control for border-input					No	No	Yes

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses.

Table 2.7: FTA's Effect with data in 5-year intervals (1970-2005)

	(1) 1974	(2) 1979	(3) 1984	(4) 1989	(5) 1994
FTA lag 0	0.200* (0.103)	0.219** (0.100)	0.238*** (0.089)	0.381*** (0.045)	0.261*** (0.064)
FTA lag 5	0.414*** (0.119)	0.435*** (0.117)	0.456*** (0.109)	0.655*** (0.060)	0.493*** (0.094)
FTA lag 10 +	0.327** (0.148)	0.352** (0.146)	0.388*** (0.138)	0.543*** (0.100)	0.562*** (0.112)
Input FTA lag 0	-0.022 (0.041)	-0.049 (0.040)	-0.067* (0.040)	-0.116** (0.047)	-0.136** (0.061)
Input FTA lag 5	-0.053 (0.039)	-0.080** (0.039)	-0.097** (0.042)	-0.101 (0.067)	-0.218*** (0.081)
Input FTA lag 10 +	-0.090 (0.059)	-0.125** (0.060)	-0.146** (0.065)	-0.068 (0.094)	-0.254** (0.102)
Observations	18160	15890	13620	11350	9080

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses. The year in each column denotes the starting year in the sample.

Table 2.8: The evolution of the FTA's Effect with data in intervals

The Telecom and Internet revolutions triggered a suite of information management innovations that made it easier, cheaper, faster, and safer to coordinate separate complex activities spatially. Email, editable files, and more specialized web-based coordination software packages revolution-



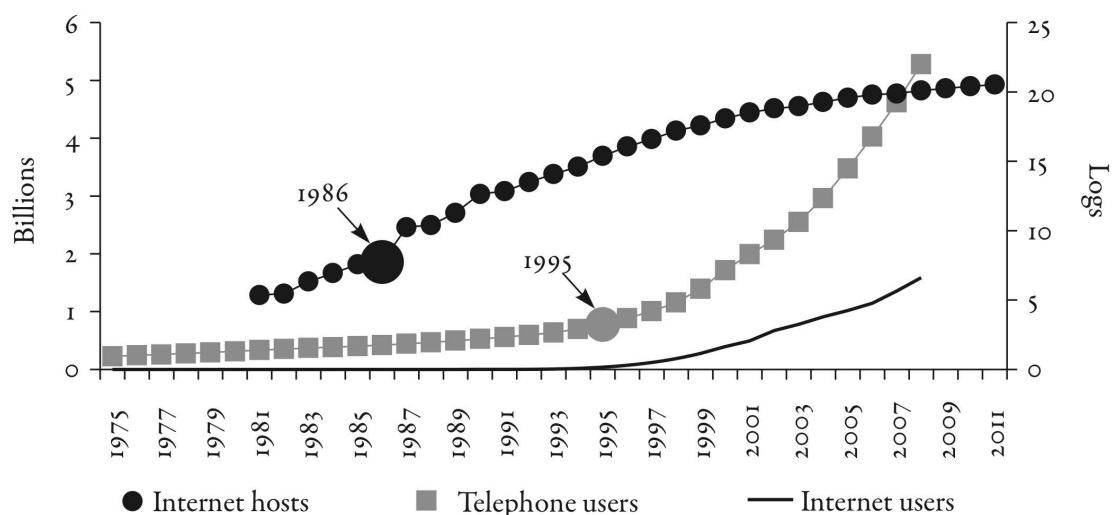
	(1) 1974	(2) 1979	(3) 1984	(4) 1989	(5) 1994
FTA lag 0	0.187* (0.102)	0.211** (0.100)	0.243*** (0.090)	0.387*** (0.046)	0.270*** (0.064)
FTA lag 5	0.410*** (0.119)	0.435*** (0.117)	0.469*** (0.110)	0.666*** (0.060)	0.503*** (0.094)
FTA lag 10 +	0.276* (0.141)	0.308** (0.140)	0.358*** (0.134)	0.557*** (0.101)	0.574*** (0.112)
Input FTA lag 0	-0.012 (0.040)	-0.040 (0.039)	-0.070* (0.040)	-0.120** (0.048)	-0.149** (0.060)
Input FTA lag 5	-0.047 (0.037)	-0.075** (0.037)	-0.104** (0.041)	-0.110 (0.068)	-0.233*** (0.081)
Input FTA lag 10 +	-0.053 (0.052)	-0.090* (0.054)	-0.126** (0.060)	-0.080 (0.094)	-0.271*** (0.102)
EU lag 0	0.166*** (0.051)	0.167*** (0.050)	0.164*** (0.051)	0.208*** (0.049)	0.221*** (0.046)
EU lag 5	0.152** (0.067)	0.153** (0.066)	0.153** (0.068)	0.219*** (0.073)	0.238*** (0.068)
EU lag 10 +	0.359*** (0.076)	0.356*** (0.073)	0.365*** (0.070)	0.272*** (0.072)	0.296*** (0.067)
Input EU lag 0	-0.142*** (0.044)	-0.148*** (0.042)	-0.165*** (0.042)	-0.183*** (0.041)	-0.251*** (0.039)
Input EU lag 5	-0.155*** (0.045)	-0.161*** (0.045)	-0.179*** (0.046)	-0.235*** (0.050)	-0.307*** (0.045)
Input EU lag 10 +	-0.273*** (0.047)	-0.277*** (0.048)	-0.306*** (0.049)	-0.267*** (0.051)	-0.342*** (0.047)
Observations	18160	15890	13620	11350	9080

**Note:** \*, \*\*, and \*\*\* denote  $p < 0.10$ ,  $p < 0.05$ , and  $p < 0.01$ , respectively. Standard errors clustered by exporter-importer, are reported in parentheses. The year in each column denotes the starting year in the sample. The Input-FTA and EU lags capture the additional effect with respect to the FTA lags. The Input-EU lags captures an additional effect with respect to the EU lags.

Table 2.9: European Union effect on trade in finals and intermediates

ized people's ability to manage multifaceted procedures across great distances. While the steam revolution took decades to transform globalization, the ICT revolution took years. Figure (2.4) displays three ICT indicators, showing the inflection points in the growth of Internet hosts and in telephone subscribers.

These give a strong hint that the ICT Revolution occurred somewhere between 1985 and 1995. These historical facts perfectly match our results in which since 1985 and until the early 2000s, the reduction in the



**Source:** Baldwin (2016).

Figure 2.4: Indicators of the ICT Revolution

border effect not only stimulated trade but stimulated more final goods than intermediate goods. For us, this reflects the different nature of the two types of goods and is arguably justified by the ICT revolution. Note that the ICT revolution that made easier to coordinate separate complex activities spatially also made easier to sell final goods all over the world. And the empirical evidence points towards a larger effect on final than intermediate goods.

Baldwin (2016) go on and explains that the ICT revolution, however, was not the only big change in the time frame we cover. Continuous technological improvements in ships, trains, and trucks reduced the cost of moving goods, but failed to overcome the age-old problem of loading and unloading. A big breakthrough on this front came in the 1960s and grew exponentially in the 1970s and 1980s with the “containerization”. Also, the development of air cargo stimulated the development of international production networks. Air freight first became commercially viable, but it did not really get going until the mid-1980s with the rise of international

logistics firms. Indeed, the development of reliable air cargo services mirrors the rise of global value chains for rather obvious reasons. Air cargo allowed manufacturers to know that intermediate goods could flow among distant factories almost as surely as they flow among factories within a nation. [Hummels and Schaur \(2013\)](#) show that fully 40 percent of the parts and components imported into the United States are imported by air. They model exporters' choice between fast, expensive air cargo and slow, cheap ocean cargo, which depends on the price elasticity of demand and the value that consumers attach to fast delivery. The key here is not the cost. While air shipments have been getting cheaper, air cargo even today is many times more expensive than sea freight. The critical attraction of sending things by air is speed. European freight sent by sea, for example, takes an average of twenty days to reach U.S. ports and a month to reach Japan. Air shipments take a day or less.

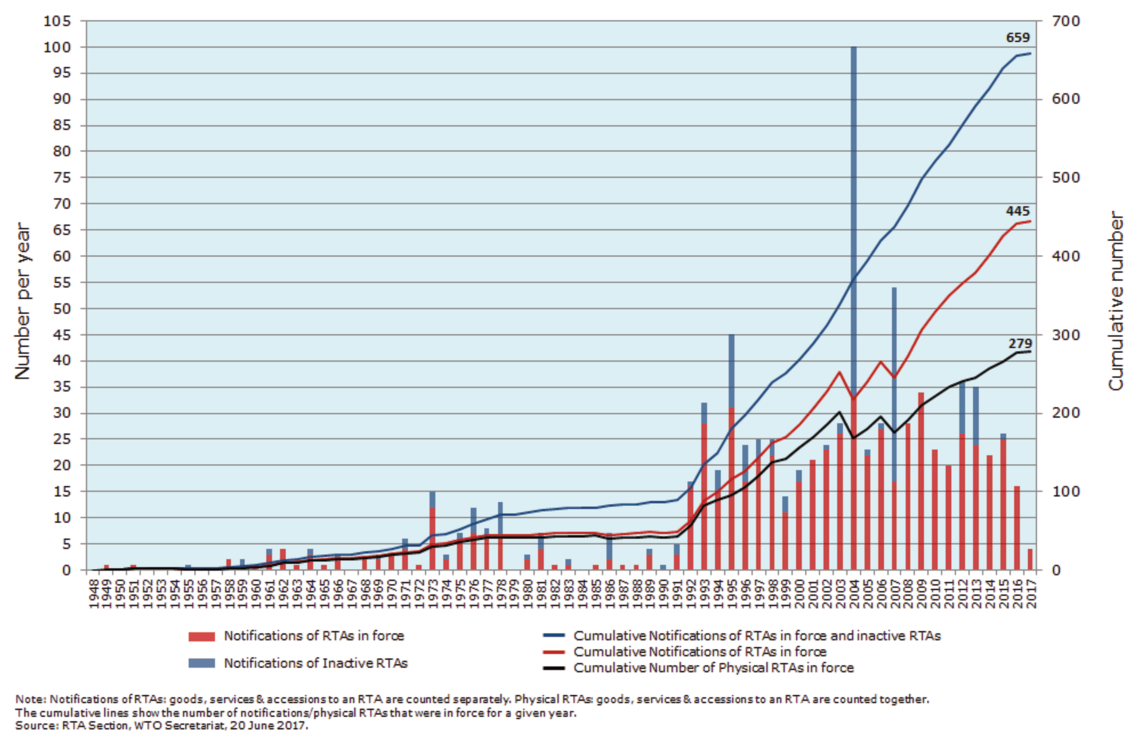
With the basic facts and timing of the ICT revolution and air cargo developments in hand, in this chapter, we have turned to the quantitative impact that these changes brought by making a careful use of the "border effect" and by distinguishing between final and intermediate goods.

