Dottorato in Economia e Metodi Quantitativi
XXIX CICLO

Tesi di dottorato

ESSAYS ON SPECIALIZATION PATTERN, INTERNATIONAL FRAGMENTATION OF PRODUCTION AND TRADE IN VALUE ADDED

Dottorando: Laura Dell'Agostino

Docente Guida: Prof.ssa Silvia Nenci

Coordinatore: Prof. Luca Salvatici

Table of contents

Abstract **5**

Introduction **6**

1. Linking trade specialization and international fragmentation of production. A conceptual framework. **10**

Abstract **10**

1.1 Introduction **11**

1.2 Differences in technology or in factor endowments? **12**

1.3 Intra-industry trade and increasing returns to scale **15**

1.4 Specialization in a world with international fragmentation of production (and heterogeneous firms) **17**

1.4.1 Trade in goods or trade in tasks? 18

1.4.2 Geography and other non-conventional determinants of comparative advantage 20

1.4.3 Ricardo's theory of comparative advantages to the test of time and data 23

1.4.4 Firms rather than countries trade 25

1.4.5 Specialization and international fragmentation of production: elements for a conceptual framework. 28

1.5 Conclusions **30**

References **31**

2. Trade specialization, international supply and production networks using value added trade data. The case of manufacturing in Italy. **36**

Abstract **36**

2.1 Introduction **37**

2.2 Measuring fragmentation and trade in value added: a review of the literature **41**

2.2.1 From the case studies to the input-output tables 43
2.2.2 Vertical specialization and value added indexes 45

2.3 The decomposition of gross exports: methods and data **48**

2.3.1 Accounting frameworks to disentangle gross exports at country level 48
2.3.2 Accounting frameworks to disentangle gross exports at bilateral and bilateral sector level 52
2.3.3 The World Input-Output Database (WIOD) 59

2.4 The case of manufacturing in Italy: descriptive and empirical analyses **61**

2.4.1 The Italian trade specialization pattern with value added data 61
2.4.2 International competitors of Italy in its specialization sectors 69
2.4.3 The export structure in value added of Italy and other selected countries 74
2.4.4 The main source countries of Italy in the supply chains with value added data 78
2.4.5 Supply and production links between Italy and its main partners 85

2.5 Synthesis of outcomes and conclusions **88**

Appendix A - National and world input-output tables: concepts and basic notation **91**

Appendix B - Datasets **95**

Appendix C - WIOD 2013 release: countries and sectors' coverage **96**

References **98**

3. The effect of the euro on trade using value added trade data. **103**

Abstract **103**

3.1 Introduction **104**

3.2 The common currency effect on trade: a review of the literature **107**

3.2.1 The pre-euro literature 107

3.2.2 Studies on the impact of the euro 110

3.3 Estimating the euro's trade effect: methodology and data **114**

3.3.1 A "gravity-like" approach 114

3.3.2 A matching-estimator approach 117

3.3.3 Data description and sources 120

3.4 Empirical outcomes and assessment of the euro's effect on trade **122**

3.5 Conclusions **140**

Appendix D - Gravity estimates with standard errors clustered by country pair **142**

Appendix E - Difference in the EURO coefficient between estimates with value added components and gross exports value **148**

Appendix F - Matching estimates using the value of the exports in a single year **149**

Appendix G - PSM and PSM-DID results **151**

G.1 Propensity Score Matching 151

G.2 PSM-Difference in Differences 155

References **159**

General conclusions **164**

List of Figures **166**

List of Tables **167**

DOTTORATO IN ECONOMIA
UNIVERSITÀ DEGLI STUDI ROMA TRE

Abstract

Recently, international trade theory has seen a resurgence in studies on specialization patterns and the determinants of trade flows in a world with international fragmentation of production and trade in intermediate goods. This dissertation consists of three essays at the current frontier of research on these issues.

Starting from a historical excursion of the issue of specialization in international trade theory, the first essay attempts to insert the most recent contributions into a conceptual framework that links trade specialization and international fragmentation of production. In particular, this essay focuses on the pioneer works that, in the last two decades, have brought the role of comparative advantage in explaining the patterns of trade back to the centre of the debate. These new lines of research have improved the level of knowledge and could continue to extend it regarding specific features of global trade, specialization and international fragmentation of production.

The second essay presents a descriptive analysis of trade specialization of Italy and its main competitors in the manufacturing industry, using value added trade data and the most recent mathematical frameworks for trade decomposition and contributing to the long-standing debate on the “anomaly” of Italian comparative advantages. Moreover, this essay analyses the sectoral export structure so that the role of each country within the global supply and production networks can be defined and examines the bilateral trade dimension in order to identify the main source countries of foreign value added in country exports and the bilateral links between Italy and the main destination markets of its exports.

Finally, the third essay presents a quantitative analysis of the impact of the euro on bilateral trade between Eurozone member states and provides two original contributions. First, the euro’s effect on trade is investigated from a value added perspective using a “gravity-like” approach. Second, this effect is estimated also using matching techniques to control for non-linearity-with-self selection. This third essay fits into a larger economic and political debate on the costs and benefits of the common currency that is more than ever still open.

Introduction

In the late 20th and early 21st centuries, international trade theory has seen a resurgence in studies on comparative advantage and specialization patterns and on the determinants of trade flows. These studies aim to properly explain these issues in a world in which international fragmentation of production has become increasing important and there is growing trade in intermediate goods. Furthermore, the field of international trade has exhibited an expansion in the range of analytical tools brought to bear on these topics. In this framework, this dissertation consists of three essays at the current frontier of research.

Starting from an historical excursion of the issue of specialization in the traditional trade theory and the so-called “new trade theory”, the first essay attempts to insert the most recent contributions into a conceptual framework that links trade specialization and international fragmentation of production. This essay observes how, following the Ricardian principle of comparative advantage based on technology differences across countries, during the 20th century international trade theory turned first to differences in factor endowments and then to increasing returns to scale as explanations for specialization and gains from trade. However, in the last two decades, Ricardo’s theory of comparative advantage turns back to centre stage to explain specialization in a world with international fragmentation of production and increasing trade in intermediate goods, stimulating several, fascinating lines of research. Each of these lines focuses on specific features of global trade and a tentative effort to synthesize all the main elements in a unified framework seems to move toward a “kaleidoscopic” notion of comparative advantage and specialization. An overview of such a wide literature could only be selective. Therefore, this first essay focuses on the pioneer works that have explained new empirical phenomena and have given rise to several lines of research along which international trade theory may continue to improve our knowledge of specialization and international fragmentation of production. This first essay is a first effort to create a conceptual framework that underlines the role of specialization and comparative advantages in a world characterized by international fragmentation of production and heterogeneous firms. It also serves as a necessary conceptual framework for setting the next empirical essays.

On the empirical side, the international fragmentation of production has challenged the opportunity to measure trade specialization by using standard trade statistics and in the early 21^{st} century, trade in value added has emerged as a novel, relevant topic of research in international economics. This promising field of study seeks to allocate the value added in gross trade flows to its country and sector of origin and destination in order to quantify more appropriately trade specialization and provide a better understanding of the nature and extent of global supply and production networks.

The second essay presents the first, to the best of my knowledge, extensive descriptive analysis of trade specialization of Italy and its main competitors, using value added trade data and the most recent and influential methodologies for trade decomposition. It focuses on the manufacturing industry and, especially, on two important industries with different technological characteristics: *Leather, leather products and footwear* and *Machinery*. As far as I am aware, this work is the first to contribute, from a value added perspective, to the long-standing debate on the "anomaly" of Italian comparative advantages. Thereafter, this second essay analyses the sectoral export structure so that the role of each country within the global supply and production networks can be defined and examines the bilateral trade dimension in order to identify the main source countries of foreign value added (suppliers) in country exports and the bilateral links between Italy and the main destination markets (consumers) of its exports. The analysis shows that Italy's comparative advantages measured in value added basically confirm the pattern of trade specialization described using traditional gross statistics. However, focusing on the domestic value added in exports, the Italian specialization pattern is not completely aligned with the one arising from gross trade data, suggesting that traditional analysis tends to bias the role of some sectors in the composition of exports. Comparing Italy with its main competitors, using value added data as well, Italy remains the country with the most relevant comparative advantages in the *Leather, leather products and footwear* sector, whereas in the other sectors, some new EU members emerge as international competitors. The sectoral analysis shows that the structure of the Italian exports in the *Machinery* sector appears similar to the German one but reflects a downstream position and a lower level of internationalization. The organization of production emerging from the structure of the Italian *Leather, leather products and footwear* exports confirms, from a value added perspective, the consolidation of some trends that are well documented in sectoral studies. Finally, Italy has strengthened its comparative advantage in both sectors without making substantial shifts in its international suppliers, except for the increasing role of China, and maintaining strong supply links with the European countries, especially with Germany that is an important commercial bridge to third markets.

Overall, by combining different methodologies and different levels of disaggregation of gross exports, this essay shows how trade specializations and the structure and evolution of supply and production networks can be better understood if the increasing importance of international fragmentation of production and trade in intermediate goods is accounted for. The value added approach enables us to observe the growing role of some emerging countries as both competitors and partners, strengthening the perception of the level of productive integration between countries, rather than that of fragmentation and favouring a vision of the countries in terms of partnerships and not only competition.

The value added exports data and especially the different value added components of the bilateral gross export flows are used in the third essay to present a quantitative analysis of the impact of the euro on bilateral trade between Eurozone member states. This purpose arises from the fact that, more than a decade after its establishment, the assessment of the impact of the euro on bilateral trade between Eurozone countries remains at the top of the academic and political debate and that, although a consensus wisdom suggests that the euro has increased trade by 5% to 10% on average, the literature results are not univocal.

This essay joins the debate on the euro's effect on trade by providing two original contributions. First, the euro's effect on trade is investigated from a value added perspective using a "gravity-like" approach on a panel dataset of 39 countries in the period from 1995 to 2011. I am aware that the traditional gravity approach needs in-depth theoretical work to properly explain bilateral value added trade and that these estimates could be biased due to the inability of the current gravity framework to fully account for the "third-countries" effect in a value added perspective. Therefore, in the second step, this essay uses matching techniques to control for non-linearity-with-self selection that could also affect gravity estimates. To the best of my knowledge, this work is the first to assess the euro's effect on trade using both value added trade data and a matching estimator besides standard gravity estimates. These two methodologies lead to opposite results in terms of the sign of the euro's effect.

While the "gravity-like" approach leads to a negative impact of the euro, non-parametric estimates show a positive euro trade effect with both gross and value added exports data. This result suggests that the gravity approach may not be the proper technique to assess this effect in the presence of fragmentation of production. Focusing on the value added perspective, it is interesting to note that in both methods, the use of value added components does not modify the sign of the euro's effect obtained using gross exports data. Therefore, it seems that the bias of "gravity-like" estimates could be considered not as relevant.

Overall, although the results of this empirical analysis should be considered tentative and require further research, they confirm the difficulties involved in detecting the euro's effect on trade unequivocally and confirm that further advances in our understanding of the euro's impact on trade should be made.

Although the three essay are closely related, they have been written so that each one can be read independently of the others.

1. Linking trade specialization and international fragmentation of production. A conceptual framework.

Abstract

The determinants of the pattern of specialization have a prominent place in international trade theory. Starting in the 19th century with the Ricardian principle of comparative advantage based on technology differences across countries, during the 20th century, trade theory turned first to differences in factor endowments and then to increasing returns to scale as explanations for specialization. More recently, Ricardo's theory of comparative advantage has moved back to centre stage to explain specialization in a world with international fragmentation of production and increasing trade in intermediate goods. This essay presents a historical excursion of the issue of trade specialization in international trade theory and focuses on the most recent contributions in order to provide a conceptual framework of the links between trade specialization and international fragmentation of production.

JEL Classification: B27, F11, F12

Keywords: trade theory, trade specialization, international fragmentation of production, comparative advantage

1.1 Introduction

International trade theory has devoted a considerable volume of work to the identification of the factors governing trade flows between countries and, within this literature, the determinants of the pattern of specialization have a prominent place. Indeed, in the absence of international trade, a country can only consume what it produces. However, when presented with the opportunity to trade, countries benefit by specializing in the production of goods they do relatively better. International trade allows for an extension beyond national borders of the division of labour. Thus, the pattern of specialization is key to understanding how international trade affects the production structure of an economy.