### **2.7.2 The Strengthened Effect of FTAs on Trade**

The GATT was very successful at facilitating the reduction of tariffs — at least among developed nations. An important change took place when GATT members launched the Uruguay Round in 1986, the same year that some of the leading GATT members also started massive regional trade liberalization initiatives ([Martin and Messerlin, 2007](#)). Specifically, three liberalization initiatives were launched in 1986. The United States

and Canada started talks on a free trade agreement that finished in 1989 (this eventually turned into the North American Free Trade Agreement also encompassing Mexico or NAFTA). The year 1986 also saw Europe both deepen and widen trade liberalization, which was by then called the European Union (EU). Spain and Portugal were admitted as new members, and the EU embarked on a deep liberalization of many other economic barriers in the context of the Single Market program.

The Uruguay Round lasted from 1986 to 1994. As Figure (2.5) shows, there was an inflection point around these years in the number of free trade agreements in the global economy. These reductions were the beginning of a revolution in the attitudes of developing nations, who tried increase exports and stimulate job creation.



**Source:** WTO.

Figure 2.5: RTAs notified to the GATT/WTO (1948-2018)

GATT's early multilateral negotiations ("rounds") dealt mostly with new

rules and the admission of new members. From the Kennedy Round onward, the rounds returned to tariff cutting, but also touched on increasingly complex trade barriers — things like technical barriers to trade, investment rules, government purchases, and the like. The GATT was quite successful at lowering the tariffs of Japan, Europe, and North America, but developing nations could keep their tariffs high under a provision called “Special and Differential Treatment” that was aimed at allowing poor nations to industrialize behind tariff walls. As part of the Uruguay Round final agreement, the GATT became the WTO in 1995. Apart from changing the name, the deal institutionalized the GATT’s judicial role in dispute settlement and added some basic rules for international investment, regulations, intellectual property, and services.

Our results confirm the strong trade impact of FTAs and support the notion that deeper trade liberalization in the past two decades has had an even greater impact on international trade than agreements signed in earlier decades.

Our motivation section already anticipated that while exported final goods are produced or designed to be consumed, intermediate goods are designed to be part of further production processes that might require certain specificities and more importantly, a certain degree of coordination between the different stages of production. Therefore, we conjectured that while we expected a positive effect of a reduction in the effect of reduced trade barriers on both types of trade, final goods could have benefited more from the same reductions at the bilateral level. This is not in contradiction with the well-known expansion of global value chains, since the effect of FTAs and the border effect reduction is expected to be positive for both final goods and intermediate inputs.

Moreover, for the case of the FTA effect on trade in final goods, we think it is important to note that the tariff trade barriers that were in place were (and continue to be) larger for final goods. This tends to leave room for a larger reduction in this type of goods. [Blanchard et al. \(2016\)](#) explore how global supply chain linkages modify countries' incentives to impose import protection. They find that these linkages are empirically important determinants of trade policy.<sup>25</sup> Theory predicts that discretionary final goods tariffs will be decreasing in the domestic content of foreign-produced final goods. Provided foreign political interests are not too strong, final goods tariffs will also be decreasing in the foreign content of domestically-produced final goods. Their results imply that global supply chains matter for trade policy, both in principle and in practice. Nevertheless, they focused on how governments set protection on final goods, setting aside the issue of optimal input tariffs. That is, they do not tackle the more complex problem of how governments could jointly set tariffs on final goods and intermediate inputs to protect and promote domestic value added. The empirical evidence we have provided in this chapter is an important input to the discussion of how optimal tariffs depend on the intensity of the input-output structure of trade.

## 2.8 Concluding remarks

Reductions in trade barriers over the past decades have been made possible through the implementation of Free Trade Agreements (FTAs) and technological progress, which in turn have greatly stimulated international trade. In this chapter, we examined the role reduced trade barriers

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<sup>25</sup>To address these questions, [Blanchard et al. \(2016\)](#) introduce supply chain linkages into a workhorse terms-of-trade model of trade policy with political economy.

from two dimensions: (i) the implementation of FTAs and, (ii) the reduction of the border effect (capturing trade barriers to international in relation to domestic trade). Our results show that the lowering of trade barriers have significantly expanded trade in the manufacturing sector: FTAs are estimated to increase bilateral trade by 54% after 10 or more years, for both final and intermediate goods when controlling for the border effect. The reduction of the border effect has, on the other hand, had a greater impact on final products than intermediate inputs. For final goods, the increase has been an astounding 443%, relative to domestic trade since 1970 and a 195% rise for intermediate inputs. These results give some indication as to how important technological advances has been for trade in consumer goods, but also for the emergence of global value chains.

We have also observed a strengthening effect of FTAs over time. Therefore, we have focused on the trade effect of specific institutional arrangements such as the European Union. With it, we have shown implicitly what could be the trade effect of leaving such an agreement. Joining the EU has had a significant additional effect on intra-EU trade among its member states: it more than doubles the effect of an average FTA, when we consider the whole sample. Future research should take care of further clarifying the strengthening effect of FTA over time and the difference between final and intermediate goods. We think that the larger FTA trade impact on final goods, after disentangling the intra-EU effect, is related to the fact that developing countries became more important in intermediate goods trade. This is something we plan to study more in detail in our future research. It would also be interesting to further clarify the interaction between technological advances and FTAs. One could arguably anticipate that FTAs did not create the international supply chains, but the FTAs rules governing commerce allowed them to emerge ([Blanchard et al.](#),

2016). Understanding this interaction is also important when considering to reverse the policy environment created by years of trade liberalization.



## Chapter 3

# Euro Trade Imbalances in GVCs

**Abstract:** In this chapter, I study through the lenses of Global Value Chains (GVCs), what are the causes and some of the implications of the euro area imbalances that built up before the 2008-2009 financial crisis. While both economic phenomena (imbalances and GVCs) have received much attention due to the risks they entail and the challenges they pose to traditional policymaking, we do not fully understand their interactions. I try to contribute to filling this gap by developing a multi-sector, multi-country framework that disentangles the different components contributing to the evolution of the trade balance to GDP ratio, in the presence of international input-output linkages. Regarding the policy implications, I use the same framework to shed some light on to what extent the effectiveness of internal devaluations is affected by the input-output structure of trade. Macroeconomic monitoring schemes used by the European Commission and the IMF would benefit from incorporating these insights in their surveillance tasks.

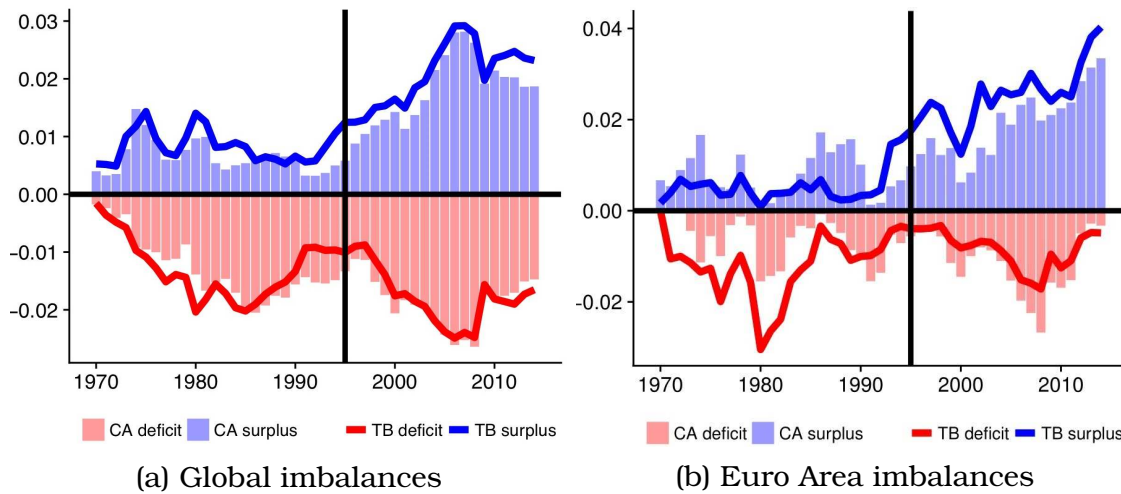
*"Economists' arguments that today's global trade imbalances reflect either a savings shortage or a savings glut are misguided. ... But no solution is possible until we abandon these hypotheses and connect today's global financial imbalances with global production patterns and inadequate demand in developing countries."*

**Thomas I. Palley. Oct 30, 2007. Project-Syndicate.org**

## 3.1 Introduction

During the years prior to the global financial crisis, unprecedented current account imbalances built up within the euro area. When the crisis arrived, and the macroeconomic situation of the debtor countries deteriorated, these imbalances became a concern for economic stability. Moreover, these imbalances seem to have been at the core of the euro area crisis itself ([Baldwin and Giavazzi, 2015](#)). Figure (3.1) tracks the long-term evolution of the current account and trade imbalances for the global economy and the euro area. Broadly speaking, the imbalances started to build up around the early 1990's, with the world economy going from levels of less than 1% of global GDP, to record levels close to 3% in 2007. On the other hand, the euro area trade balance and current account started to build on the surplus side. Nevertheless, coinciding with the introduction of the single currency, intra-euro area imbalances grew quickly with the accumulation of large surpluses and deficits. The post-crisis years seem to have narrowed the global imbalances to some extent, while for the euro area internal deficits disappeared and surpluses continue to grow. Note that the current account is highly correlated with net exports ([Obstfeld, 2012](#)), and in fact, the bulk of current account of both advanced and emerging economies is due to the trade balance ([Alberola-Ila et al., 2018](#)).

Figure 3.1: Global and Euro imbalances (as % of GDP)



**Source:** World Development Indicators Data (World Bank).

**Note:** The vertical line in both graphs shows the beginning of the period covered in this chapter (1995-2007). Belgium was omitted due to missing current account data for the whole period (1970-2014). Nevertheless, it is included in the analysis done in this chapter for the period 1995-2007.

In this chapter, I study the roots of the euro area imbalances before the crisis (between 1995 and 2007) in the context of changing trade patterns brought by the emergence of the so-called Global Value Chains (GVCs).<sup>1</sup> I also study to what extent the effectiveness of internal devaluations is affected when the input-output structure of trade is considered.<sup>2</sup> Note that this chapter does not question the fact that the adjustment of large trade imbalances calls for real exchange rate changes. This is already well established in the literature (Obstfeld and Rogoff, 1996, 2007). Nevertheless, the adjustment of the euro imbalances calls for price adjustments through differentials in inflation rates across euro countries, rather than being purely based on the internal devaluation of the deficit countries.

The 2008-2009 financial crisis renewed the policy relevance of global

<sup>1</sup>The GVC dimension will be explained in detail, but the idea is that the analysis and policy implications of trade balances are more complex in an international production network.