Starting in the 19th century with Ricardo's principle of comparative advantage, during the 20th century, international trade theory proposed different explanations of how countries specialize. While Ricardo (1817) and the Ricardian model he inspired (Haberler, 1930) identify the determinants of the pattern of trade in the technological differences between counties, the contributions by Heckscher (1919) and Ohlin (1933) focus on differences in relative factor endowments. Afterwards, in the late 1970s and early 1980s, a "new trade theory" emerged, showing that each country gains from trade due to increasing returns to scale (Krugman, 1979). Finally, in the last two decades, there was increasing interest, both theoretically and empirically, in the splitting of production processes across international locations. In recent years, the intersection between the literature on trade specialization and this new strand of research has brought the role of comparative advantage in explaining the pattern of trade back to the centre of debate.

This essay presents a historical excursion of the issue of trade specialization in the international trade theory through the main empirical works and theoretical reflections that have been the turning points in the development of new contributions during the last century and especially in the last decades. The aim of this work is not to provide a comprehensive review of the literature, but rather to analyse how the issue of specialization has been addressed in the different theoretical frameworks and, in particular, in the studies that have linked this issue to the increasing relevance of international fragmentation of production. Following a survey of the main elements that shape the traditional trade theory (Section 2) and the so-called "new trade theory" (Section 3), Section 4 focuses on the most recent contributions to analysing how trade specialization is increasingly influenced by fragmentation of production on a global scale and how this phenomenon has modified our understanding of comparative advantages. In this way, this work provides a conceptual framework of the links between trade specialization and international fragmentation of production which also represents a useful background for setting the second and third essays.

1.2 Differences in technology or in factor endowments?

Specialization has been an important issue in economic theory since its origins. As is well known, Smith (1776) emphasized the division of labour as the main driver of the growth of production. Indeed, at the time of the first industrial revolution, he observed that breaking down the production process into smaller tasks, each worker became more specialized in a specific task and this led to an increase in productivity. In his view, the size of the market would determine the extent of the division of labour. After a few decades, during the first globalization unbundling, the issue of specialization joined the theme of international trade within the principle of comparative advantage proposed by Ricardo (1817). In this principle, the gains from international trade are driven by relative (or compared) costs, rather than by absolute costs as the economic debate - including Smith[1] - had argued until that moment. This change of perspective is the core of the original contribution formulated by Ricardo. This section presents a brief overview of the traditional trade theories, whose fundamental element lies in this principle, in order to outline the main features of their conceptual framework and point out the main shortcomings of these theories.

In the numeric example proposed by Ricardo (1817) in order to present the principle of comparative advantage, there are two countries which can produce each of two goods using only a fixed amount of labour per unit of output[2]. Perfect competition is assumed. Ricardo shows that when presented with the opportunity to trade, countries could gain from trade by specializing in the production of goods they do relatively better, i.e. the good it can produce with less labour than the other good, compared with the other country. This good is that in which they have comparative advantage. Thus, comparative advantage is defined in terms of the differences in the labour requirement in the production of the goods in the two countries.

[1] Smith (1776) made a first attempt to explain gains from trade due to increasing return to scale, but did not provide an analytic demonstration.

[2] It seems to be a one-factor model. Nevertheless, a more integrate view of the wide content of the "*On the Principles of Political Economy and Taxation*" (Ricardo, 1817) leads some historians of economic thought to argue that a proper reconstruction of the underlying assumptions should also comprise profits and capital, in addition to wages and labour. Indeed, it is worth mentioning that there is still open debate among historians of economic thought over the reconstruction of the discovery of comparative advantage, in order to provide the most accurate interpretation of Ricardo's thought. Ruffin (2002) and Gehrke (2015) are two of the most recent contributions.

Through this basic example, Ricardo (1817) - whose main objective was to demonstrate gains from international trade - points out that these gains and the pattern of trade are strictly related. Indeed, as summarized by Deardorff (2005a), the presence of comparative advantage provides the scope for countries to gain from trade by specializing and the pattern of trade is explained by the pattern of comparative advantage.

The principle of comparative advantage and most of Ricardo's intuitions have been incorporated in the so-called Ricardian model which is the result of an intellectual endeavour starting with John Stuart Mill (1844) and culminating in the reinterpretation by Haberler (1930). The Ricardian model considers a world with two countries and two goods, where labour is the only factor of production. In this model, constant returns to scale in production and perfect competition are assumed. In the spirit of Ricardo (1817), Haberler (1930) recognizes that what was relevant to explaining international trade is not the absolute labour cost but rather the opportunity cost of producing one good instead of the other. He defines the opportunity cost of good j in terms of good k as the amount of good k that could have been produced with the resources used to produce a given amount of good i. Therefore, in his version of Ricardo's principle, a country has a comparative advantage in producing good j if the opportunity cost of producing that good in terms of good k is lower in that country than it is in other countries. Haberler (1930) expresses this opportunity cost in terms of the unit labour requirement or labour productivity, i.e. the number of hours of labour required to produce a unit of good j or k, which summarizes the technological endowment of each country. Therefore, in the Ricardian model, each country specializes in producing the good in which it has a comparative advantage which is determined by international differences in the productivity of labour due to different technological endowment. This model, in which differences in technology across countries are the source of comparative advantages, still constitutes a benchmark for traditional trade theory.

The Ricardian model differs from the second branch of the traditional trade theory, starting with the work of Heckscher (1919) and Ohlin (1933). They consider a world with two countries, two goods and two factors of production and assume constant returns to scale in production and perfect competition. In this theoretical approach, comparative advantages - and, therefore, specialization - are endogenously determined by the interaction of differences in relative factor endowments across countries and differences in relative factor intensities across sectors. Although this could be considered to be in line with the general approach of the Ricardian model, this shift in the source of comparative advantage is the relevant difference. In terms of specialization and patterns of trade[3], in these models each country tends to export the good whose production uses more intensively the factor that in the country is relatively more abundant[4].

While the Ricardian model identifies the differences in technology between countries as the source of comparative advantage, the Heckscher-Ohlin framework focuses on the difference in relative endowments. Nevertheless, both these traditional trade models share several strong assumptions: (i) technology is assumed to feature constant returns to scale; (ii) market structure is characterized by perfect competition; (iii) the number of goods and factors is very low, with often only two of each.

In the late 1960s and 1970s, some scholars started to deal with the (iii) shortcoming. Within the Ricardian framework, Dornbusch et al. (1977) partially overcome this limit by extending the model to an infinite number (*a continuum*) of goods but only two countries. In their model, the specialization emerges as the result of a "chain of comparative advantages" determined by technology differences across countries. Using elementary geometry and calculus, they assume that the set of goods corresponds to all the points on an interval between 0 and 1 and show that goods can be ranked by comparative advantage, i.e. decreasing relative labour requirements, to form a chain. Demand conditions determine where the chain is broken, separating exporters from importers of each good and determining the pattern of trade and specialization. Another significant advance provided by this paper is the introduction of trade costs, assuming the iceberg (or ad valorem) trade cost proposed by Samuelson (1952) in which the trade costs are proportional to the volume shipped, as the amount melted to form the iceberg is proportional to its volume. With this hypothesis, trade costs are linear in the volume shipped and the distribution of goods continues to require resources in the same proportion as in production. Because of trade costs, goods no longer cost the same in each location. With the work of Dornbusch et al. (1977) the Ricardian framework becomes a tool that can address a variety of questions, but it is still limited to only two countries. We have to wait for the work of Eaton and Kortum (2002) to extend this framework to *a continuum of* countries. The same theoretical issue arises in the process of extending the Heckscher-Ohlin framework. Jones

[3] Contributions by Stolper and Samuleson (1941) and Rybczynski (1955) offer a more complete formalization to the cluster of so-called *à la* Heckscher-Ohlin models, allowing them to deliver sharp results on factor price and output level. These contributions have shown different properties of the Heckscher-Ohlin framework which Ethier (1974) has defined as the "core propositions" of the international trade theory.

[4] This clear prediction about trade and the specialization pattern is a central feature of the Heckscher-Ohlin framework and has inspired some scholars to look for empirical testing, starting with the study by Leontief (1953) on the US pattern of trade.

(1956) argues that when the number of commodities is increased and only two factors and countries remain, it is possible to construct a "chain" of comparative advantages, similar in terms of factor intensities, rather than relative labour productivities as in the Ricardian model. Deardorff (1979) demonstrates this proposition by placing the factor endowments in different "cones" of specialization. Nevertheless, he shows that free trade is a key assumption for the validity of this strong relationship. Without this assumption, comparative advantage fails to provide a strong prediction of the pattern of trade and specialization.

While both the Ricardian and the Heckscher-Ohlin framework offer the first significant results about the determinants of the pattern of trade and specialization, some of their main assumptions - such as constant returns to scale and perfect competition - could be called into question. The same holds for the fact that traded goods are typically considered only as final goods produced by different industries.

1.3 Intra-industry trade and increasing returns to scale

In the mid 1970s, Grubel and Lloyd (1975) produced overwhelming empirical evidence to demonstrate that in the real world a significant and increasing share of international trade consists of flows of goods within the same industries and that the bulk of trade flows occurs between countries with similar levels of technological development and similar relative factor endowments. Several years before, Balassa (1966) pointed out this phenomenon in a seminal paper on the rise of intra-industry trade in Europe. He observed that each country produced only part of the range of potential products within each industry, importing those goods it did not produce, since specialization in narrower ranges of products permitted the exploitation of economies of scale. At that time, a relevant share of the manufacturing production was increasing geographical concentrated in the advanced countries and was characterized by high scale economies. These were the main features of the so-called "Fordist" mode of production that was the dominant production paradigm.

Although the Ricardian framework and the Heckscher-Ohlin one focus on inter-industry or inter-sectoral trade that is the trade of goods produced by different industries, some scholars started to discuss the importance of trade in intermediate input or intra-industry trade. It is worth mentioning the work of McKenzie (1954) which argues that trade in intermediate goods may expand production possibilities and alter the pattern of trade. Another contribution is made by Jones (1961) who shows that the standard applications of comparative advantage also apply with trade in intermediate goods if countries differ only in their labour requirements for the production of final goods and intermediate inputs but do not differ in the coefficients that relate inputs to output. Nevertheless, without this strong assumption, the role of comparative advantage in intermediate goods continues to be difficult to establish.

In the late 1970s and early 1980s, a new chapter in the international trade theory opened, stimulated by the empirical evidence provided by Grubel and Lloyd (1975). The pioneers of the so-called “new trade theory” were a group of young trade economists, led by Paul Krugman and Elhanan Helpman, who proposed new models to reconcile the empirical evidence with theory, focusing attention on the relationship between international trade and industrial structure. New explanations for specialization emerged, breaking away from the approach of comparative advantage and dealing with the other main issues left open in traditional trade theories.

In order to explain the high share of intra-industry trade, these new models consider industries characterized by increasing geographical concentration in countries with little difference in technological endowment and increasing returns to scale. Moreover, the “new trade theory” - starting from its pioneer contributions (Krugman, 1980; Krugman and Helpman, 1985) - takes advantage of a parallel line of research that provides new models of imperfect competition. In particular, borrowed from Dixit and Stiglitz (1977), the “new trade theory” models converge in the use of a particular market structure, i.e. monopolistic competition and a specific modelling of product differentiation, i.e. a preference for variety of the representative consumer. Through these tools, the “new trade theory” shows that when technology features increasing returns of scale, each country involved in international trade gains forms trade as long as specializing in particular differentiated varieties of a sector’s goods allows it to expand its sales and operate at lower average costs. Therefore, increasing returns to scale are the main determinants of the pattern of trade and specialization.

Moreover, while in traditional trade theory countries trade with each other, in Krugman (1979, 1980) and in the models he inspired, the assessment of the industrial structure also needs to take some firm characteristics into account. These models assume a homogeneous behaviour of firms within an industry: each firm produces differentiated products, but with the same level of productivity, and all varieties enter symmetrically into demand function with an elasticity of substitution between any pair of varieties that is constant and common for any pair. Assuming iceberg trade costs, in “new trade theory” models firms within an industry will export their output to every single country in the world.

However, rapid transformations of the production paradigm and new empirical evidences have quickly called into question both the possibility of specialization due to increasing returns of scale and the assumption of homogeneous firms.