<sup>2</sup>For this part, I focus on the case of the Spanish economy in the year 2007. The input-output structure of trade refers to the production linkages across countries due to trade in intermediate goods.

current account and trade imbalances. For [Blanchard and Milesi-Ferretti \(2009\)](#), before the crisis, there were strong arguments for reducing global imbalances. Now that these imbalances have significantly narrowed, it does not mean that they are a problem of the past. The systemic and domestic distortions that cause the imbalances still need to be addressed to avoid threatening the sustainability of the recovery. For [Obstfeld \(2012\)](#) the current account still matters. Large and persistent imbalances deserve careful attention from policymakers. Something that will be emphasized in this chapter is that conclusions must be country specific, but for [Obstfeld \(2012\)](#) the case in the mid-2000s arguably signals macroeconomic and financial stresses, rather than been warranted by fundamentals. Economists correctly emphasize the role of domestic savings and investment decisions in determining current account and trade balances. Moreover, country specificities play a key role, like the fact that the increase in the wealth to income ratio (due to the real state bubble), in countries like the US and Spain, augmented consumption spending to high levels.<sup>3</sup> Nevertheless, as [Bernanke \(2005\)](#) explains, this economic analysis often goes on to conclude that, for the most part, the current account balance is a domestic matter and is independent (to a first approximation) of developments in the rest of the world. This chapter works on making explicit how trade balances depend on developments in the domestic economy vis-a-vis the rest of the world. Globalized markets are still beyond the perimeter of globalized governance ([Obstfeld, 2012](#)), but nowadays and learning from the lessons from the crisis, international organizations have monitoring schemes in place to identify and address macroeconomic imbalances that could adversely affect economic stability.

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<sup>3</sup>For the euro area case, it is important to remember that even if Germany did not experience a current account deficit or a real state bubble, German banks lent to economies with those symptoms, and the propagation of the crisis across countries only became evident later on.

Two examples of these schemes are the International Monetary Fund's External Balance Assessment [see [IMF \(2013\)](#)] and the European Commission's European Macroeconomic Imbalance Procedure (MIP).

Interestingly, the 1990s not only witnessed the emergence of euro and global imbalances, but also the emergence of the so-called Global Value Chains (GVCs). Global trade patterns changed rapidly, with the fragmentation of production process across countries and the growth in intermediate good trade flows ([Johnson and Noguera, 2012](#)). The traditional policymaking faces important challenges due to this emergence of GVCs, including the undermined validity of standard competitiveness indicators ([Amador and Cabral, 2017](#)). [Amador et al. \(2015\)](#), following an analysis based on the concept of foreign value added in exports, conclude that GVCs are important for the euro area and there has been a rebound since the trade collapse in 2009. Moreover, there is a strong relevance of regional production linkages in Europe, with a large role for Germany and Central and Eastern European countries. Imbalance monitoring schemes have pointed towards the fact that role of Global Value Chains deserves more attention due to its policy implications ([IMF, 2017](#)). While the aggregate (country-level) trade balances are the same in both gross and value-added terms, the reason to follow a value-added (GVC) approach is not only on the fact that focusing on total exports tends to mask differences across final and intermediate products, but also on recognizing that the expansion of the international supply chain has increased the exposure of euro economies to final demand outside Europe. The extent of this dimension is not captured by bilateral gross trade statistics. Therefore, to obtain a complete picture of the issue, we need to connect global imbalances with global production patterns and use the right measures of domestic demand vis-a-vis the rest of the world. This is the main motiva-

tion for this chapter.

In this chapter, I contribute to the literature from different perspectives. First, I disentangle the contribution of trade performance (competitiveness) and domestic demand vis-a-vis the rest of the world.<sup>4</sup> Disentangling these two components is important to identify the roots of the euro area imbalances. The scoreboard of the Macroeconomic Imbalance Procedure (MIP) includes an indicator on export market shares. This indicator aims at capturing structural losses in competitiveness. Figure (3.2) tracks the evolution of the export market shares of Germany, France, Greece and Spain.<sup>5</sup> The main conclusion from this figure is that competitiveness developments are not perfectly linked to the evolution of trade balances. Take for instance the deficit countries Greece and Spain. The fact that these countries showed a strong export performance (at the same level or better than Germany) and increasing trade deficits suggests an important role for domestic demand vis-a-vis the rest of the world.

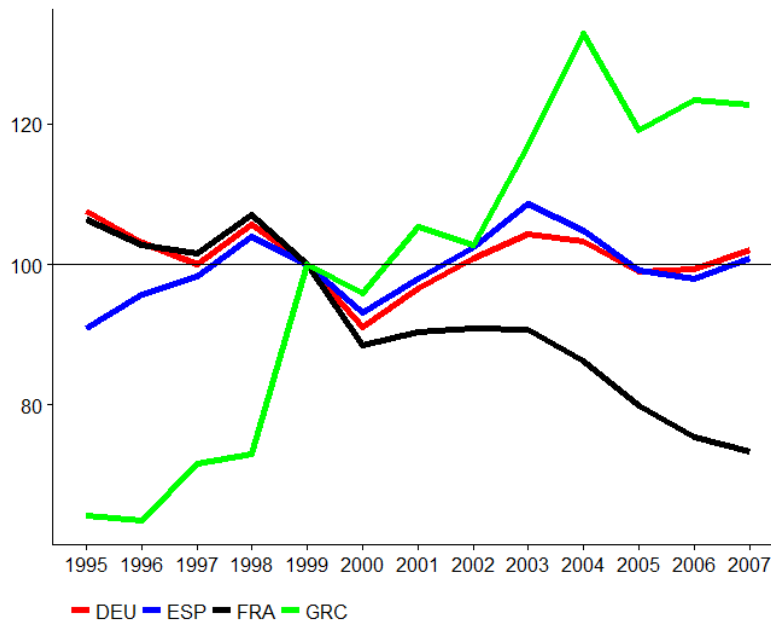
Second, I study trade balances through the lenses of Global Value Chains. Gross trade statistics and frameworks considering 100% domestically produced goods do not consider the imported content of exports. The implications of the gross trade abstraction are that international spillovers, generated by forward and backward linkages, are not considered. Moreover, the rest of the world demand is not properly captured since it is both direct via trade partners and indirect via forward linkages.<sup>6</sup>

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<sup>4</sup>In this chapter, I refer to the trade performance component also as competitiveness and expenditure switching.

<sup>5</sup>See [Gaulier et al. \(2013\)](#) for a more detailed analysis on the export market share.

<sup>6</sup>With the rise of GVCs, intermediate goods cross borders multiple times before being consumed in their final destination. Gross trade flows thus tell little about the sources of the value added that is embodied in these flows, or the destinations where this value added is ultimately consumed. For foreign demand, it is the destination where domestic value added is ultimately consumed that matters.



**Note:** Market shares do not consider domestic trade. Computed in gross terms. Indexes with base = 1999.

Figure 3.2: Market share evolution for selected euro countries

Third, I study the effectiveness of internal devaluations in the adjustment of trade imbalances. Therefore, this chapter relates to recent contributions to the literature saying that the use of imported intermediate goods in production dampens the role of domestic prices in domestic competitiveness (Bems and Johnson, 2017). This chapter also relates to Bems (2014). It shows that GVC linkages might have large implications for the adjustment process, both in terms of the welfare consequences of a domestic expending adjustment and the relative price adjustment accompanying the trade balances adjustment. Nevertheless, there are important differences with respect to Bems (2014): (i) it is done in a small size input-output (a few countries and a few sectors), while I develop a multi-country, multi-sector model able to deal with as many countries and sectors as data allows.<sup>7</sup> And (ii) I focus on the effectiveness of internal devaluations

<sup>7</sup>In this chapter I use the 2013 version of the World Input-Output Database (WIOD), which covers 40 countries (and a rest of the world region) and 35 sectors in each country.

rather than in a transfer problem as in [Obstfeld and Rogoff \(1996\)](#) and [Obstfeld and Rogoff \(2007\)](#).

The rest of the chapter is organized as follows. Section 2 develops the framework, including its extension into an international macroeconomic model that can study internal devaluations. Section 3 presents the WIOD data that is used for analysis. Section 4 presents the results for the pre-crisis period. The simulation of the internal devaluation is done in Section 5, using the Spanish economy in 2007 as an example. Section 6 concludes.

## **3.2 Framework**

In this section, I model the evolution of the trade balance to GDP ratio of a given country in a framework with a general world economy with  $N$  countries and  $S$  sectors in each country. This framework considers the input-output structure of international trade to (i) disentangle the different components, in value-added terms, contributing to the trade balance to GDP ratio and (ii) to determine to what extent competitiveness factors (expenditure switching) or domestic demand vis-a-vis the rest of the world drive the trade balance for each country.

### **3.2.1 Value-Added Components of the Trade Balance**

Trade balances are usually measured in relation to the size of the economy, which allows for comparisons across countries. That is, the main object of interest in the trade balance to GDP ratio. The aggregate (country-level) trade balance is the same in both gross and value-added terms ([Koopman](#)



et al., 2014). Therefore, the trade balance itself is obtained from exports and imports in value-added terms. Surprisingly, this is not the case of GDP. From national accounting, we know that GDP is the sum of private consumption ( $C$ ), government consumption ( $G$ ), investment ( $I$ ), and the trade balance  $GDP_i = C_i + G_i + I_i + TB_i$ . GDP is a measure of the total value added in the domestic economy. Nevertheless, this measure of domestic value added is obtain by adding gross terms components. The sum of private consumption, government expenditure and investment make up the Gross National Expenditure (GNE). But the GNE contains both domestic and foreign value added. Making explicit the source of the value added in each component yields the following expression for GDP:<sup>8</sup>

$$GDP_i = \underbrace{GNE_i^{DVA} + GNE_i^{FVA}}_{GNE = C+G+I} + \underbrace{X_i^{DVA} - M_i^{FVA}}_{TB} = \underbrace{GNE_i^{DVA}}_{C_i^{DVA} + G_i^{DVA} + I_i^{DVA}} + X_i^{DVA} \quad (3.1)$$

Equation (3.1) states that GDP can be computed in value-added terms (adding the domestic value added in GNE and value-added exports). Therefore, from a value-added perspective the trade balance to GDP ratio depends on three components: value-added exports,  $X_i^{VA}$ , value-added imports,  $M_i^{VA}$ , and the domestic value added in domestic GNE,  $GNE_i^{DVA}$ , such that:

$$\frac{TB_i}{GDP_i} = \frac{X_i^{VA} - M_i^{VA}}{GNE_i^{DVA} + X_i^{VA}} \quad (3.2)$$

Each of the three components in Equation (3.2) is a scalar, but due to the "network nature" of value-added trade flows, matrix algebra is required

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<sup>8</sup>DVA stands for domestic value added and FVA for foreign value added. The key in this expression is that  $GNE_i^{FVA} = M_i^{FVA}$ . That is, that the foreign value added contain in GNE is being absorbed through value-added imports.

for their computation. I focus on disentangling the different components contributing to the evolution of the trade balance. This means that the trade balances must be in changes. Taking the total derivative of equation (3.2) we arrive at the following expression for the trade balance to GDP ratio change:

$$\mathbf{d} \frac{TB_i}{GDP_i} = \left[ \frac{GDP_i - TB_i}{GDP_i^2} \right] \mathbf{d} X_i^{va} - \left[ \frac{1}{GDP_i} \right] \mathbf{d} M_i^{va} - \left[ \frac{TB_i}{GDP_i^2} \right] \mathbf{d} GNE_i^{DVA} \quad (3.3)$$

Equation (3.3) shows that, as expected, the growth of value-added exports has a positive impact on the trade balance and growth of value-added imports has a negative impact. The impact of the third component on changes in the trade balance depends on the sign of the trade balance. The impact of the GNE component is negative when there is a trade surplus and positive when there is a trade deficit. The intuition for this is that GNE growth makes the domestic economy larger and reduces the size of the trade balance in relation to the size of the economy. Therefore, GNE reduces both trade deficits and surpluses.

### 3.2.2 Adding the Input-Output Structure

The next step is to add the input-output structure of trade. I use [Johnson and Noguera \(2012\)](#)'s accounting framework to compute the different value-added components of the trade balance to GDP ratio in equation (3.3). The  $NS \times N$  bilateral value-added exports in the world economy, result of  $N \times S$  country-sectors supplying value added to final consumers in  $N$  countries, are used to compute the country-level value-added exports,

imports, and GNE, as follows:<sup>9</sup>

$$X_i^{va} = \mathbf{1} \times [VR_i \times B \times \sum_j F_{j \neq i}] \quad (3.4)$$

$$M_i^{va} = \mathbf{1} \times [\sum_{j \neq i} VR_j \times B \times F_i] \quad (3.5)$$

$$GNE_i^{DVA} = \mathbf{1} \times [VR_i \times B \times F_i] \quad (3.6)$$

Where  $VR_i$  is the  $NS \times NS$  diagonal matrix of value-added to output ratios for each country-sector. This matrix controls the origin of the value-added trade flows. Only those entries corresponding to the origin country are different from zero.  $B$  is the  $NS \times NS$  matrix known and Leontief inverse. And  $F_i$  is the  $NS \times 1$  column-vector of international final goods trade flows from all country-sectors to country  $i$ .  $i$  is the destination country where the value added from different countries is absorbed embodied in those final goods.<sup>10</sup> Finally, the  $1 \times NS$  row-vector  $\mathbf{1}$  that pre-multiplies equations (3.4), (3.5) and (3.6), aggregates the sector-level trade flows to the country level. Therefore, note that  $X_i^{va}$ ,  $M_i^{va}$  and  $GNE_i^{DVA}$  are scalars, as required for the computation of the trade balance to GDP ratio for a given country.

To compute the changes of the trade balance to GDP ratio components in equation (3.3), take the total derivative of equations (3.4), (3.5) and (3.6). This yields the following equations:

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<sup>9</sup>Note that for consistency, I use the same "country-sector" notation as in chapter 1.

<sup>10</sup>See [Johnson and Noguera \(2012\)](#) for further details. Final good gross trade flows are divided into  $N$  vectors, as required by the computations in this chapter.

$$dX_i^{va} = \mathbf{1} \times \left[ \mathbf{d}(VR_i \times B) \times \sum_j F_{j \neq i} + VR_i \times B \times \sum_j (\mathbf{d}F_{j \neq i}^{ES} + \mathbf{d}D_{j \neq i}) \right] \quad (3.7)$$

$$dM_i^{va} = \mathbf{1} \times \left[ \left( \sum_{j \neq i} \mathbf{d}(VR_j \times B) \right) \times F_i + \sum_{j \neq i} VR_j \times B \times (\mathbf{d}F_i^{ES} + \mathbf{d}D_i) \right] \quad (3.8)$$

$$dGNE_i^{va} = \mathbf{1} \times \left[ \mathbf{d}(VR_i \times B) \times F_i + VR_i \times B \times (\mathbf{d}F_i^{ES} + \mathbf{d}D_i) \right] \quad (3.9)$$

The expansion of the international supply chains has increased the exposure of countries to final demand in third countries to an extent not captured by bilateral gross trade statistics. Changes in the value-added components in equations (3.7), (3.8) and (3.9) address this issue by dividing those terms into two changes: (i) the change of value-added exports due to changes in the production network,  $\mathbf{d}(VR_i \times B)$ , keeping final goods flows constant. This reflects the reorganization of the international supply chain. (ii) The change in final goods flows consumed in a given country ( $\mathbf{d}F_i$ ), keeping the input-output structure of trade constant.<sup>11</sup> Changes in the final goods are further divided into changes in expenditure switching factors (competitiveness in a broad sense),  $F^{ES}$ , and changes in the demand level in the destination country  $D_i$ . These last derivations are explained in the next section.

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<sup>11</sup>Remember that the three components (value-added exports, imports, and GNE) are only different in terms of the source and destination of the bilateral value-added trade flows.

### 3.2.3 Trade performance and demand growth

One of the main purposes of this chapter is to disentangle demand growth from expenditure switching or competitiveness factors. For this purpose, note that bilateral final goods trade flows from country-sector  $i$  to country  $j$ ,  $f_{ij}$ , are conceptually divided into two parts: first, we have the demand level in destination  $j$ . Second, we have a demand shifter specific to the bilateral trade flow  $ij$ . This yields the following expression:<sup>12</sup>

$$f_{ij} = \underbrace{f_{ij}^{ES}}_{\text{Exp. shifter}} \times \underbrace{d_j}_{\text{Demand level}} \quad (3.10)$$

Bilateral sector-level trade flows,  $f_{ij}$ , are observable in data. Aggregate sectoral demand levels,  $d_j$ , and sectoral bilateral expenditure shifters,  $f_{ij}^{ES}$ , can be computed from data in an intuitive way: the demand level is computed aggregating imports to the sector level, such that  $d_j = \sum_{i \in s} f_{ij}$ .<sup>13</sup> While  $f_{ij}^{ES}$  is computed as the share of each trade flow in the total sector demand of country  $j$ , such that  $f_{ij}^{ES} = \frac{f_{ij}}{d_j}$ . This is a tractable accounting framework that will allow disentangling the role of demand growth and expenditure switching in changes in final good trade flows, and in turn in trade balance changes, without making any particular structural assumption.

Finally, note that the production network dictates that intermediate good trade flows are not interesting by themselves, but to the extent they enter into the next stage production process. Changes in intermediate trade flows can come from changes in the level of production in the des-

<sup>12</sup>Note that in the final good trade flow from country-sector  $i$  to country  $j$ ,  $f_{ij}$ , the sector is determined by the country-sector of origin.

<sup>13</sup>The sector index  $s$  is included in the country-sector index  $i$ .

destination country-sector or changes in the expenditure switching factors. Nevertheless, what enters the value-added approach are the input-output coefficients (share on the destination country-sector output) used to compute the Leontief inverse,  $B$ . Therefore, changes in intermediate good trade flows captured in the entries of the Leontief inverse are considered to be the consequence of changes in expenditure switching or competitiveness factors.

Therefore, introducing equations (3.7), (3.8) and (3.9) into equation (3.3) make possible to compute the contribution of each of the components (and sub-components) to the evolution of the trade balance to GDP ratio for each country.

### **3.2.4 A Continuous-Time Framework Using Discrete-Time Data**

Note that this chapter develops a continuous-time framework. While this is key for the contributions it makes, it also raises the issue of doing approximation errors when using discrete-time data to apply the framework for the empirical analysis. Moreover, the decomposition of value-added trade flows can be carried out with continuous or discrete time changes. So far, the literature has used the discrete time. Mainly because the world input-output tables are available on yearly basis. Here I explain the "lack of intuitiveness" of the discrete-time approach and how I apply the continuous-time approach to data to disentangle changes in the trade balance in a more intuitive way.

Taking the expression of bilateral value-added exports in matrix form, we have that the discrete-time change is given by the difference between

the matrix-product in period 1 and the matrix-product in period 0, such that:

$$\Delta X^{va} = VR_1 \times B_1 \times F_1 - VR_0 \times B_0 \times F_0 \quad (3.11)$$

Nevertheless, to obtain its decomposition by parts some manipulation is required. One can add and subtract either  $VR_1 \times B_1 \times F_0$  or  $VR_0 \times B_0 \times F_1$ . These alternative manipulations yield the two following equivalent expressions:<sup>14</sup>

$$\Delta VAX = \Delta[VR \times B] \times F_0 - [VR_1 \times B_1] \times \Delta F \quad (3.12)$$

$$\Delta VAX = \Delta[VR \times B] \times F_1 - [VR_0 \times B_0] \times \Delta F \quad (3.13)$$

As mentioned above, these two equations are equivalent, but provide different decompositions. Moreover, weights of different years are use in each expression. To solve this issue, the literature uses a weighted average of the two. I use the continuous-time approach to obtain a more intuitive decomposition, one that clearly matches the idea of disentangling the contribution of demand growth and expenditure switching. For this approach one needs to take the time derivative of the value-added export matrix as follows:

$$\frac{\mathbf{d}X_t}{\mathbf{d}t} = \frac{\mathbf{d}[VR_t \times B_t]}{\mathbf{d}t} \times F_t - [VR_t \times B_t] \times \frac{\mathbf{d}F_t}{\mathbf{d}t} \quad (3.14)$$

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<sup>14</sup>See for instance [Nagengast and Stehrer \(2016\)](#) for the use of this discrete-time approach.

Then, multiplying both sides by the time differential  $\mathbf{d}t$ , one gets the total differential of the value-added matrix:

$$\mathbf{d}X_t = \mathbf{d}[VR_t \times B_t] \times F_t + [VR_t \times B_t] \times \mathbf{d}F_t \quad (3.15)$$

This expression shows that the change of matrix  $X$  is the result of summing the change in the input-output structure keeping final goods trade flows constant,  $\mathbf{d}[VR_t \times B_t] \times F_t$ , and the changes in final goods trade flows keeping the international input-output structure constant,  $[VR_t \times B_t] \times \mathbf{d}F_t$ . These are precisely the two components we are interested in.

The key to this approach is to "continuously update" the matrices. The challenge is the lack of "continuous-time data" since the world input-output tables, like the ones provided by the WIOD, are available by (discrete) years. Using discrete-time data to apply a framework that is derived in continuous time might introduce approximation errors in the computations. This error component is not expected to be large given that one would be using the more frequent data available. Nevertheless, I eliminate this error with a simple strategy: I use the discrete time data that is usually available to generate data "as continuous as" possible. I use linear interpolation between years to generate intermediate data points.<sup>15</sup> Note that only the actual data yearly data is of interest. The intermediate data I generate is only one of the multiple paths that trade flows might have followed within the year and it has not strict economic interest. But the intermediate data avoids discrete-time jumps and a potential approximation error.

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<sup>15</sup>I interpolate 12 points for all bilateral trade flows in final and intermediate goods between years. Computing the corresponding Leontief inverses.



### 3.2.5 A Macroeconomic Model for Evaluating Internal Devaluations

In this final subsection, I use the framework derived before in this chapter to put in place a Macroeconomic model able to shed some light on to what extent the effectiveness of internal devaluations is affected by the existence of Global Value Chains. [Bems \(2014\)](#) points towards the fact that the traditional multi-sector macroeconomic model without input-output linkages is a "*value-added trade model*", that is to say, a model in which countries produce goods with a 100% domestic content. Therefore, in those models countries only trade final goods and they directly trade domestic value added. Small-scale exercises, like the one carried out by [Bems \(2014\)](#) itself, show that calibrating such a miss-specified value-added trade model to available data in gross terms yields substantially different predictions regarding the relative price response to external adjustment when compared to a model using data in gross terms and in presence of trade in intermediate goods.