1.4 Specialization in a world with international fragmentation of production (and heterogeneous firms)

In the 1990s, some changes in the organization of production as far back as the 1960s converged towards a new configuration of production processes and international division of labour[5]. One of the dominant features of this new paradigm is international fragmentation of production which is defined as the segmentation and reorganization of previously integrated production activities over a network of production plants located in different countries (Jones and Kierzkowski, 1990). Naturally, the coordination of these different stages of production requires additional costs. Therefore, as discussed in detail by Baldwin and Martin (1999) and Baldwin (2011), the main driver of this transformation - the so-called "globalization's second unbundling"[6] - has been identified as the radical decrease in communication and coordination costs favoured by the ICT revolution, especially since 1980, that makes international fragmentation of production economically more viable. In addition, this phenomenon generates a relevant growth of trade in intermediate inputs and unfinished products which sometimes cross border several times before being embedded into a final good that is sold domestically or abroad, leading to a spectacular integration of the global economy through trade in the last decades (Feenstra, 1998). Indeed, at the same time, new players were integrated into global trade and the global production network, increasing cross-border flows of intermediate goods and foreign direct investment, as pointed out by Hanson (2012). He reports that from 1992 to

[5] Arrighetti and Ninni (2014) refer to this phenomenon as a "silent transformation". Indeed, these authors point out that the complete configuration of the current production paradigm was preceded by a process of division of labour at national level that has characterized the flexible specialization paradigm in the advanced countries in the late 1970s and 1980s. This production model had become prevalent compared with the so-called "Fordist" mode of production that dominated in the years of the long post-1945 boom when manufacturing production was concentrated in relatively few places and few, often very large, firms.

[6] These authors emphasize the existence of two "waves" of globalization: the first one took place between the steam revolution and 1914; the second one between 1960 and the present. The first wave has been characterized by a sharp drop in transport costs which favoured the growing of inter-industry trade driven by factor endowments differences and technology. In the second wave, the costs of a communication drop and a voluminous intra-industry trade among similar nations driven by scale economies and product differentiation characterize international trade (Baldwin and Martin, 1999; Baldwin, 2011).

2008, low and middle-income countries, such as China and India, increased their share of global export from 21 to 43 percent and inflows of FDI as a share of GDP rose from 2.1 to 3.4 in low-income countries and from 1.3 to 4.4 in middle-income countries. As a result, Antràs (2015) observes that in a world with international fragmentation of production, most goods are "Made in the World" and the typical "Made in" labels in manufactured goods have become archaic symbols of an old era. Furthermore, other scholars point out that the nature of international trade has changed "from trade in goods to trade in tasks" (Grossman and Rossi-Hansberg, 2008) or "from selling things to making things" (Baldwin, 2011).

Starting with Jones and Kierzkowski (1990), both theoretical and applied economic literature has devoted increasing attention to the effects of this new production paradigm on different fields of economic research, including the theory of international trade. Indeed, due to the disintegration of production and the increasing trade flows between advanced and developing countries, models based on increasing returns to scale can no longer provide the explanation for international trade patterns (see, among other, Hanson, 2012). In particular, in the late 20th and early 21st centuries, international trade theory has seen a resurgence in studies on comparative advantage and determinants of pattern of specialization and trade, in order to explain the principle of comparative advantage in a world in which international fragmentation of production has become increasingly important and there is a growing trade in intermediate and unfinished goods. The purpose of this section is to provide a succinct review of this rich intellectual work, focusing on the contributions that represent the main references of the debate, and offer key elements to compose a conceptual framework of the linkages between specialization and international fragmentation of production. This framework forms a useful background for the analyses that will be presented in the second and third essays.

1.4.1 Trade in goods or trade in tasks?

The work of Baldone et al. (2007) is one of the first to offer a benchmark framework for understanding the implication that the international disintegration of production processes has on the traditional concept of comparative advantage.

According to these authors, the new configuration of the production paradigm invalidates one of the basic assumption of traditional trade models, whether based on technological differences or on relative factor endowments, which considers traded goods as the final products of production activities integrated within each country[7]. In fact, they observe how in a world with trade in intermediate goods, the final exported goods embodied technology and factors of other countries. Therefore, these authors state that the traditional concept of comparative advantage becomes less relevant in explaining the pattern of trade because advantages of different counties are combined in a traded good, and the concept of absolute advantage regains importance. They obtain this result through an effective numerical example with two countries that produce two final goods using labour and two intermediate goods. Production is structured along two stages of production, with constant returns to scale: the first produces two intermediate goods which in the second stage, are processed in the two final goods. They show that, if transport and coordination costs are negligible and international trade is extended to intermediate inputs, the pattern of specialization could be different from those that emerge in a scenario with production process integrated in the home country. In fact, with international fragmentation of production, the determination of the pattern of specialization has to take into account the total labour required in each stage of production which includes both the direct labour content and the total labour embodied in intermediate inputs in all the previous stages of production. Therefore, according to Baldone et al. (2007), a final good is the result of the selection of a composite set of production processes, on the basis of the absolute advantage[8] and with the aim of minimizing the global cost of production and each country specializes in stages of production rather than in the production of a particular good.

In the composition of our conceptual framework, Baldone et al. (2007) offer a twofold contribution. First, they show that, with international fragmentation of production, the traditional concept of comparative advantage reduces its ability to explain specialization patterns and the absolute advantage becomes increasingly relevant. Second, they emphasise that trade in intermediate goods is "de facto trade in stages of production" due to the shift from a concept of comparative advantage (and specialization) related to the production and export of goods to a concept that focuses on the implementation of stages of production.

This second contribution anticipates what Grossman and Rossi-Hansberg (2008) call trade in tasks[9]. Their work differs from Baldone et al. (2007) in a number of ways. First, in Grossman and Rossi-Hansberg (2008), trading costs are relevant and they observe that

[7] At least until Sanyal and Jones (1982).

[8] Baldone et al. (2007) recall that absolute advantage involves, to some extent, political and institutional characteristics.

[9] Grossman and Rossi-Hansberg (2008) themselves point out that the distinction between "tasks" and "intermediate inputs" is largely semantic.

fragmentation of production (or offshoring, as this phenomenon used to be called) results from combining the possibility of hiring some production factors more cheaply abroad with the major cost for monitoring and coordinating production. Second, in the model proposed by Grossman and Rossi-Hansberg (2008) - in line with the research line based on heterogeneous firms starting with Melitz (2003) (see Section 1.4.4) - firms rather than countries produce, trade and choose how to organize their production activities at home or abroad. Their work focuses on the effect on factor prices of the organization of the global production process, rather than on trade specialization and I will not therefore go further into their model. However, what is worth noting for the construction of our conceptual framework is that Grossman and Rossi-Hansberg (2008) take into account both trading costs and firms. Both these elements will prove to be relevant aspects when outlining the links between specialization and fragmentation of production.

1.4.2 Geography and other non-conventional determinants of comparative advantage

In the early 21st century, the role of comparative (and absolute) advantage in explaining the pattern of trade has been brought back to the centre of the debate thanks to the success of the Eaton and Kortum (2002) model. Its importance lies in its ability to synthesize in an original and unified framework some open issues in the international economy. In particular, Eaton and Kortum observe that while gravity literature had recognized the importance of geographic barriers[10] as a determinant of trade flows and especially that the amount of trade between two countries grows as the “distance” between them falls[11], most of the formal models of international trade had typically ignored this regularity. Moreover, these authors claim that the increasing relevance of trade in intermediate goods increases the resistance imposed by

[10] Eaton and Kortum (2002) point out that these geographic barriers reflect a wide range of natural and artificial impediments such as transport costs, tariffs and quotas, delay and institutional constraints, problems with negotiating a deal from afar.

[11] Gravity literature started with Tinbergen (1962) and proposed an econometric model formulated along the lines of Newton’s law of universal gravitation in which bilateral trade flows were directly related to the economic size of the countries and inversely related to their distance. Since then, the gravity equation has been largely used to empirically analyse bilateral trade, becoming the most stable empirical relation in economics according to Leamer and Levinshon (1995). Inspired by Anderson (1979), three decades of theoretical work have shown that the gravity equation can be derived from different theoretical frameworks. The paper by Eaton and Kortum (2002) inserts itself in this literature and proposes the first derivation from a Ricardian framework of a mathematically equivalent structural gravity model.

geographic barriers to bilateral trade. Therefore, Eaton and Kortum (2002) argue that geography competes with technology in determining patterns of specialization[12].

To prove this, they propose to use a probabilistic formulation of technological heterogeneity which allows the Dornbusch, Fischer and Samulson (1977) Ricardian model based on technological differences with two countries and *a continuum* of goods to be extended to a world with many countries separated by geographic barriers. In the Eaton and Kortum (2002) model, countries differ both in absolute and comparative advantages. The state of technology of each country governs absolute advantage whereas the heterogeneity of technology across countries governs comparative advantage. Geographic barriers are represented by iceberg trade costs which seem to be effective in capturing the gravity relationship between the amount of trade between two countries and their distance. With this new tool, Eaton and Kortum (2002) show that geography, by influencing trade cost, can play an important role in determining both specialization and technology. Indeed, as geographic barriers fall from their autarky level, production activities tend to concentrate in larger countries where intermediate goods are cheaper. However, if geographic barriers continue to decline, smaller countries can buy these cheaper intermediate inputs and technology turns out to be the main determinant of specialization.

The work by Eaton and Kortum (2002) contributes to the construction of our conceptual framework in several ways. First, it shows that geography and technology are competing forces in determining patterns of specialization. Second, their model delivers an important piece of evidence regarding the role of productivity differences in determining comparative advantage, but both absolute and comparative advantage are relevant in explaining specialization patterns.

Finally, in wider terms, it is noteworthy that Eaton and Kortum (2002) were the first to propose and structurally estimate a statistical model based on the gravity equation, initiating a flourishing steam of quantitative gravity literature in which these quantitative trade models are calibrated and simulated to assess the effects of different scenarios. As argued by Costinot and Rodriguez-Clare (2014), this newer literature has a more appealing micro-theoretical foundation and offers a tighter connection between theory and data.

A parallel research line based on heterogeneous firms, of which the main theoretical reference is Melitz (2003), provides quantitative trade models they are consistent with several stylized facts highlighted by the analysis of firm-level datasets (see Section 1.4.4).

[12] Specifically economic geography.

Within these new quantitative trade models, some scholars focus specifically on the extension of the Eaton and Kortum (2002) model by combining the Ricardian framework with elements from different fields of the economic research to explore new questions. In particular, Chor (2010) presents a model for quantifying the importance of different sources of comparative advantage that link specialization patterns to country and industry characteristics, which is of particular interest when creating our conceptual framework[13]. Chor (2010) observes that, beyond the Ricardian and Heckscher-Ohlin framework, the literature on institutional determinants of trade has identified different institutional sources of comparative advantage at country level, such as financial development (e.g. Manova, 2008), the security of contract enforcement (e.g. Levchenko, 2007) and labour market flexibility (e.g. Cuñat and Melitz, 2009). In this literature, these institutional conditions vary among industries and industries also differ in terms of technology or factor endowments. Chor (2010) states that the resulting productivity level of firms is driven by an interaction between country and industry characteristics and that comparative advantage results from this interaction. The model proposed by Chor (2010) brings industries into the Eaton and Kortum (2002) model and provides a unified framework for explaining different sources of comparative advantage which incorporate a role for distance, Ricardian and Heckscher-Ohlin forces[14] and institutional determinants. In particular, the parameter used by Eaton and Kortum (2002) to capture the country's state of technology is substituted by a more general productivity term which links productivity to observable characteristics that reflect the ability of the country to meet the technological and institutional requirements of industries. This model offers strong evidence of the importance of both Ricardian and Heckscher-Ohlin forces, together with institutional determinants (financial development, legal institutions and labour market regimes) as sources of comparative advantage, although in the Ricardian framework, the gains from trade are higher.

In the composition of the linkages between trade specialization and international fragmentation of production, the contribution by Chor (2010) is twofold. First, he shows the significance of several institutional characteristics that could influence comparative advantages, in addition to

[13] In addition to Chor (2010), a number of papers extend the Eaton and Kortum (2002) model incorporating factors of production that are different from labour, as in Shikher (2011). Other models focus on low-income countries (Fieler, 2011). Bernard et al. (2003) introduce imperfect competition.

[14] Other recent studies have incorporated Ricardian and Heckscher-Ohlin forces within a common setting (Morrow, 2008; Burstein and Vogel, 2009).

traditional determinants. Second, Chor (2010) shifts the attention from country to industry level, moving closer to the research line based on heterogeneous firms.

Within the Ricardian framework, Costinot (2009) also investigates in more depth the determinants of technological differences across countries and industries, recovering in an explicit way the link between division of labour, productivity and specialization, as first highlighted by Smith (1776). He argues that levels of country's institutional quality and education are sources of comparative advantage that are complementary to technology in more complex industry. He considers a world with two countries, *a continuum* of goods and workers and increasing returns to scale in production. Goods differ in the number of elementary tasks required to produce one unit: the more the tasks there are to perform, the more complex is the good. Countries differ in institutional quality and human capital which capture the level of education. These country's characteristics affect both the enforcement of labour contracts, which represents transaction costs, and the size of the work teams, which increases with institutional quality and falls with education. In the spirit of Adam Smith, larger gains of specialization call for more workers to be employed and, thus, more contracts to be enforced and more transaction costs to be covered. Costinot (2009) shows that if two countries differ in these characteristics but not in technological know-how, the country with larger teams specializes in the most complex goods. Since the team's sizes are determined though institutional quality and education, he concludes that these factors are sources of comparative advantage.