One of the main features of the framework presented in this chapter so far is its ability to carry the ex-post analysis without making any structural assumption. Moreover, it is able to handle as many sectors and countries as required (and allowed by the available data). To make it into an international macroeconomic model able to provide some insights on the effectiveness of internal devaluations, some additional assumptions regarding the production and consumption structure are required. Each country-sector ( $j$ ) supplies a differentiated good that can be used both as final good by consumers and as an intermediate good by other country-sectors. Output is produced combining domestic value added and intermediate inputs, such that production in country-sector  $j$  is given by the

following expression:

$$Y_j = VA_j^{\beta_j} \left[ \prod_{s=1}^S \left( \sum_{i \in s} X_{ij}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1} \alpha_{s,j}} \right]^{1-\beta_j} \quad (3.16)$$

where  $X_{ij}$  stands for the flow of intermediate inputs from country-sector  $i$  to country-sector  $j$ .  $\rho$  is the elasticity of substitution between intermediate goods in each sector,  $\beta_j$  and  $VA_j$  are the value-added share in production and the value-added in country-sector  $j$  respectively. Therefore, changes in demand for intermediate inputs over total output value (input-output coefficients) are given by:

$$\hat{a}_{ij} = (1 - \rho) (\hat{p}_i - \hat{P}_j^x) \quad (3.17)$$

Where  $p_{si}$  is the price of the differentiated good from country-sector  $i$ ,  $P_j^x$  is the producer price index (PPI) at the sector level of country-sector  $j$ . Consumer utility in country  $d$  is specified as a CES demand system, as in [Armington \(1969\)](#):

$$F_d = \prod_{s=1}^S \left( \sum_{i \in s} F_{id}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \pi_{sd}} \quad (3.18)$$

$F_{id}$  stands for the consumption of final goods from country-sector  $i$  in country  $d$ .  $\sigma$  is the elasticity of substitution across countries and  $\pi_{sd}$  is the share of sector  $s$  in country  $d$ 's consumption basket. The representative consumer in each country is subject to the following budget constraint:

$$\sum_{s=1}^S \sum_{i \in s} p_i F_{ij} = \sum_{i \in j} p_j^{va} VA_j + T_j \quad (3.19)$$

Where  $p_j^{va}$  is the price of value added in country-sector  $j$  and  $T_j$  captures the trade deficit for country  $j$ . Given this budget constraint, changes in demand for final goods are given by:

$$\hat{f}_{id} = (1 - \sigma) (\hat{p}_{id} - \hat{P}_{sd}^f) + \hat{D}_{sd} \quad (3.20)$$

where  $P_{sd}^f$  is country  $d$ 's sectoral CPI and  $\hat{D}_{sd}$  denotes country  $d$ 's demand growth at the sector level.

On top of the data requirements, the elasticities of substitution in consumption and production need to be set. I set  $\sigma = 6$  and  $\rho = 4$ . These values are within the range of elasticities estimated in the literature [see [Broda and Weinstein, 2006](#)]. The lower production elasticity is motivated by the commonly-held view that production chains are less flexible ([Bems and Johnson, 2017](#)).

Once the framework has become a structural macroeconomic model, one can explore to what extent internal devaluations offset the loss of intra-Euro exchange flexibility. This is a valuable economic policy experiment given the existing concerns regarding whether domestic price changes can sufficiently contribute to the trade imbalances adjustment, and if so what is the burden of that adjustment. Note that this exercise considers an aggregate shock to domestic value-added prices, homogeneous across sectors.

### **Price Dynamics in GVCs**

In a world where trade is predominantly in intermediate goods, foreign marginal costs and domestic production costs are linked. [Auer et al.](#)

(2017) show that GVCs propagate cost pressures across borders, generating sizable spillovers with substantial cross-country heterogeneity.<sup>16</sup> To model these price dynamics I follow Bems and Johnson (2017), such that country-sector  $i$  has a cost function that depends on its own value-added price and the vector of prices from all possible source country-sectors. This implies that the change in the cost function is given by:

$$\widehat{W}_i = \left(1 - \sum_{j=1}^{NS} a_{ji}\right) \widehat{p}_i^{va} + \sum_{j=1}^{NS} a_{ji} \widehat{p}_j \quad (3.21)$$

Where  $a_{ji}$  is share of expenditure on input by country-sector  $j$  over the total value of output of country-sector  $i$ , such that  $\left(1 - \sum_{j=1}^{NS} a_{ji}\right)$  is the share of value added in the total value of output in country-sector  $i$ . I assume full pass-through of cost changes to the producer price index (PPI),  $\widehat{PPI}_i = \widehat{W}_i$ . This assumption is consistent with marginal cost pricing and constant mark-ups over marginal cost. It serves as benchmark for the purpose of focusing on the properties of the global input-output structure and the implications of neglecting this dimension.<sup>17</sup> Therefore, in matrix form the gross price vector is given by:

$$\widehat{p} = [I - A']^{-1} S^{va} \widehat{p}^{va} \quad (3.22)$$

Here exchange rate movements are ignored, but value-added prices are in a given common currency.<sup>18</sup> Also, note that there is incomplete pass-through of exchange rates due to the international sourcing of inter-

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<sup>16</sup>They document that cost propagation, rather than correlated shocks, are responsible for the bulk of producer inflation synchronization.

<sup>17</sup>See Auer et al. (2017) for details and different assumption on the pass-through degree.

<sup>18</sup>The currency choice is not relevant given that the value-added export changes are homogeneous of degree zero in the vector of output and value-added prices.

mediate goods.

### 3.3 Data

The framework presented in this chapter requires the use of bilateral trade flows between countries, differentiating the trade in final and intermediate goods at the bilateral level. The World Input-Output Database (WIOD) provides this information in its World Input-Output Tables (WIOTs). There are two WIOD versions available [see [Timmer et al. \(2015\)](#) and [Timmer et al. \(2016\)](#) for the details of the 2013 and 2016 versions respectively]. They mostly differ in the time and sector coverage. The 2013 version covers the 1995-2007 period with 40 countries and 35 sectors, while the 2016 version covers the 2000-2014 period with 43 countries and 56 sectors. Since I am interested in covering as many years as possible before the global financial crisis and the introduction of the single currency in the Euro Area, I use the 2013 version of the WIOD to carry out the analysis covering the period between 1995 and 2007.

The literature has stressed that analysis in a Global Value Chains setup needs to incorporate the sectoral dimension. Different sectors within a country participate in international production sharing at different stages [[Patel et al. \(2017\)](#)]. Therefore, sector level variations are also important for disentangling the net demand and GVC competitiveness components of the trade balance changes. Moreover, as it explained the framework section, all demand changes need to be computed at the country-sector level. The international input-output tables from the World Input-Output Database provide this sectoral dimension. In all my computations I use the data in full detail, at the sector level, and then aggregate up to the

country-level trade balance.

## **3.4 Results**

This subsection presents the results of applying the framework developed in this chapter to the evolution of the country-level trade balance to GDP ratio. I use data for final and intermediate good trade flows, covering the period between 1995 and 2007. I then use the year 2007 data to simulate the internal devaluation of the Spanish economy.

### **3.4.1 Components of the Trade Balance to GDP**

To help to understand the framework and the results presented later, I first disentangle the components contributing to the evolution of the world trade balance. Note that world trade is balanced by definition. The deficit of some countries is the surplus of other countries, such that the world trade balance is always zero. Data discrepancies across countries usually do not guarantee this balanced trade condition is satisfied. Nevertheless, world input-output tables like the ones in the World Input-Output Database (WIOD) balance all international trade flows, such that this condition is satisfied. The 1995-2007 period was a one of increasing trade openness, with countries increasingly trading final and intermediate goods. It is expected to see a negative contribution from the imports final good expenditure switching (ES) and input-output (IO) structure change given that consumers and producers had easier to consume final goods and use imported intermediate goods from foreign countries. The GVC intuition dictates that cheaper access to intermediate inputs, regardless

of their origin, should generally lower production costs for importer countries and therefore promote exports to all destinations. Therefore, the important question is whether each domestic economy managed to benefit from this trend and increase its competitiveness, which should be reflected in a positive contribution from the exports final expenditure switching (ES) and input-output (IO) change components. Also, note that this was a period of economic and consumption growth for all countries, domestic demand is expected to have played a negative role through imports, and foreign demand a positive role through exports for most countries. At the country level, the important analysis will be at the evolution of net domestic demand vis-a-vis the rest of the world.

Figure (3.3) shows the contribution of the different components to the evolution of the world trade balance. There are two important results: (i) the effects of foreign demand, making exports grow, and domestic demand, making imports grow, are the largest drivers of the global imbalances. These two components have the same size but opposite sign. Arguments suggesting that global trade imbalances reflect either a savings shortage or a savings glut ([Bernanke, 2005](#)) are here properly connected with the global production patterns by using the right measure of foreign demand through the international supply chain. (ii) During the build-up period (1995-2007), the input-output (IO) structure changes and final goods expenditure switching components played a non-negligible role. These components are not comparable in size to the demand components, but they might have been key in the evolution of the country-level trade balances.

Next, I focus on disentangling the different component contributing to the evolution of the trade balance to GDP ratio of some euro countries.

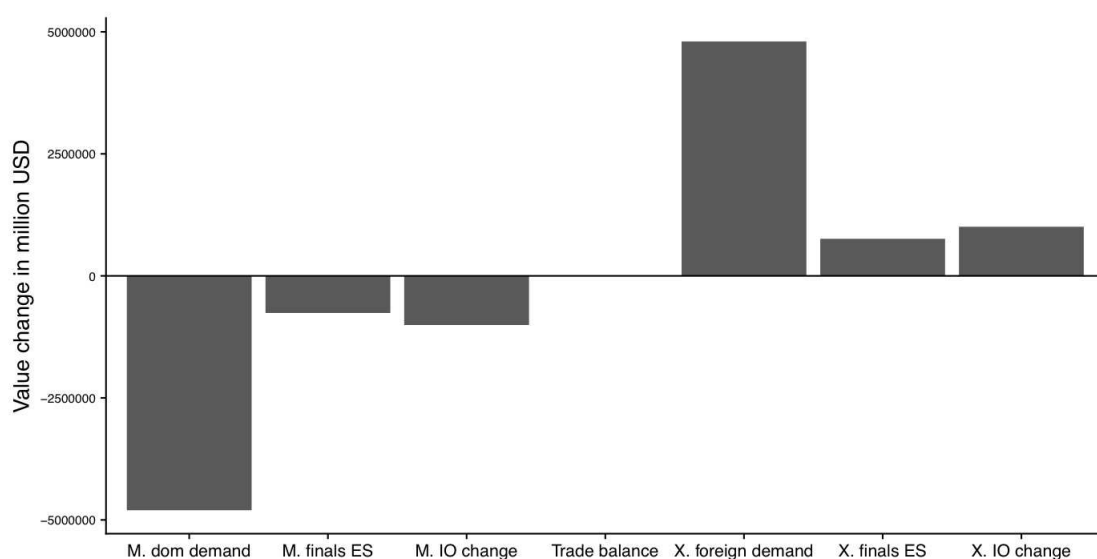


Figure 3.3: Global imbalances by component (1995-2007)

Germany is considered for being the largest euro economy with a large trade surplus. France, an economy with an arguably similar structure to Germany, had a trade surplus in 1995 that deteriorated over the period and had turned into a deficit by 2007. Spain and Greece are the two cases that received more attention during and after the 2008-2009 financial and economic crisis. Figure (3.4) shows the results for these four countries, one by one. Figure (3.5) shows the results for all countries covered in the WIOD to allow for international comparisons in each component.