Although Costinot (2009) does not explicitly account for international disintegration of production, this model offers interesting outcomes for our conceptual framework. Indeed, if we consider a world with fragmentation of production on a global scale, we can suppose that the most complex goods are produced in the countries that have the highest quality of institution and human capital. Therefore, as later pointed out by Costinot and Donaldson (2012), differences in absolute endowments across countries could influence the position of countries in the value chain.

1.4.3 Ricardo's theory of comparative advantages to the test of time and data

While the quantitative trade models focus on determinants of technological differences and propose several complementary sources of comparative advantage, the revival of the Ricardian model has *stimulated a broader debate* on the original contribution by Ricardo.

Deardorff (2005a) provides an analysis of the current relevance of comparative advantage in order to face a common criticism that, according to the author, states that "comparative advantage may have been valid two centuries ago when David Ricardo first proposed it, but for various reasons it is wrong or irrelevant in the world of today". Recalling the traditional models and their generalizations with more goods and countries, Deardorff (2005a) shows how comparative advantage has a significant ability to predict trade patterns in the former. However, the chain of comparative advantage loses this power when a large number of both countries and goods and a small number of realistic assumptions - such as the existence of trade barriers or trade in intermediate inputs - are allowed for[15]. Nevertheless, the author claims that in this case it is possible to say something about the pattern of trade by looking at the average relationship between comparative advantage and trade, i.e. according to the weaker correlation version of the law of comparative advantages proposed by himself in Deardorff (1980). Therefore, Deardorff (2005a) argues that this result is a good reason to believe that comparative advantage works, on average, when determining the gains from trade and the pattern of trade that follows. Moreover, according to the author, this general result is as strong as that of the traditional models, but only under some assumptions. Deardorff (2005a) lists multiple goods and countries, tariffs and other artificial trade costs, transport costs and other real trade costs, and trade in intermediate inputs among the assumptions that are consistent with the generalization of comparative advantage in the form of a correlation. On the contrary, he identifies in the domestic distortions and increasing returns to scale the assumptions that are hard to reconcile with the theory of comparative advantage on the base of current knowledge. Since both assumptions are "facts of economic life", Deardorff (2005a) seems to conclude that they should represent relevant fields of further research for the economic theory. Despite these limitations, the work of Deardorff (2005a) suggests that comparative advantage is less informative ("works on average") but it could maintain a central position within the conceptual framework of the links between specialization and fragmentation of production. Indeed, trade in intermediate inputs - which is the assumption that is more directly linked to the disintegration or production processes - is consistent with the weaker statement of the law of comparative advantages[16].

[15] The same holds when considering the cones of specialization that emerge in the Hecksher-Ohlin framework, rather than the chain of comparative advantage of the Ricardian model, as shown by Deardorff (1979).

[16] For more details on the role of comparative advantage in a Ricardian model with intermediate inputs, see Deardorff (2005b).

Moving from a strictly theoretical approach to a more empirical one, Costinot and Donaldson (2012) offer an empirical assessment of the Ricardo's theory of comparative advantage, "to bring the ideas to the data". Until then, this exercise was rather arduous since it requires data on relative productivity differences that cannot be directly observed. Costinot and Donaldson (2012) overcome this problem by using a novel agricultural dataset which presents information on the productivity of several crops and countries and for the first time are able to compute ex-ante relative productivity differences. Their empirical results show that the Ricardian theory of comparative advantage has a significant explanatory power in the data since the output level predicted by the theory is in line with actual data. This first piece of evidence suggests that comparative advantage could have a significant role in explaining the specialization of countries and, therefore, in our conceptual framework.

Finally, Hanson (2012) provides a more traditional (ex-post) assessment of trade specialization in low and middle-income countries which have become important players in global trade in the last decade. He shows that trade specialization appears in line with comparative advantage of countries, whether resource or technology based. Moreover, Hanson (2012) observes a rapid change in specialization over time, consistent with the explanation offered by Schott (2003). These studies point out that, in recent years, middle-income countries have moved into more capital-intensive goods thanks to the accumulation of human and physical capital, whereas low-income counties have covered the specializations left over by the former. This dynamic view of specialization offered by Hanson (2012) and Schott (2003) is an interesting element to consider in the conceptual framework of the linkages between specialization and international fragmentation of production.

1.4.4 Firms rather than countries trade

Although the "new trade theory" brought firms into trade models, it assumes homogeneous behaviour of firms within an industry. In the mid-1990s, taking advantage of newly available firm-level data for different countries, empirical research started to examine international trade at the level of firms and observed a significant firm heterogeneity within a sector, in terms of revenue, productivity, factor inputs and trade behaviour. Bernard and Jensen (1995, 1999), Clerides et al. (1998) and Aw et al. (2000), among others[17], have pointed out that

[17] While Bernard and Jensen (1995, 1999) focus on US, Clerides et al. (1998) investigate Colombia, Mexico, and Morocco and Aw et al. (2000) analyse Taiwan and South Korea. Later, empirical research showed that productivity heterogeneity is a pervasive feature of all economies including many European economies (Mayer and Ottaviano,

most firms do not export - exporters are in the minority - and, compared to non-exporters, exporters have positive performance characteristics (including higher productivity, larger size, greater capital intensity) and pay higher wages. Another stylized fact that emerges from their works is that there are substantial sunk costs of entry into foreign markets. This empirical evidence has opened up a new line of research, the so-called “new new trade theory”, whose goal is to bridge the gap between the micro and macro levels of analysis, showing how a systematic understanding of the firm-level data can provide important information that explains some facts of international trade emerging at the aggregate level. In this literature as well as in the traditional trade theory, specialization results from a comparative advantage of productivity. What is new, here, is that the comparison is no longer between sectors but between individual firms within sectors.

The pillar of the “new new trade theory” is the paper by Melitz (2003) which systematizes the empirical evidences in a model with monopolistic competition that incorporates firm level heterogeneity - in terms of productivity differences - and fixed export costs. The model proposed by Melitz (2003) shows that only a portion of the firms - the most productive ones which can cover fixed costs - exports goods to foreign markets. While in this seminal work by Melitz (2003) firms are involved in foreign markets only via the export of final goods produced with local labour, this model has been extended in several ways[18] and some of them are particularly relevant to the analysis of the organization of production in a world with fragmentation of production on global scale. In particular, besides export, this literature recognizes that firms can be involved in a number of foreign activities which include both the production of intermediate or final goods abroad through different foreign direct investment (FDI) activities (offshoring) and the import intermediate inputs from abroad (outsourcing). This section overviews the pioneer contributions in these two fields of research to order to identify their potential contribution to our conceptual framework.

Within the “new new trade theory”, Helpman et al. (2004) is a reference model that explains the close correlation between firm-level heterogeneous productivity, exports and FDI[19]. The authors propose a multi-country, multisector model with monopolistic competition.

2008; Bartelsman, Hatiwangerand and Scarpetta, 2009) as well as China and India (Hsieh and Klenow, 2009). Wagner (2007) offers a survey of the studies from different countries all around the world.

[18] Grossman and Rossi-Hansberg (2008) is an example. Although this literature is quite recent, a number of useful reviews already exist, e.g. Melitz and Redding (2013), Antràs and Yeaple (2013) and Costinot and Rodríguez-Clare (2014).

[19] In recent years, a rich empirical and theoretical literature focusing on the heterogeneous participation of firms in FDI has grown rapidly. Nocke and Yeaple (2007) and Bernard et al. (2009) are some examples.

In each industry there are heterogeneous firms which differ in productivity levels. To produce and sell in the home market, a firm bears the fixed costs of entry in an industry and fixed production costs. If the firm chooses to export, it has to cover additional transportation costs (of the iceberg type), whereas if the firm chooses to serve a foreign market via FDI, it has to bear the additional costs of building another production facility and forming a distribution and servicing network. This choice presents a trade-off: exporting involves lower fixed costs whereas FDI involves lower variable costs. By means of this model, Helpman et al. (2004) confirm the results of Melitz (2003), according to which only the most productive firms serve foreign markets. Moreover, they show that among these firms only the most productive engage in FDI and that exports are larger in sectors with more firm heterogeneity. Thus, this model indicates the important role of within-sector firm productivity differences in explaining the pattern of international trade and the organization of the production on global scale. This result is a significant element to include in the conceptual framework of the linkages between specialization and international fragmentation of production.

In a parallel paper, Antràs and Helpman (2004) investigate the correlation between firm-level heterogeneous productivity, international outsourcing and trade in intermediate inputs. They propose a theoretical model that combines the intraindustry heterogeneity of Melitz (2003) in which firms differ in productivity within sectors, with incomplete contracting[20]. In this model there are two countries[21], North and South, in which only the firms localized in the North know how to produce final-good varieties. Intermediate inputs can be produced in the North or in the low-wage South. Final-good producers can adopt four organizational forms to obtain intermediate inputs: (i) produce these inputs in the North by themselves; (ii) produce inputs in the South, engage in FDI and export input in the North (intrafirm trade); (iii) buy intermediate input from other firms based in the North; (iv) import intermediate input from firms based in the South. The relationship between final-good producers and suppliers of intermediate input is governed by imperfect contracts. Moreover, there are trading costs. Antràs and Helpman (2004) present a wide range of results to argue that the organizational form of the firms based in the North and, therefore, the pattern of international trade depends on the wage differential between the North and the South, on transport costs, on the level of contract

[20] With this contribution, the "new new trade theory" crosses the field of contract theory and especially the theory of incomplete contracts with seminal contributions by Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995).

[21] This simplified two-country framework presented by Antràs and Helpman (2004) has featured prominently in the literature, but can be extended to a multi-country environment (see Antràs, 2015).

enforcement and on their productivity level in terms of technology. The important role of contractual aspects in addition to firm productivity differences in shaping the pattern of international trade and influencing the disintegration or production seems to be the main element provided by Antràs and Helpman (2004) forming a conceptual framework of the linkages between specialization and international fragmentation of production.

Although the pioneer models with heterogeneous firms do not explicitly address the issue of specialization, it seems clear that their contribution cannot be ignored when considering international fragmentation of production. Moreover, these theories of heterogeneous firms and trade have then been considerably expanded in a number of directions in order to investigate other empirical facts[22] and challenge traditional models of international trade. Therefore, nowadays, the international trade field considers not only countries and industries as something to be studied, but also firms and products.

1.4.5 Specialization and international fragmentation of production: elements for a conceptual framework.

This overview has selected the main contributions by the most recent literature on international trade that help to identify a *fil rouge* that links specialization and international fragmentation of production, covering the frontiers of current knowledge on both issues. This aims to be a first effort to create a conceptual framework that underlines the role of specialization and comparative advantages in a world that is characterized by international fragmentation of production and heterogeneous firms.

First, the Ricardian framework has experienced a revival in international trade theory thanks to the quantitative trade model proposed by Eaton and Kortum (2002). Although Deardorff (2005a) has confirmed from a theoretical point of view that, although in a world with a number of countries and goods in which comparative advantage is less informative, it could maintain a role in determining the pattern of trade and specialization, Costinot and Donaldson (2012) have provided the first piece of empirical evidence.

Second, the increasing trade in intermediate inputs has challenged the concept of comparative advantage and specialization. Indeed, a number of studies (Baldone et al., 2007; Grossman and Rossi-Hansberg, 2008) consider this kind of trade as trade in stages of production

[22] In particular, Melitz and Ottaviano (2008) insert competition effects, offering relevant, clear evidence that firms rather than countries trade with each other, just to mention another pillar of this fruitful line of research.

or trade in tasks, modifying the wisdom of the specialization from a concept related to the production and export of a good to a concept that focuses on the implementation of stages of production.

Third, the literature has deeply investigated the determinants of the pattern of trade, showing that in a world with fragmentation of production, absolute advantage becomes increasingly relevant (Baldone et al., 2007; Eaton and Kortum, 2002). Moreover, geography (Eaton and Kortum, 2002) and several institutional characteristics (Chor, 2010; Costinot, 2009) compete with technology in determining specialization at country or industry level.

Finally, a new line of research has shifted the focus from country and industry to firms, emphasizing the role of within-sector firm productivity differences (Helpman et al., 2004) and incomplete contracting (Antràs and Helpman, 2004) in shaping the pattern of international trade and the international organization of production.