The German trade surplus significantly expanded during the period 1995-2007. Looking to the contribution from the different export components, final goods expenditure switching and input-output changes had a positive contribution. This shows competitiveness gains of the German economy in international markets. On the import side, final goods expenditure and input-output changes contributed negatively due to the increasing use of foreign final and intermediate goods. Note that while the increase in intermediate goods imports increased the domestic con-



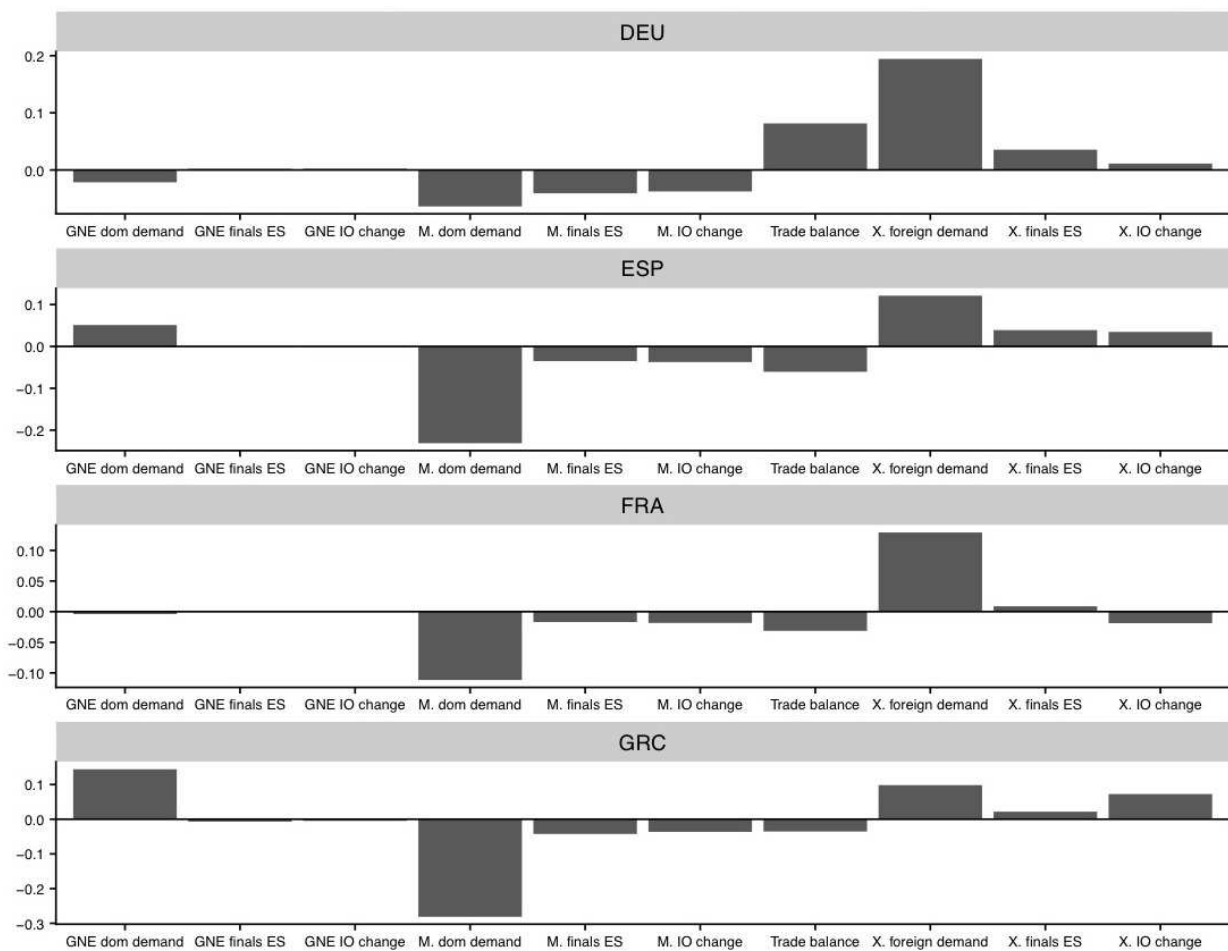
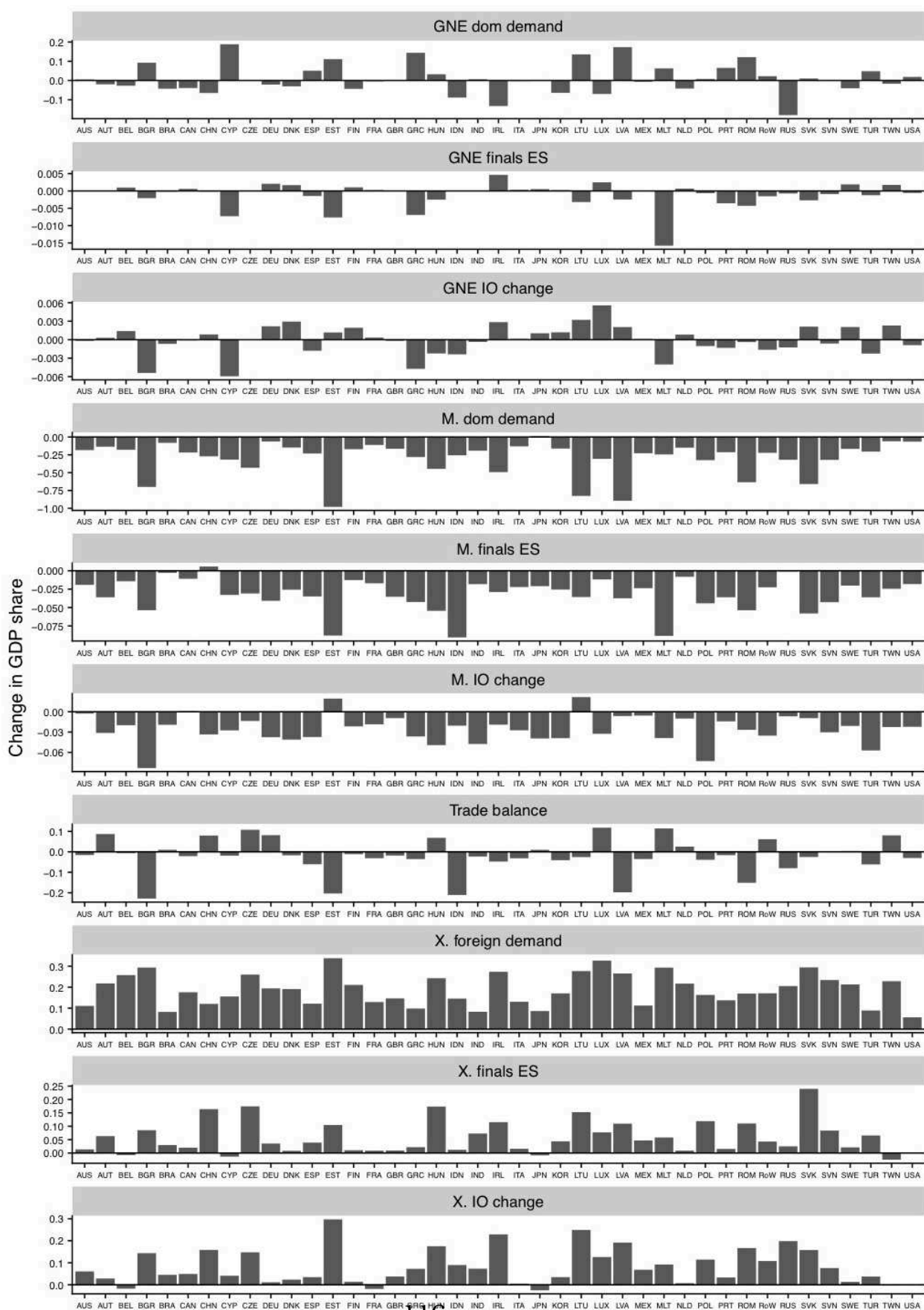


Figure 3.4: Trade balance decomposition for selected countries

Figure 3.5: Trade balance decomposition (1995-2007)



sumption of foreign value added, it is likely to be the responsible for a significant share of the competitiveness gains observed in the German exports. Moreover, the main driver of the trade balance improvement is the large increase in the foreign demand. Compared with the rest of countries in Figure (3.4), these results show that the negative contribution of domestic demand growth in imports is particularly small, allowing Germany to enjoy a positive domestic demand (vis-a-vis the rest of the world) component. The GNE domestic demand component had a (small) negative contribution, as expected for a growing economy (increasing domestic consumption) with a trade surplus.

France was a different case to Germany. The French economy enjoyed a slightly larger positive contribution from foreign demand (through in exports) than the negative contribution from domestic demand (through imports). What seems to be important in this case is that France did not manage to compensate the negative contribution of final goods expenditure switching and IO changes on the important side with competitiveness gains on the export side. In fact, France seems to have lost competitiveness, at least due to the IO structure changes. This points towards possible troubles of the French economy to adapt to the new GVC competitive environment. Finally, note that the GNE domestic demand contribution is roughly zero. The explanation for this is that the French economy had a trade surplus during most of the period that then turned into a deficit.

The case of the Spanish economy turns out to be important in understanding the (opposite) evolution of demand and competitiveness factors. The negative contribution from the domestic demand was the main driver. It was almost twice the positive effect of the foreign demand. Nevertheless, Spain experienced a competitiveness gain on the export side, re-

flected both in positive final good expenditure switching and input-output changes. These competitiveness gains are also present in other analysis of the evolution of the Spanish market share (using gross trade flows) provided, for instance, by [Gaulier et al. \(2013\)](#).<sup>19</sup> On the import side, the negative effect of final goods expenditure switching and IO changes almost compensated the positive contribution on exports. The fact that the Spanish value-added exports did not lose competitiveness is something important to be considered in the design of policies targeting to adjust the accumulated trade deficit. The GNE domestic demand component had a positive contribution, as expected for an economy with a trade deficit and increasing consumption.

The Greek trade balance was always on the deficit side, at least since 1995. Moreover, most of the trade deficit seems to have been accumulated before that year. The exports final ES and IO components show a certain ability of the Greek economy to capture more value added in international markets. The negative contribution of the ES and IO components on the import side seem to be of the same size. Nevertheless, the negative contribution from the domestic demand component on imports is significantly large. This component alone made the trade balance to GDP ratio to fall 30 percentage points, while countries that experienced strong domestic consumption booms like Spain show a negative contribution of 20 percentage points. This points towards the fact that while the Greek Economy avoided losing competitiveness in international markets, the domestic demand (vis-a-vis the rest of the world) was so large that it might not be justified by the underlying economic fundamentals. Note that for the same reason the GNE domestic demand component significantly con-

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<sup>19</sup>Note that this chapter is not the first contribution to the literature concluding that Spain experienced an export competitiveness gain.

tributed to limit the trade balance deterioration.

### **3.5 Euro Area Internal Devaluations in GVCs**

This sub-section uses the Macroeconomic model introduced in section (3.2.5) to study to what extent the effectiveness of internal devaluations (reductions in domestic value-added prices) is affected by the input-output structure of trade. This is an important issue for trade deficit countries targeting to adjust trade imbalances via such policies. To explore these questions, I simulate the evolution of the trade balance after an internal devaluation, that is, the fall of domestic value-added prices in relative terms to all other countries in the global economy.

I take the situation of the Spanish economy in 2007 as an example. The Spanish case is particularly important for at least two reasons: (i) given the size of its economy, its trade deficit and external debt ended up putting in doubt the stability of whole euro area. Greece was another important case, nevertheless, the Greek trade deficit was already at a high level at the beginning of the sample in 1995. Therefore, while the bulk of the Spanish trade deficit was due to domestic demand developments vis-a-vis the rest of the world, it is difficult to conclude what was the main driver of the Greek trade deficit. (ii) In the run-up to the financial and economic crisis, the Spanish wage growth outstripped productivity and led an increase in Spain's unit labor costs, compared with other euro countries. This is usually linked to a loss of competitiveness for Spain. From this diagnostic, it was often assumed that Spain was left facing the task of achieving an internal devaluation. [Lipton \(2018\)](#) defines an internal devaluation as an "economic adjustment with your hands tied

behind your back". Now that the Spanish trade balance is on the surplus side, [Lipton \(2018\)](#) argues that this was accomplished with tough fiscal measures and labor market reforms that supported wage moderation to improve Spanish external competitiveness.

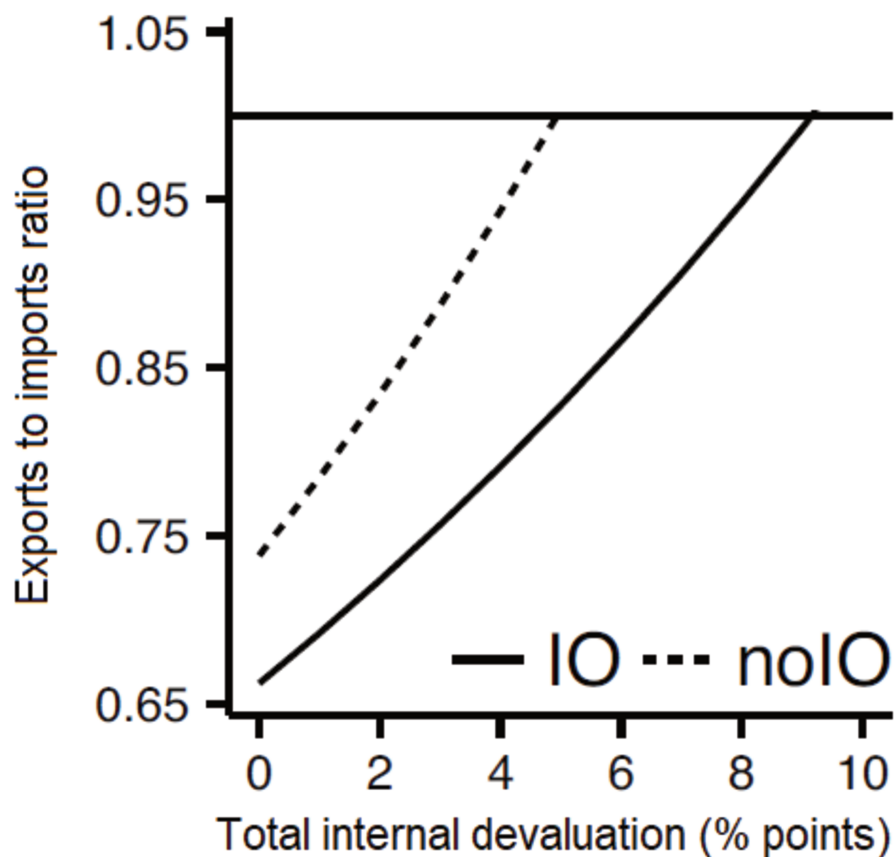
I am interested in understanding the effectiveness of an internal evaluation and the specific role of the international input-output of trade. Therefore, I present the results of such simulation using the detailed sectoral data in final and intermediate trade flows available in the WIOD database. I then switch off the input-output structure by assuming that all intermediate good trade flows are in fact in final goods, such that they are produced only with domestic value added. Note that to isolate the role of GVCs, in the macroeconomic model, I assumed full pass-through of marginal costs into gross prices.<sup>20</sup> The specific way in which I run this simulation is by hitting all sectors in the domestic economy with a -0.0001 value-added price shocks until the whole trade deficit is adjusted. The shock is this small as required by the continuous-time nature of the model. In each iteration, the whole international trade flows of final and intermediate goods (and Leontief inverse) are updated. Finally, given that trade balances are the same both in gross and value-added terms ([Koopman et al., 2014](#)), rather than reporting the trade balance to GDP ratio, I report the export to imports ratio. Unlike the trade balance, the export to imports ratio differ in gross and value-added terms, and it will also differ when I switch on and off the input-output structure of trade.

Figure (3.6) plots the results of the internal evaluation simulation. Results show that the existence of international input-output linkages increases the internal devaluation required to close the 2007 Spanish trade

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<sup>20</sup>This framework could be adapted to the different degrees of pass-through consider in [Auer et al. \(2017\)](#).

deficit by an 84%. This means that Global Value Chains do reduce the effectiveness of internal devaluations and increase its burden in terms of the fall in domestic value-added prices.



**Note:** the input-output (IO) of trade is switched off by assuming that all intermediate good trade flows are in fact in final goods.

Figure 3.6: Internal devaluation (Spain 2007)

These results call for more coordination within the euro area. It seems more plausible that Spain had adjusted its trade deficit so far via domestic demand contraction than due to an internal devaluation. In fact, [Moral-Benito and Viani \(2017\)](#) show that cyclical factors explain 60% of the adjustment of the Spanish trade deficit between 2008 and 2015. This implies that if domestic demand starts growing faster than demand from the rest of the world, the trade balance could move to the deficit side again and keep cumulating negative net foreign assets.

Note that in these simulations I have assumed perfect pass-through of marginal cost into gross prices. This significantly speeds up the adjustment of the imbalances. Moreover, an internal devaluation assumes that all other countries in the world economy, including the euro area, are increasing their value-added prices. This might turn out not to be feasible given that other euro countries might need to adjust the trade imbalance too. The adjustment of structural trade deficits would require the adjustment of real effective exchange rates. [Gaulier and Vicard \(2018\)](#) use GDP deflators to construct these REERs. Their estimates of misalignments in real effective exchange rates show that euro area imbalances are still large. With Germany exhibiting a 20-percentage point undervaluation compared to the rest of the euro area. Therefore, the rebalancing process might involve a 2 percent higher inflation in Germany (and other surplus countries) than in the rest of the euro area over a decade. Nevertheless, at the current inflation pattern and without incorporating the input-output structure of trade, the trade imbalances adjustment would involve a horizon of adjustment of 20 years.

### **3.6 Concluding Remarks**

In this chapter, I study through the lens of Global Value Chains (GVCs), what are the causes and consequences of the euro area imbalances that built up before the 2008-2009 financial crisis. GVCs are an interesting dimension to be considered due to the risks they entail and the challenges they pose to traditional policymaking ([Amador and Cabral, 2017](#)). I develop a multi-sector, multi-country framework that disentangles the different components that contribute to the evolution of the trade balance



to GDP ratio, in the presence of international input-output linkages. I also explore how the effectiveness of internal devaluations is affected by the emergence of GVCs.

The main results are that: (i) The contribution of the different components is heterogeneous across countries, therefore, they must be interpreted country by country, since it is not the case that all trade deficit countries experienced competitiveness losses. (ii) The effectiveness of internal devaluations within the euro area to facilitate the adjustment of the imbalances seems more limited when GVCs are considered. This points towards a large burden for the economies under the still ongoing process. Note that the conclusion in this chapter is not that imbalances do not require price adjustments, but the need for more intra-euro area coordination. [Obstfeld and Rogoff \(2007\)](#) show that the adjustment of imbalances calls for a real exchange rate depreciation and [Bems \(2014\)](#) has "updated" the transfer problem for the GVCs era, although with a small number of countries and sectors.

These results add to previous contributions in the literature showing that in the face of a shock that calls for a real exchange rate depreciation, an internal devaluation might not be desirable in a currency union ([Gali and Monacelli, 2016](#)).<sup>21</sup> The literature has also shown that episodes of large capital inflows in small open economies, like the experienced by some euro area deficit countries, are often associated with a shift of resources from the tradable to the non-tradable sector and sometimes lead to balance-of-payments crises ([Kalantzis, 2015](#)). These dimensions should also be more carefully incorporated into the analysis.

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<sup>21</sup>While [Gali and Monacelli \(2016\)](#) study the gains from increased wage flexibility using a small open economy model with staggered price and wage setting, I emphasize the role of the international productions network.

Finally, Macroeconomic monitoring schemes used by the European Commission and the IMF would benefit from incorporating these developments in the surveillance tasks. And future research should focus on incorporating the GVCs in a framework able to evaluate the current account sustainability, like the External Balance Assessment methodology ([IMF, 2013](#)).

# Bibliography

Ahmed, Swarnali; Appendino, M. A. R. M. (2015). Depreciations without exports ? global value chains and the exchange rate elasticity of exports. Policy Research working paper 7390, World Bank Group.

Alberola-Ila, E., Estrada, A., and Viani, F. (2018). Global imbalances from a stock perspective. the asymmetry between creditors and debtors. *BIS Working Papers No 707*.

Amador, J. and Cabral, S. (2017). Networks of value-added trade. *The World Economy*, 40(7):1291–1313.

Amador, J., Cappariello, R., and Stehrer, R. (2015). Global value chains: A view from the euro area. *Asian Economic Journal*, 29(2):99–120.

Anderson, J. E. and van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1):170–192.

Anderson, J. E. and Yotov, Y. V. (2016). Terms of trade and global efficiency effects of free trade agreements, 1990-2002. *Journal of International Economics*, 99:279 – 298.

Antras, P. and Chor, D. (2018). On the measurement of upstreamness and downstreamness in global value chains. Technical report, National Bureau of Economic Research.