All these contributions are key elements that should be accounted for when analysing specialization in a world of international fragmentation of production and heterogeneous firms. Taken together, these elements seem to give form to a "galaxy" in evolution rather than a framework with a sharp outline. The Ricardian framework is at the centre of this "galaxy", where the pioneering contributions analysed in this section shed light on relevant empirical facts regarding the current production paradigm and start new lines of research. The extensions of the Eaton and Kortum (2002) model as well as the "new new trade theory" are the main examples. Moreover, these contributions represent poles of attraction for other areas of economic theory which intersect the orbit of the studies on specialization and trade and lead to an original combination of different fields of study. One example is the theory of incomplete contracts which joins the "new new trade theory" starting with Antràs and Helpman (2004).

This perception appears in line with Hanson (2012) who argues that "available theories of trade are capable of explaining specific features of global trade […] but they do not yet appear capable of explaining the rich tableaux of trade patterns that we observe […] in the world economy". However, it should bear in mind that - as stated by Deardorff (2005a) regarding comparative advantages - a single model "can hardly be expected to explain every aspect of something as widespread and complicated as trade". In this context, the tentative effort to synthesize all the main elements in a unified framework seems to move toward the notion of "kaleidoscope comparative advantage" evoked by Bhagwati and Dehejia (1994). Indeed, in the current production paradigm, a number of factors determine trade specialization and small shifts in one of these determinants could cause comparative advantage to shift suddenly from one country, industry or sector to another, hence making comparative advantage and specialization extremely dynamic concepts.

1.5 Conclusions

Starting in the 19th century with the Ricardian principle of comparative advantage based on technology differences across countries, during the 20th century, the international trade theory turned first to differences in factor endowments and then to increasing returns to scale as explanations for specialization and gains from trade. However, in the last two decades, this theory has seen a resurgence in studies on comparative advantage and determinants of patterns of specialization and trade, in order to explain the principle of comparative advantage in a world with international fragmentation of production and increasing trade in intermediate goods. Several lines of research have returned to the assumption that countries gain from trade because they have access to different technologies which could be available to producers in a country, as in the Ricardian model, or exclusive to individual firms.

Taken together, all these contributions seem to bring Ricardo's theory of comparative advantage back to the centre of a "galaxy" in evolution where each strand of research can explain specific features of global trade and a tentative effort to synthesize all the main elements in a unified framework seems to move toward an extremely dynamic notion of comparative advantage and specialization. Indeed, a number of factors can determine trade specialization and small shifts in one of these determinants could cause comparative advantage to shift suddenly from one country, industry or sector to another. At present, international trade theory seems to offer several fascinating directions in which to improve our knowledge of specialization and international fragmentation of production.

References

Anderson J. E. (1979), A theoretical foundation for the gravity equation, The American Economic Review, Vol. 69, No. 1, pp. 106-116.

Antràs P. (2015), Global Production: Firms, Contracts, and Trade Structure, Princeton University Press.

Antràs P. and Helpman E. (2004), Global sourcing, Journal of Political Economy, Vol. 112, No. 3, pp. 552-580.

Antràs P. and Yeaple S.R. (2013), Multinational firms and the structure of international trade, NBER Working Paper, No. 18775.

Arrighetti A. and Ninni A. (ed.) (2014), La trasformazione 'silenziosa'. Cambiamento strutturale e strategie d'impresa nell'industria italiana, Dipartimento di Economia, Università di Parma.

Aw B.Y., Chung S. and Roberts M. (2000), Productivity and Turnover in the Export Market: Micro Evidence from Taiwan and South Korea, World Bank Economic Review, Vol. 14, No. 1, pp. 65–90.

Balassa B. (1966), Tariff reductions and trade in manufacturers among the industrial countries, American Economic Review, Vol. 56, No. 3, pp. 466-473.

Baldone S., Sdogati F. and Tajoli L. (2007), On Some Effects of International Fragmentation of Production on Comparative Advantages, Trade Flows and the Income of Countries, World Economy, Vol. 30, pp. 1726–1769.

Baldwin R. (2011), Trade and industrialisation after globalisation's 2nd unbundling: How building and joining a supply chain are different and why it matters, NBER Working Paper, n. 17716.

Baldwin R. and Martin P. (1999), Two waves of globalization: superficial similarities, fundamental differences, NBER Working Paper, No. 6904.

Bartelsman E., Haltiwanger J. and Scarpetta S. (2009), Measuring and analyzing cross-country differences in firm dynamics, in Producer dynamics: New evidence from micro data, University of Chicago Press, pp. 15-76.

Bernard A. B., Eaton J., Jensen J. B. and Kortum S. (2003), Plants and productivity in international trade, American Economic Review, Vol. 93, No. 4, pp. 1268-1290.

Bernard A.B., Jensen J.B. and Lawrence R.Z. (1995), Exporters, jobs, and wages in US manufacturing: 1976-1987, Brookings papers on economic activity. Microeconomics, pp. 67-119.

Bernard A.B. and Jensen J.B. (1999), Exceptional exporter performance: cause, effect, or both?, Journal of international economics, Vol. 47, No. 1, pp. 1-25.

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

Bernard A.B., Jensen J.B., Redding S.J. and Schott P.K. (2009), The margins of US trade, American Economic Review, Vol. 99, No. 2, pp. 487-493.

Bhagwati J. and Dehejia V. (1994), International trade theory and wages of the unskilled, in Bhagwati J. and Kosters M. (ed.), Trade and wages: Leveling wages down, American Enterprise Institute, Washington, pp. 36-75.

Burstein A. and Vogel J. (2010), International Trade Patterns, the Skill Premium, and Heterogeneous Firms, in Society for Economic Dynamics, Meeting Papers No. 1247.

Chor D. (2010), Unpacking sources of comparative advantage: A quantitative approach, Journal of International Economics, Vol. 82, No. 2, pp. 152-167.

Clerides S.K., Lach S. and Tybout J. R. (1998), Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco, Quarterly Journal of Economics, Vol. 113, No. 3, pp. 903-947.

Costinot A. (2009), On the origins of comparative advantage, Journal of International Economics, Vol. 77, No. 2, pp. 255-264.

Costinot A. and Donaldson D. (2012), Ricardo's theory of comparative advantage: old idea, new evidence, American Economic Review, Vol. 102, No. 3, pp. 453-458.

Costinot A. and Rodriguez-Clare A. (2014), Trade theory with numbers, in Gopinath G., Helpman E. and Rogoff K.(ed.), Handbook of International Economics, Amsterdam: Elsevier, Vol. 4., pp. 197-261

Cuñat A. and Melitz M.J. (2012), Volatility, labor market flexibility, and the pattern of comparative advantage, Journal of the European Economic Association, Vol. 10, No. 2, pp. 225-254.

Deardorff A.V. (1979), Weak Links in the Chain of Comparative Advantage, Journal of International Economics, Vol. 9, pp. 197-209.

Deardorff A.V. (1980), The general validity of the law of comparative advantage, The Journal of Political Economy, pp. 941-957.

Deardorff, A.V. (2005a), How robust is comparative advantage?, Review of International Economics, Vol. 13, No. 5, pp. 1004-1016.

Deardorff A. V. (2005b), Ricardian comparative advantage with intermediate inputs, The North American Journal of Economics and Finance, Vol. 16, No. 1, pp. 11-34.

Dixit A.K. and Stiglitz J.E. (1977), Monopolistic competition and optimum product diversity, The American Economic Review, Vol. 67, No. 3, pp. 297-308.

Dornbusch R., Fischer S. and Samuelson P. (1977), Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods, American Economic Review 67, pp. 823-839.

Eaton J. and Kortum S. (2002), Technology, geography, and trade, Econometrica, Vol. 70, No. 5, pp. 1741-1779.

Eaton J. and Kortum S. (2012), Putting Ricardo to work, Journal of Economic Perspectives, Vol. 26, No. 2, pp. 65-89.

Feenstra R.C. (1998), Integration of trade and disintegration of production in the global economy, The journal of economic perspectives, Vol. 12, No. 4, pp. 31-50.

Fieler A.C. (2011), Nonhomotheticity and bilateral trade: Evidence and a quantitative explanation, Econometrica, Vol. 79, No. 4, pp. 1069-1101.

Gehrke C. (2015), Ricardo's discovery of comparative advantage revisited: a critique of Ruffin's account, European journal of the history of economic thought, Vol. 22, No. 5, pp. 791-817.

Grossman S. J. and Hart O. D. (1986), The costs and benefits of ownership: A theory of vertical and lateral integration, Journal of Political Economy, pp. 691-719.

Grossman G.M. and Rossi-Hansberg E. (2008), Trading Tasks: A Simple Theory of Offshoring, American Economic Review, Vol. 98, No. 5, pp. 1978-97.

Grubel H. G. and Lloyd P.J. (1975), Intra-industry trade: the theory and measurement of international trade in differentiated products, Macmillan London

Hanson G.H. (2012), The rise of middle kingdoms: Emerging economies in global trade, Journal of Economic Perspectives, Vol. 26, No. 2, pp. 41-63.

Haberler G. (1930), The Theory of Comparative Cost and Its Use in the Defense of Free Trade, originally published in German in WeltwirtschaftlichesArchiv, Vol. 32, pp. 349-370; translated and reprinted in Koo, Anthony Y.C. (ed.) (1985), Selected Essays of Gottfried Haberler, MIT Press, pp. 3-19.

Hart S.L. (1995), A natural-resource-based view of the firm, Academy of management review, Vol. 20, No. 4, pp. 986-1014.

Hart O. and Moore J. (1990), Property Rights and the Nature of the Firm, Journal of political economy, pp. 1119-1158.

Heckscher E. F. (1919), The effect of foreign trade on the distribution of national income, EkonomiskTidskrift, Vol. 21, pp. 497-512

Helpman E. and Krugman P.R. (1985), Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy, MIT press.

Helpman E., Melitz M.J. and Yeaple S.R. (2004), Export versus FDI with heterogeneous firms, American Economic Review, Vol. 94, No. 1, pp. 300-316.

Hsieh C. and Klenow P. (2009), Misallocation and Manufacturing TFP in China and Indiap, NBER Working Paper No. 13290.

Jones R.W. (1961), Comparative Advantage and the Theory of Tariffs: A Multi-Country, Multi-Commodity Model, Review of Economic Studies, Vol. 28, pp. 161-175.

Jones R.W. and Kierzkowski H. (1990), The Role of Services in Production and International Trade: A Theoretical Framework, in, in Jones R.W. and Krueger A. (ed.), The Political Economy of International Trade, Oxford: Blackwells.

Krugman P.R. (1979), Increasing returns, monopolistic competition, and international trade, Journal of international Economics, Vol. 9, No. 4, pp. 469-479.

Krugman P.R. (1980). Scale economies, product differentiation, and the pattern of trade. The American Economic Review, 70(5), 950-959.

Leamer E. and Levinsohn J. (1995), International trade theory: The evidence, in Handbook of International Economics, Vol. 3, pp. 1339-1394.

Leontief W. (1953), Studies in the Structure of the American Economy, Oxford University Press, New York.

Levchenko A.A. (2007), Institutional quality and international trade, Review of Economic Studies, Vol. 74, No. 3, pp. 791-819.

Manova K. (2008), Credit constraints, equity market liberalizations and international trade, Journal of International Economics, Vol. 76, No. 1, pp. 33-47.

McKenzie L. W. (1953), Specialization and efficiency in world production, Review of Economic Studies, Vol. 21, No. 3, pp. 165-180.

Mayer T. and Ottaviano G.I. (2008), The happy few: the internationalization of European firms, Intereconomics, Vol. 43, No. 3, pp. 135-148.

Melitz M.J. (2003), The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, Econometrica, Vol. 71, No. 6, pp. 1695–1725.

Melitz M.J. and Redding S.J. (2014), Heterogeneous Firms and Trade, in Handbook of International Economics, 4th ed., Vol. 4, pp. 1-54.

Mill J. S. (1844), Of the Laws of Interchange between Nations; and the Distribution of the Gains of Commerce among the Countries of the Commercial World, in J. M. Robson (ed.), Collected Works of John Stuart Mill, Vol. 4, pp. 232-61.

Morrow P.M. (2008), East is East and West is West: A Ricardian-Heckscher-Ohlin model of comparative advantage, University of Toronto mimeo.

Nocke V. and Yeaple S.R. (2007), Cross-border mergers and acquisitions vs. greenfield foreign direct investment: The role of firm heterogeneity, Journal of International Economics, Vol. 72, No. 2, pp. 336-365.

Ohlin B. (1933), International and interregional trade, Harvard University Press.

Ricardo D. (1817), On the principles of economics, and taxation, in Sraffa P. and Dobb M.H. (1951), The Works and Correspondence of David Ricardo, Cambridge University Press.

Rybczynski T. M. (1955), Factor Endowments and Relative Commodity Prices, Economica, Vol. 22, pp. 336-341.

Ruffin R. (2002), David Ricardo's Discovery of Comparative Advantage, History of Political Economy, Vol. 34, pp. 727-48.

Smith A. (1776), An Inquiry into the Nature and Causes of the Wealth of Nations, W. Strahan and T. Cadell, London

Sanyal K.K. and Jones R.W. (1982), The Theory of Trade in Middle Products, American Economic Review, Vol. 72, No. 1, pp. 16-31.

Schott P. K. (2003), One size fits all? Heckscher-Ohlin specialization in global production, The American Economic Review, Vol. 93, No. 3, pp. 686-708.

Shikher S. (2011), Capital, technology, and specialization in the neoclassical model, Journal of international Economics, Vol. 83, No. 2, pp. 229-242.

Stolper W.F. and Samuelson P.A. (1941), Protection and real wages, Review of Economic Studies, Vol. 9, No. 1, pp. 58-73.

Tinbergen J. (1962), Shaping the World Economy, Twentieth Century Fund, New York.

Wagner J. (2007), Exports and Productivity: A Survey of the Evidence from Firm-level Data, World Economy, Vol. 30, pp. 60–82

2. Trade specialization, international supply and production networks using value added trade data. The case of manufacturing in Italy.

Abstract

The most recent contributions of the literature on international fragmentation of production using trade in value added have greatly improved our understanding of the current manufacturing production paradigm. This essay analyses the evolution of both trade specialization and international supply and production networks of some selected countries in manufacturing sectors, taking full advantage of the informative potential of the recent Word Input-Output Database (WIOD) and combining different methodologies (Koopman et al., 2014; Wang et al., 2013) to look at these issues "through the lenses of value added". More specifically, the essay focuses on Italy and other relevant trading partners and offers a comprehensive analysis of: (i) comparative advantages and export structure in value added terms; (ii) main suppliers of foreign value added in exported goods of two important industries with different technological characteristics (*Leather, leather products and footwear* and *Machinery*); (iii) bilateral links shaping the organization of production in these sectors.

JEL Classification: F15, L23, L60

Keywords: trade in value added, comparative advantage, supply and production networks

2.1 Introduction

International production sharing has always been part of international trade since countries import goods used as inputs in the production of their exported goods. However, as extensively documented in the literature (see, among others, Feenstra, 1998; Baldwin 2006), starting from the 1980s, production processes have been progressively fragmented[23]and reorganized in plants located in different countries, each one specialized in a specific production stage and contributing with its own value added share to the production of final goods. This value added equals the value paid to the domestic factors of production and is embedded in the cost of the next stage of production (Koopman et al., 2014). Several multi-country and inter-industry networks of supply and production arise because of this phenomenon, shaping the current production paradigm. Each national industry can participate in these international production systems both as a user of foreign inputs and as a supplier of intermediate goods and services used in the other countries' production.

These networks, sometimes named Global Value Chains (GVC)[24], led to a sustained expansion of trade in intermediate goods due to parts and components that cross international borders many times at different stages of production. Moreover, in the late 20th and early 21st centuries, manufacturing has become more globalized as it has expanded its production networks in emerging economies which have assumed the role of important partners in the production of intermediate inputs or in the assembly of final goods (Hanson, 2012; Koopman et al., 2012). These phenomena are the main driver underlying the high growth rate of international trade and an important feature of the deepening productive integration and interdependence of the world economy over the last decades (Arndt and Kierzkowski, 2001).

[23] This reorganization of production processes on a global scale has been named "international fragmentation of production" by Jones and Kierzkowski (1990). Since then, the economic literature has elaborated many other terminologies to describe specific aspects of the current production paradigm, e.g. offshoring (Grossman and Rossi-Hansberg, 2008), global production sharing (Yeats, 1998; Feenstra, 1998), slicing the value chain (Krugman, 1996).

[24] In this essay, I prefer to use "network" rather than "chain", because in recent years the production of complex goods often relies on components made in a number of countries, connected through a web of production linkages (Spencer, 2005; Nunn, 2007) which are not necessarily sequential like a chain. These networks can assume different shapes. Baldwin and Venables (2013) have introduced the concepts of "spiders" (production processes where multiple parts and components are assembled in no particular order) and "snakes" (processes whose sequencing is dictated by engineering and where goods move in a sequential way from upstream to downstream stages with value being added along the way). Most international production processes are an intricate mixture of the two.

For all these reasons, the value of a country's exports increasingly differs from the share of GDP (or value added)[25] related to the production of goods shipped to the foreign markets since the manufacturing processes involve extensive flows of intermediate inputs supplied by other countries, i.e. value added from abroad. In addition, due to the increasingly large share of intermediate goods that cross international borders more than once, traditional trade statistics, which record the gross value of goods at each border-crossing rather than the (net) value added between border-crossings, include a relevant number of double counting of the value of these intermediate inputs.

Accordingly, on the one hand, conventional gross trade data overstate the domestic contribution to exports and may lead to a misrepresentation of the specialization of countries. Indeed, trade specialization is typically assessed on the basis of indicators and econometric techniques measuring comparative advantages by using international trade data, starting from the widely known index of Revealed Comparative Advantage (RCA) by Balassa (1965)[26]. On the other hand, gross trade data are not able to represent the role of each country in international supply and production networks adequately because these data give information on the amount of trade flows that cross borders but not on their composition in terms of domestic and foreign contribution.

The empirical trade literature suggests different data sources and methods to quantify more appropriately the effects of the international fragmentation of production on the organization of production, trade flows and international specialization. Recently, several scholars have implemented different projects to compile new datasets[27], typically merging input-output tables with the System of National Accounts and international trade statistics, in order to estimate the value added in trade by tracing the value added embedded in goods back to its country of origin.

This essay focuses specifically on manufacturing. This choice is based on a number of different reasons. First, international trade largely relates to physical goods (merchandise trade); trade in services, although growing, accounts for a much lower share. In 1995, the value of world merchandise trade was around US$ 5.2 trillion against US$ 1.25 trillion in world

[25] A country's value added is made up of rewards of its production factors like labor and capital. It has long been recognized that trade and GDP are not directly comparable, because trade is note measured in terms of value added. See Irwin (1996), Feenstra (1998) and Johnson (2014) among others.

[26] The Balassa RCA index uses gross exports data as a proxy for the domestic value added in terms of national production factors contained in the exported goods.

[27] Among these initiatives: the Global Trade Analysis Project (GTAP); the Asian International Input–Output Tables constructed by Institute of Developing Economies–Japan External Trade Organization (IDE-JETRO); the TiVA database by OECD–WTO and the World Input–Output Database (WIOD). See Appendix B for a review.

commercial service exports. In 2011, merchandise trade advanced to US$ 18.46 trillion, whereas the exports of commercial services reached US$ 4.41 trillion (World Bank Open Data). Moreover, manufacturing represents the majority of merchandise trade: in 1995, it accounted for about 73.9% of world merchandise trade and in 2011, for about 66.2% (World Bank Open Data). Second, international fragmentation of production mainly concerns goods rather than services, although services are increasingly integrated in manufacturing. Indeed, the fragmentation of production requires more services: separate stages of production in several plants in different countries is not without cost. Stages need to be coordinated which involves incurring the costs of transportation, communication, insurance and other related service links. Third, long European stagnation has fuelled renewed debate about the importance of a strong European industrial base to sustain and strengthen recovery and foster competitiveness. In particular, the European Commission (2014) has underlined that «the economic importance of industrial activities is much greater than suggested by the share of manufacturing in GDP. Industry accounts for over 80% of Europe's exports and 80% of private research and innovation. Nearly one in four private sector jobs is in industry, often highly skilled, while each additional job in manufacturing creates 0.5-2 jobs in other sectors». Raising the contribution of industry to GDP to as much as 20% by 2020 has become one of the priorities for the Commission. Designing the appropriate policy measures to achieve this goal requires a full understanding of the characteristics of the current manufacturing production paradigm in terms of organization of international supply chains and production networks.

Following a survey of the more relevant empirical measures used to detect international fragmentation of production (Section 2.2.2) and a description of the methodologies used to disentangle gross export in value added components (Section 2.2.3), this work provides a comprehensive analysis of the evolution of both trade specialization and international supply and production networks of some selected countries, by looking at trade in value added. For this purpose, I use the World Input Output Database (WIOD - 2013 release)[28] and apply the accounting frameworks developed by Koopman, Wang and Wei (2014) and Wang, Wei and

[28] The 2013 release of the World Input Output Database provides global input-output tables for 40 countries and 35 sectors of activity (2-digit, according to the ISIC nomenclature rev.3), including 14 manufacturing sectors, for the years 1995-2011. See Section 2.3.2 and Appendix C for full lists of countries and sectors. For a complete description of the database and its construction, see Timmer (ed., 2012). In November 2016, a new version of the dataset has been made available which covers more countries (43) and sectors (58) for the period 2000-2014, but due to different construction criteria, this 2016 release is not directly comparable with the previous one. For the main methodological changes in the WIOD 2016 release, see Timmer et al. (2016)

Zhu (2013) to decompose gross exports into value added components at national, bilateral and sectoral level.

Focusing on Italy, this essay makes five main contributions[29]. First, it contributes, from the value added perspective, to the long-standing debate on the "anomaly" of the Italian comparative advantages in the manufacturing industry that has been revived since the recession period which started in 2008. Indeed, the economic downturn has seen a strong, persistent fall in domestic demand, whereas export-oriented enterprises have benefited from a more dynamic foreign demand, especially from extra EU markets. Most of the literature (Faini and Sapir, 2005; De Benedictis, Gallegati and Tamberi, 2009; Amighini, Leone and Rabellotti, 2011) considers the composition of Italian exports an "anomaly" among major industrial countries since the qualitative distribution of its comparative advantages appears mainly concentrated in the "traditional" sectors (such as leather and footwear, textiles and textile products), with a high level of persistence. Nevertheless, some papers have pointed out that some changes have occurred over time in the distribution of the Italian comparative advantages, with an increasing specialization in machinery and with several sectors that were comparatively disadvantaged in the mid '80s showing a comparative advantage at the end of the '90s (De Benedictis, 2005). This essay fits into this debate by investigating the dynamics of Italy's trade pattern in the period 1995-2011[30] with value added data (Section 2.4.1). Specifically, the index of Revealed Symmetric Comparative Advantage (RSCA) as proposed by Dalum, Laursen and Villumsen (1998) is calculated both in gross value and in value added for the Italian manufacturing sectors. In this way, it is possible to detect if long-term trends in Italian comparative advantages diverge significantly when trade is measured in terms of domestic value added in exports (according to the definition by Koopman et al., 2014) instead of gross exports, both in levels and in dynamics, underlining specific characteristics of each sector as regards the fragmentation of production. To the best of my knowledge, this is the first work to provide this kind of descriptive analysis for Italy using the accounting framework proposed by Koopman, Wang and Wei (2014)[31]. Second, in Section 2.4.2, I calculate the same indicator for all the countries in the WIOD database in order to compare the international position of Italy in terms of trade specialization with that of its main "competitors" and identify whether changes occur moving from gross

[29] This analysis can be replicated and applied to the study of any other country or region.
[30] This time span is due to the WIOD database - 2013 release.
[31] Borin and Mancini (2017) present a critical review of the methods used to decompose gross exports proposed both by Koopman et al. (2014) and Wang et al. (2013) and prefer to use basic accounting relations to compute RCA for Italy in value added terms. Although they use the WIOD 2016 release, their analysis is limited to one year (2014).

statistics to value added trade data. Third, Section 2.4.3 provides a decomposition of sectoral exports for Italy and other main exporter countries in order to highlight differences and changes in the structure of each country's value added exports, especially with regard to domestic and foreign components, and define each country's role in international supply and production networks and some characteristics of its organization of export production. Section 2.4.4 identifies the main foreign suppliers of intermediate goods both of Italy and other leading exporters to capture changes in the geographical origin of imported inputs and convey additional information about the organization of their international supply networks. Finally, Section 2.4.5 analyses the bilateral links between Italy and its main foreign markets at industry level in order to detect productive linkages that underlie export flows.

Overall, by combining different methodologies and different levels of disaggregation of gross exports, this essay shows how trade specializations and the structure and evolution of supply and production networks can be better understood by bringing to light the increasing importance of international fragmentation of production and the growing role of some emerging countries as both "competitors" and "partners".