- Armington, P. S. (1969). A theory of demand for products distinguished by place of production (une théorie de la demande de produits différenciés d'après leur origine) (una teoría de la demanda de productos distinguiéndolos según el lugar de producción). *Staff Papers (International Monetary Fund)*, 16(1):159–178.
- Auer, R., Levchenko, A., and Saur, P. (2017). International inflation spillovers through input linkages. *NBER Working Paper No. 23246*.
- Baier, S. L. and Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics*, 71(1):72 – 95.
- Baldwin, R. and Giavazzi, F. (2015). The eurozone crisis: A consensus view of the causes and a few possible remedies. *A VoxEU.org eBook*.
- Baldwin, R. E. (2016). *The Great Convergence: Information Technology and the New Globalization*.
- Baldwin, R. E. and Taglioni, D. (2014). Gravity chains: Estimating bilateral trade flows when parts and components trade is important. *Journal of Banking and Financial Economics*, 2(2):61?82.
- Bems, R. (2014). Intermediate inputs, external rebalancing and relative price adjustment. *Journal of International Economics*, 94(2):248 – 262.
- Bems, R. and Johnson, R. C. (2017). Demand for value added and value-added exchange rates. *American Economic Journal: Macroeconomics*, 9(4):45–90.
- Bergstrand, J. H., Larch, M., and Yotov, Y. V. (2015). Economic integration agreements, border effects, and distance elasticities in the gravity equation. *European Economic Review*, 78(Supplement C):307 – 327.

- Bernanke, B. S. (2005). The global saving glut and the u.s. current account deficit. *Speech 77, Board of Governors of the Federal Reserve System*.
- Blanchard, E. J. (2010). Reevaluating the role of trade agreements: Does investment globalization make the wto obsolete? *Journal of International Economics*, 82(1):63 – 72.
- Blanchard, E. J., Bown, C. P., and Johnson, R. C. (2016). Global supply chains and trade policy. Working Paper 21883, National Bureau of Economic Research.
- Blanchard, O. J. and Milesi-Ferretti, G.-M. (2009). Global imbalances: In mid- stream? *IMF Staff Position Notes 09/29*.
- Bussiere, M., Callegari, G., Ghironi, F., Sestieri, G., and Yamano, N. (2013). Estimating trade elasticities: Demand composition and the trade collapse of 2008-2009. *American Economic Journal: Macroeconomics*, 5(3):118–51.
- Caliendo, L. and Parro, F. (2015). Estimates of the trade and welfare effects of nafta. *The Review of Economic Studies*, 82(1):1–44.
- Cheng, I.-H. and J.Wall, H. (2005). Controlling for heterogeneity in gravity models of trade and integration. *Federal Reserve Bank of St. Louis Review, January/February 2005*, 87(1), pp. 49-63.
- Cipollina, M. and Salvatici, L. (2010). Reciprocal trade agreements in gravity models: A meta-analysis. *Review of International Economics*, 18(1):63–80.
- diMauro, F., Nagengast, A., and Stehrer, R. (2016). On the correction

- of eurozone external imbalances and the pitfalls of bilateral imbalance measures. *VoxEU article*.
- Eaton, J. and Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, 70(5):1741–1779.
- Fally, T. (2015). Structural gravity and fixed effects. *Journal of International Economics*, 97(1):76 – 85.
- Gali, J. and Monacelli, T. (2016). Understanding the gains from wage flexibility: The exchange rate connection. *American Economic Review*, 106(12):3829–68.
- Gaulier, G., Santoni, G., Taglioni, D., and Zignago, S. (2013). In the wake of the global crisis : evidence from a new quarterly database of export competitiveness. *Policy Research Working Paper Series 6733, The World Bank*.
- Gaulier, G. and Vicard, V. (2018). Some unpleasant euro arithmetic. Technical report.
- Head, K. and Mayer, T. (2014). Chapter 3 - gravity equations: Workhorse, toolkit, and cookbook. In Gopinath, G., Helpman, E., and Rogoff, K., editors, *Handbook of International Economics*, volume 4 of *Handbook of International Economics*, pages 131 – 195. Elsevier.
- Hummels, D. L. and Schaur, G. (2013). Time as a trade barrier. *American Economic Review*, 103(7):2935–59.
- IMF (2013). The external balance assessment (eba) methodology. Technical report, International Monetary Fund.
- IMF (2015). Exchange rates and trade flows: Disconnected? *Chapter*

3. *WORLD ECONOMIC OUTLOOK Adjusting to Lower Commodity Prices*  
September 2015.

IMF (2017). External sector report. Technical report, International Monetary Fund.

Johnson, R. C. and Noguera, G. (2012). Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics*, 86(2):224 – 236.

Johnson, R. C. and Noguera, G. (2017). A portrait of trade in value-added over four decades. *The Review of Economics and Statistics*, 0(0):null.

Kalantzis, Y. (2015). Financial fragility in small open economies: Firm balance sheets and the sectoral structure. *The Review of Economic Studies*, 82(3):1194–1222.

Koopman, R., Wang, Z., and Wei, S.-J. (2014). Tracing value-added and double counting in gross exports. *American Economic Review*, 104(2):459–94.

Larch, M., Wanner, J., Yotov, Y. V., and Zylkin, T. (2017). The currency union effect: A ppml re-assessment with high-dimensional fixed effects. *CESifo Working Paper Series 6464*, CESifo Group Munich.

Lipton, D. (2018). Speech at the conference "spain: Building a flexible economy to face the future".

Martin, W. and Messerlin, P. (2007). Why is it so difficult? trade liberalization under the doha agenda. *Oxford Review of Economic Policy*, 23(3):347–366.

McCallum, J. (1995). National borders matter: Canada-u.s. regional trade patterns. *The American Economic Review*, 85(3):615–623.

- Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6):1695–1725.
- Mongelli, F. P., Dorrucchi, E., and Agur, I. (2005). What does european institutional integration tell us about trade integration?
- Moral-Benito, E. and Viani, F. (2017). An anatomy of the spanish current account adjustment: The role of permanent and transitory factors. banco de espana working paper no. 1737.
- Nagengast, A. and Stehrer, R. (2016). Accounting for the differences between gross and value added trade balances. *The World Economy*, 39(9):1276–1306.
- Noguera, G. (2012). Trade costs and gravity for gross and value added trade. *Job Market Paper*.
- Obstfeld, M. (2012). Does the current account still matter? *American Economic Review* 102 (3): 1–23.
- Obstfeld, M. and Rogoff, K. (1996). *Foundations of International Macroeconomics*. MIT Press, Cambridge, Massachusetts. MIT Press, publication website Table of Contents Why We Wrote This Book (Preface) Introduction Typos Notation Guide.
- Obstfeld, M. and Rogoff, K. (2007). *The Unsustainable U.S. Current Account Position Revisited*, pages 339–376. University of Chicago Press.
- Ollivaud, P., E. R. and Schwellnus, C. (2015). The changing role of the exchange rate for macroeconomic adjustment. Working Paper 1190, OECD Economics Department.
- Patel, N., Wang, Z., and Wei, S.-J. (2017). Global value chains and effective



exchange rates at the country-sector level. *BIS Working Papers No 637*, May 2017.

Rouzet, D. and Miroudot, S. (2013). The cumulative impact of trade barriers along the value chain: An empirical assessment using the oecd inter-country input-output model'. In *16th Annual Conference on Global Economic Analysis*.

Silva, J. M. C. S. and Tenreyro, S. (2006). The log of gravity. *The Review of Economics and Statistics*, 88(4):641–658.

Timmer, M. P., B., L., Stehrer, R., and de Vries, G. J. (2016). An anatomy of the global trade slowdown based on the wiod 2016 release. *Available as GGDC research memorandum number 162*.

Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R., and de Vries, G. J. (2015). An illustrated user guide to the world input–output database: the case of global automotive production. *Review of International Economics*, 23(3):575–605.

Trefler, D. (1993). International factor price differences: Leontief was right! *Journal of Political Economy*, 101(6):961–987.

Zylkin, T. (2017). Ppml panel sg: Stata module to estimate structural gravity models via poisson pml.



**Titre :** Essais sur les dimensions commerciales et macroéconomiques des chaînes mondiales de valeur

**Mots clés :** Chaînes Mondiales de Valeur, Macroéconomie, Intégration Économique

**Résumé :** La phase la plus récente de la mondialisation, que constituent les chaînes de valeur mondiales ("CVM"), date du début des années 1990. Il est caractérisé par la libéralisation des échanges commerciaux, le progrès technologique, et l'augmentation du commerce des biens finaux et intermédiaires. Ça a généré la structure de production du réseau du commerce international, liant les pays non seulement du côté de la consommation mais aussi de la production. Cette thèse couvre les thèmes suivants : l'équation de gravité à valeur ajoutée, le rôle des accords de libre-échange et des technologies de l'information et de la communication captés comme un "effet frontière", et les déséquilibres commerciaux. Alors que les résultats pour de nombreux pays sont rapportés, j'accorde une attention particulière aux pays européens. D'une manière générale, les résultats montrent que : (i) les conséquences de négliger la dimension des CMV pour l'élasticité des exportations à valeur ajoutée sont qu'elles ne sont pas constantes dans le temps et inférieures à celles des exportations

brutes. Cela facilite la mise en oeuvre d'autres outils qui ont été développés auparavant dans la littérature, comme les taux de change effectif réel en termes de valeur ajoutée. (ii) Les accords de libre-échange augmentent le commerce bilatéral de 54% en moyenne après 10 ans ou plus, autant pour les biens finaux que pour les biens intermédiaires. "L'effet frontière" est devenu moins contraignant avec le temps, les échanges de biens finaux ont augmenté de 443% par rapport au commerce intérieur depuis 1970, tandis que la hausse a été de 195% pour les biens intermédiaires. (iii) L'utilisation d'une approche à valeur ajoutée pour étudier les déséquilibres commerciaux permet de démêler les différentes composantes de la dynamique de la balance commerciale (la performance commerciale et la croissance de la demande) tout en intégrant les liens internationaux du réseau de production entrées-sorties. J'explique aussi dans quelle mesure les dévaluations internes sont suffisantes pour compenser la rigidité des taux de change intra-Euro.

**Title :** Essays on the Trade and Macroeconomic dimensions of Global Value Chains

**Keywords :** Global Value Chains, Macroeconomics, Economic Integration

**Abstract :** The recent wave of globalization, the so-called Global Value Chains (GVCs), dates back to the early 1990s and is characterized by the increase in trade in intermediate goods. This trade in intermediate goods links countries not only on the consumption side but also on production, generating the network structure of international trade. Trade liberalization and technological advances arguably constituted the main drivers of the emergence of GVCs. This thesis covers the themes of the derivation of the gravity equation in value-added terms, the role of free trade agreements and information and communication technologies captured as a "border effect", and trade imbalances. The results show that : (i) the gravity equation in value-added terms facilitates the implementation of other tools that have been developed previously in the literature, such as real effective

exchange rates in value-added terms. The implications of neglecting the GVC dimension include the fact that the elasticity of value-added exports is not constant over time and lower than those of gross exports. (ii) Free trade agreements increase bilateral trade by 54% on average after 10 years or more, both for final goods and for intermediate goods. "The border effect" has become less binding over time, trade in final goods has increased by 443% compared to domestic trade since 1970, while the increase has been 195% for intermediate goods. (iii) The use of a value-added approach to study the trade imbalances helps to disentangle the different components of the trade balance dynamics (trade performance and demand growth). I also explain to what extent internal devaluations are effective to adjust the trade imbalances.