2.2 Measuring fragmentation and trade in value added: a review of the literature

In the last decades, manufacturing production has become the outcome of complex linkages established between different sectors and countries over time, which reflect complex flows of value added sources and destinations. Due to this fragmentation of production on a global scale, the production processes increasingly combine both domestic and foreign value added. Moreover, the domestic value added included in exports may be consumed by the importer country or be integrated in other products shipped to other foreign markets. In addition, moving along the production network, part of the value added can even return to the domestic economy. In this framework, trade in value added emerges as a novel, relevant topic of research in international economics that seeks to allocate the value added in gross trade flows to its country and sector of origin and destination and to separate pure double counting from value added components.

The simple production-consumption-trade scheme in Figure 2.1 is useful for illustrating the difference between gross and value added exports. Country A exports to country B an intermediate good worth €100 that embodies only country A's domestic value added. Country B adds €40 of value added to produce a more sophisticated intermediate good that is exported to country A for €140. Country A assembles the refined intermediate good, together with €30 of domestic value added, into a final product that is exported to country C. The gross exports recorded by country A is €270 (€100 + €170), whereas its domestic value added in exports is only €130 (€100 + €30). Indeed, the country A's gross exports embody foreign value added for €40 (from country B). The difference between gross exports and the sum of value added from country A and country B is double-counted in trade statistics. In this example, it is exactly the value of the first intermediate good (€100) which has been exported twice by country A (the first to country B and the second to country C as embedded in the final product). It is evident that value added exports is a net concept since it is the difference between gross exports and the sum of foreign value added and double counting.

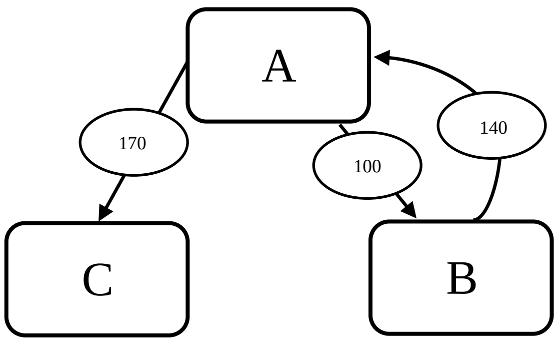


Figure 2.1 Value added and double counting in bilateral trade flows

Disentangling the simple supply and production network in Figure 2.1 is not possible using conventional trade statistics which record the gross value of goods at each border crossing rather than the net value added. In order to overcome this shortcoming, the empirical literature has produced a wide range of tools to measure trade in value added[32] and detect several aspects of the multi-country production networks.

[32] Stehrer (2012) proposes to clearly differentiate the concept of "trade in value added" from the concept of "value added in trade". The former should be measured by considering only the flows of final goods and accounts for the value added of one country directly and indirectly contained in final consumption of other countries. Exports in value added of country A to all other countries include value added created in country A to satisfy final demand in countries B and C. On the contrary, imports in value added of country A from all other countries should account for value added created in countries B and C to satisfy final demand of country A. The second concept - "value added in trade" - should consider both intermediate and final goods and calculates the net value added contained in total gross trade flows between countries. It is the difference between the domestic and foreign value added embodied in country A's exports in gross terms and the domestic and foreign value added embodied in country A's imports from B and C

2.2.1 From the case studies to the input-output tables

Starting from the mid '90s, case studies on a single specific product, like the Mattel Barbie doll (Tempest, 1996), the Apple iPod (Varian, 2007; Linden et al., 2009) and iPhone (Xing and Detert, 2010; Kraemer et al.2011), the Nokia N95 (Ali-Yrkkö, 2010) or on a single sector, such as the automotive (Baldwin, 2009) and aircraft industry (Grossman and Rossi-Hansberg, 2008) have enhanced our intuitive understanding of the fragmentation of production and have provided an effective representation of global supply and production networks. All these authors break down the selected good into its parts and components in order to show the path taken by each intermediate input through a complex network of industrial interactions that crosses international borders many times at different stages of production, revealing a discrepancy between gross and value added trade. Nevertheless, these case studies are based on detailed microdata at firm level and cannot be obtained for every traded good in the global market. In addition, following all the way through, this approach needs to perform the breakdown until any intermediate good is traced back to the raw materials required for its production. Therefore, this considerable range of studies has offered useful insights, but not results that can be spread and generalized to the entire world trade.

Providing a systematic evidence of the extent and distinctive features of the international fragmentation of production challenges the way statistics on trade are collected to go beyond traditional gross terms measures. Meanwhile, the empirical trade literature has suggested different methods of measuring trade more appropriately, making better use of the available data.

A first data source is customs statistics which record trade flows under special schemes of tariff reduction or exception. A relevant case is the so-called "processing trade"[33], which refers to intermediates flows led by the exemption from duty on imported inputs as long as they are used for further processing, assembly and ultimately re-exporting. In developing countries, this tariff policy is applied - together with other special incentives set up to attract foreign investors - to provide an impulse for national manufacturing development and exports growth[34],

[33] Processing trade can take on other names in some countries. An example is the duty drawback scheme which enables exporting companies to obtain a refund of the import fee paid for an intermediate good subsequently re-exported. More than 130 countries use some form of processing exports according to the World Trade Organization and a considerable part of the exports of many developing economies originate from processing zones (WTO and IDE JETRO, 2011)

[34] Baldwin (2011) discusses how, in the 20th century, industrialization meant building the whole supply chain within the country whereas, in the 21st century, nations could industrialize more easily by joining a supply chain and performing only intermediate stages of production by processing imported inputs for re-exporting.

since it encourages the formation of productive links between local firms and overseas companies looking to offshore production. The *US Offshore Assembly Programme* and the *EU Processing Trade dataset* record the domestic input content of imported goods that is the value of parts and components exported for processing abroad and then reimported. Examples of empirical studies using this kind of statistics are the works of Helg and Tajoli (2005), Baldone et al. (2007) and Egger end Egger (2005). There are three major limitations to this method: (i) it only captures the trade flows of processed inputs under the specific tariff scheme and not the whole trade in intermediate goods; (ii) it can be used only for a few countries that collect and make this data available; (iii) it becomes less and less relevant because of the decreasing use of this special scheme due to the general trend of tariff reduction.

A second methodology, proposed by Yeats (1998), is to measure fragmentation by comparing data on trade in intermediates with trade in final goods. Yeats (1998)adopts international trade data collecting according to the US Standard International Trade Classification (SITC) system and considers as intermediates all goods classified as “parts” and “components” in the product class of machinery and transport equipment (SITC 7)[35]. The results show that in 1995 trade of these “parts” and “components” (a subset of total trade in intermediate goods) arrived to accounts for more than 30% of total OECD countries exports. Expanding the geographical boundaries of the research, Athukorala and Yamashita (2008) observe that world trade in intermediate goods increased from 18.5% to 22% of the entire world merchandise exports between 1992 and 2003. A few years later, Miroudot et al. (2009) found that the share of parts and components on total manufacturing trade reached almost 60% in 2007. Although the most recent analyses are based on a larger quantity of available data with a wide coverage in terms of countries and time span, this approach remains strongly dependent on the product classification, that may be rather arbitrary as product definitions do not always allow a distinction to be made between intermediate and final use[36]. Moreover, other existing classifications indicate that the intermediate goods' share of total trade has been declining since 1970[37].

[35] Intermediate goods could be present in other classes, as pharmaceutical and chemical products (SITC 5), machine tools and various metal products (SITC 6), miscellaneous manufactured articles (SITC 8).

[36] Many goods may be both final and intermediate depending on the context. Take tyres for examples: a tyre sold to a consumer to replace a bad tyre is a final good, but tyres sold to an automotive company to put on new cars are intermediate goods. The final good (cars) includes the intermediate good (tyres).

[37] Using the United Nations Broad Economic Categories (BEC) classification scheme and excluding oil, Hummels et al. (2001) find that for the OECD countries both the intermediate goods' share of imports and of exports declined from about 1970 to 1992. Also using the OECD Input–Output Database (OECD, 1995) these authors observe a declining intermediate share of imports in this period.

Due to several limitations associated with these methods, trade economists began to use information from input-output tables together with traditional trade data to provide an adequate representation of supply and demand linkages among the economies. Input-output analysis has its origin in classical political economy and in the 20th century Leontief (1936)[38], who computed the first national input-output table (IOT), revived it. He demonstrated that the amount and type of intermediate inputs needed in the production of one unit of output can be estimated based on the input-output structure across countries and industries which traces the gross output in all stages of production that is needed to produce one unit of final goods. Hereafter, in many countries, the structure of the input–output table (see Appendix A) has been incorporated into the System of National Accounts and is used to calculate measures such as national GDP. Recently, by linking these tables to bilateral trade data, the empirical literature has suggested several possibilities for measuring trade in value added and accounting for a country's engagement in international production. A first wave of studies has introduced synthetic indicators to focus on a specific and narrower aspect of the international fragmentation of production (Hummels et al., 2001; Daudine et al., 2011; Johnson and Noguera, 2012).

2.2.2 Vertical specialization and value added indexes

Hummels et al. (2001) was a pioneering attempt at dealing with measurement issues related to the international fragmentation of production using input-output techniques. These authors provide empirical evidence of a single key aspect of production sharing: the increasing use of imported inputs in producing goods that are then exported. Hummels et al. (2001) call this phenomenon "vertical specialization"[39], following Balassa (1967) and Findlay (1978) who were the first to note and name it. To measure the imported input content of exports (or foreign value added embodied in exports), they propose a primary index of vertical specialization (VS) at sectoral level. This index is obtained by multiplying the share of imported inputs into sectoral gross output by the value of sectoral exports. The authors then carry out their analysis at country level using the VS share of total exports that is an export-weighted average of the VS at sectoral level. To empirically implement their measure, Hummels et al. (2001) use input-output tables from ten OECD countries and four emerging markets (Ireland, South Korea, Taiwan and

[38] As is known, Leontief's main concern was the empirical implementation of the classical view of the economy as a circular flow in economic systems characterized by a sophisticated division of labor and complex interrelationships in production.
[39] "Vertical specialization" or "vertical trade" will be pursued in a number of studies, becoming almost a synonym of fragmentation of production.

Mexico). They show that the VS share of merchandise exports account for 16.5% in 1970 and 21% in 1990 which equals a growth of almost 30% in the period for the selected area. Extrapolating the results to the rest of the world, they found that the ratio of VS to world exports was about 18% in 1970 and 23.6% in 1990. Hummels et al. (2001) interpret these outcomes as evidence of the increasing fragmentation of production at global level. Moreover, by overturning the perspective, the authors suggest that a country can be part of a vertical specialization chain also when its exports are used by partner countries as inputs in their own exports. They call this flow VS1 but are not able to implement this measure because of data constraints[40]. The main shortcoming in Hummels et al. (2001) derives from the data source (IOT): imported inputs are assumed to be 100% foreign sourced. This hypothesis is unlikely to hold in a world where more than one country exports intermediate goods and production is the result of a complex network of multi-country inter-industry relationships. Indeed, a country's intermediate exports could return home embedded in its imports of more sophisticated intermediate goods used to produce exported final goods. Since the imported inputs are assumed to be 100% foreign sourced, the VS share cannot provide an accurate picture of international fragmentation of production[41].

This issue can be addressed for the first time in a more comprehensive way thanks to the release of new datasets (see Appendix B) and new computing techniques which can be used to estimate trade in value added by exploiting the analytical advantages of the inter-country input output (ICIO) tables (see Appendix A for an introduction to the basic relationship between different matrices forming the ICIO tables). Indeed, these tables contain information on all bilateral flows of intermediate and final goods and services that shape the complex network of productive linkages between countries and sectors. However, although national input-output tables are produced by National Statistic Institutes typically according to international standards, these global input-output tables are not and different datasets adopt different assumption to harmonize IOT and bilateral trade statistics to get a world input-output table. In principle, these tables are used to obtain additional indicators to measure specific aspects of the international fragmentation of production. Two relevant examples of this field of studies are Daudin et al. (2011) and Johnson and Noguera (2012).

[40] VS can be computed from national input-output tables, using the intermediate matrix of the exporter country, whereas VS1 requires the matching of bilateral trade flow data to IOT.

[41] In estimating the VS share, Hummels et al. (2001) also made a second critical assumption. They suppose that the intensity in the use of imported inputs is the same for production for exports and production for domestic use. This hypothesis is violated in the presence of processing exports. To solve this problem, Koopman et al. (2012) modify input-output coefficients of countries where processing trade prevails over normal exports.

Daudin et al. (2011) analyse global value added trade flows using an estimated ICIO table based on GTAP database, focusing on the domestic value added used in partner exports that ultimately returns home embedded in final goods or in intermediate goods used as inputs for domestic final use. The authors call it VS1* because it is a subset of VS1 used by Hummels et al. (2001). Moreover, Daudin et al. (2011) propose to compute world value added trade as the difference between gross world exports and the sum of VS and VS1*. Beneath this global index, they provide the value added exports at industry level[42] and show that some sectors have value added exports that are higher than gross exports because their products are traded mainly as inputs in other goods (e.g. agricultural raw materials). This phenomenon is particularly relevant for the tertiary sectors (e.g. business services)[43]. On the contrary, industries with a significant share of VS or VS1* have a small value added trade compared with standard trade (e.g. manufacturing sectors).

Johnson and Noguera (2012) use the same data source (GTAP database) to implement an accounting framework and demonstrate how intermediate goods trade generates differences between gross and value added trade flows. They propose two measures of the value added content of trade. The value added exports is the amount of value added from a given source country that is embodied in the final consumption in each destination. The second indicator is called the VAX ratio and is the ratio of value added export to gross exports. They find that overall value added exports represent about 73% of world gross exports, but that this share varies substantially across countries and across bilateral trading partners as well. Moreover, the VAX ratio is higher in agriculture and services than in manufacturing, confirming the results by Daudin et al. (2011). Also according to Johnson and Noguera (2012), the reason for this cross-sector variation is that the manufacturing sectors make more use of inputs from non-manufacturing sectors and therefore their exports contain value added originated in those sectors.

Although these indicators offer empirical evidence of some interesting features of the international fragmentation of production, they only use part of the information contained in

[42] Value added exports is obtained by subtracting from the gross sectoral exports the sum of the value added from other domestic industries embedded in these exports, VS and VS1*, and then adding the value added in the exports of other domestic products.

[43] Daudin et al. (2011) also point out that services are much more dependent on external demand than is suggested by gross trade statistics which undervalue the vulnerability of service workers to international competition. Many studies (see Egger and Egger, 2001 and Helg and Tajoli, 2005, among others) have investigated the effects of international fragmentation of production on the labour markets, but this issue goes beyond the scope of this work.

the ICIO tables and do not provide a very comprehensive picture of international supply and production networks.

2.3 The decomposition of gross exports: methods and data

In order to measure trade in value added and simultaneously describe the complex network of the multi-country intra-industry relationships featuring the current production paradigm, a growing recent literature proposes to use a unified mathematical framework to completely disentangle gross exports into various components. Each component has its own economic interpretation and outlines a specific aspect of the international fragmentation of production. This approach takes full advantage of the rich information set that emerges from ICIO tables and bridges the gap between gross trade statistics and the System of National Accounts. This section reviews the decomposition methodologies used to implement the empirical analysis in Section 2.4 and presents the WIOD database.

2.3.1 Accounting frameworks to disentangle gross exports at country level

Koopman, Wang and Wei (2014)[44]are usually credited with having introduced the first rigorous decomposition of gross exports at country level. Their accounting framework disentangles gross aggregated exports into the sum of three basic components: domestic value added destined for direct importing partners or third countries (DVA), domestic value added in intermediate exports that returns home from abroad (RDV), and foreign value added embodied via imports of intermediate inputs in the country's gross exports (FVA). A second level breakdown splits these three basic components into nine more detailed sub-components depending on the use (final vs intermediate) of the exported goods and on the geographical origin (foreign vs domestic) of the final demand that activated them.

In order to briefly present the decomposition of gross exports developed by Koopman et al. (2014)[45], I focus on a source country *s* that produces and exports to G countries

[44] This paper refines the methodology introduced by the same authors in their famous 2011 NBER Working Paper (Koopman et al., 2011).
[45] The reader can consult Koopman et al. (2014) for the detailed algebraic derivation of their country level decomposition.

intermediate and final goods in N different sectors[46]. The country s's gross exports to the world are defined as:

$$E_{s*} = \sum_{r \neq s}^{G} E_{sr} = \sum_{r \neq s}^{G} (A_{sr} X_r + Y_{sr}) \tag{1}$$

where:

- E_{s*} is a column vector of dimension N x 1, which reports the exports by country s to its G partner countries in each sectors (N);
- E_{sr} is a column vector of dimension N x 1, which records the sectoral exports by country s to a single partner country r;
- A_{sr} is the input-output coefficient matrix of dimension N x N, which presents the coefficients for intermediate inputs produced and exported by country s and used in different production processes in country r;
- X_r is the column vector of dimension N x 1 that reports the gross output produced by country s in each sector; thus, by multiplying A_{sr} by X_r and summing up for all the partner countries $r \neq s$ we obtain country s's gross exports of intermediate goods;
- Y_{sr} is the column vector of dimension N x 1, which presents the final goods (and services) produced in country s and exported in country r; by summing up for all the partner countries $r \neq s$ we obtain country s's gross exports of final goods.

Koopman et al. (2014) demonstrate that the aggregate exports of country s to all G countries in all N sectors, i.e. a scalar obtained pre-multiplying E_{s*} by the unit vector u, can be decomposed into nine components. To perform this decomposition, we have to compute:

- V_s, the row vector or dimension GN x 1 of direct value added share in each unit of gross output produced by country s, that is equal to one minus the sum of the direct intermediate input share of all the domestic and foreign suppliers:

$$V_s = u \left(I - \sum_{r}^{G} A_{rs} \right) \tag{2}$$

- B_{sr} is the block Leontief inverse matrix of dimension N x N indicating how much of country s's gross output of each sector is required to produce one unit of country r's final production in the different sectors.

[46] Here I recall the main equations. For an introduction to the basic notation and algebra capturing the main relationships within an ICIO table, see Appendix A.

It is then possible to disentangle the gross aggregated exports into different components of domestic and foreign value added and two items of pure double counting, as follows:

$$\begin{aligned}
uE_{S*} = &\overset{\boxed{1}}{\left[V_s\sum_{r\neq s}^{G} B_{ss}Y_{sr}\right]} + \overset{\boxed{2}}{\left[V_s\sum_{r\neq s}^{G} B_{sr}Y_{rr}\right]} + \overset{\boxed{3}}{\left[V_s\sum_{r\neq s}^{G}\sum_{t\neq s,r}^{G} B_{sr}Y_{rt}\right]} \\
&+ \overset{\boxed{4}}{\left[V_s\sum_{r\neq s}^{G} B_{ss}Y_{rs}\right]} + \overset{\boxed{5}}{\left[V_s\sum_{r\neq s}^{G} B_{sr}A_{rs}\,(I-A_{ss})^{-1}Y_{ss}\right]} + \\
&+ \overset{\boxed{6}}{\left[V_s\sum_{r\neq s}^{G} B_{sr}A_{rs}\,(I-A_{ss})^{-1}E_{S*}\right]} + \overset{\boxed{7}}{\left[\sum_{t\neq s}^{G}\sum_{r\neq s}^{G} V_tB_{ts}Y_{sr}\right]} + \\
&+ \overset{\boxed{8}}{\left[\sum_{t\neq s}^{G}\sum_{r\neq s}^{G} V_tB_{ts}A_{sr}(I-A_{rr})^{-1}Y_{rr}\right]} + \\
&+ \overset{\boxed{9}}{\left[\sum_{t\neq s}^{G} V_tB_{ts}\sum_{r\neq s}^{G} A_{sr}(I-A_{rr})^{-1}\,E_{r*}\right]}
\end{aligned} \tag{3}$$

In order to have an initial insight of what each term in equation (3) measures, it is useful to look at Figure 2.2 since there is a perfect correspondence between the nine terms in square brackets in equation (3) and the nine boxes (1)-(9) in the figure. In particular, Figure 2.2 shows that DVA in exports absorbed abroad is the sum of the first three terms in equation (3): the country s's value added absorbed by the direct importer (country *r*) in the form of final (1) and intermediate (2) goods and the value country s's value added absorbed by a third country t, after some processing in r (3), i.e. country s's value added in intermediate goods exported indirectly to country *C*[47].

[47] Koopman et al. (2011) call this component "indirect value added exports". Together with "vertical specialization", this measure also became popular and has been widely used because it effectively approximates the participation of a country in international production networks and provides immediate intuition into how much a country participates in the international network through its exports. In particular, Koopman et al. (2011) propose two indices (GVC positions and GVC participation) whose main component is "indirect value added exports".

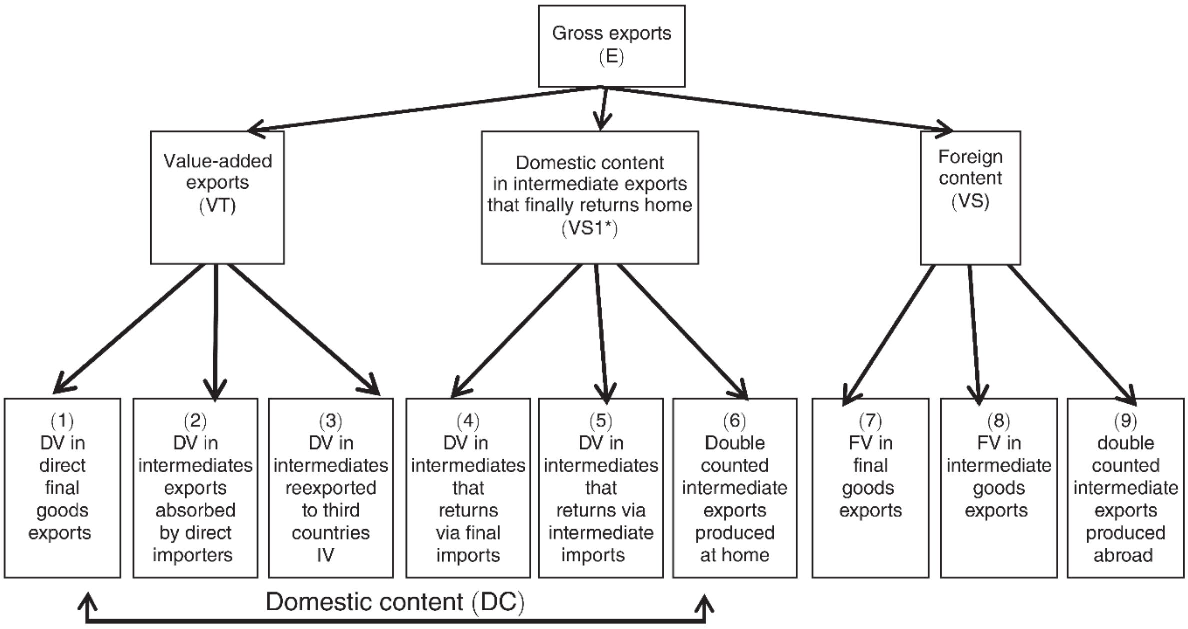


Figure 2.2 Accounting of gross exports by Koopman et al. (2014, p. 482)

The fourth and fifth terms in equation (3) form the second basic component - the RDV - which is the fraction of the domestic value added in exports of parts and components that is initially exported but ultimately returned home embedded in the imports of final (4) or intermediate (5) goods and consumed at home. Thus, in the end, it is the domestic demand that activates these exports. Finally, the FVA consists of the value added contained in intermediate inputs imported from abroad, exported by country *s* in the form of final (7) or intermediate (8) goods and is the sum of the seventh and eighth terms in equation (3) . In addition, these authors quantify for the first time different types of pure double-counted (PDC) items, which arise from intermediate goods that cross border multiple times, exploiting all the informative potential of the new datasets rather than simply excluding double counted items[48]. Indeed, when country *s*'s exports contain imported components, these intermediates are double counted in traditional statistics in gross value: the first time as an import, the second as embedded in its exports[49]. By decomposing gross exports, Koopman et al. (2014) attribute the imported inputs value to the foreign value added in final or intermediate good exports and separately register the double

[48] Due to the growing share of intermediates in international trade, double-counted items are an increasingly part of trade flows. Since information on international fragmentation of production that can be derived from traditional statistics is limited, eliminating the double counting items could lead to a relevant loss of data in a field where these are scarce. The identification of different types of PDC items is the undoubted merit of Koopman et al. (2014).

[49] As previously illustrated when describing Figure 2.1.

count component (9). The same applies to double counting in intermediate goods exports that return home (6). They also show that some previous measures of vertical specialization such as VS, VS1 and VS1* can be expressed as a linear combination of their different components[50]. What also makes this method innovative is that these three indices can be observed at the same time. Moreover, this gross exports decomposition framework also makes it possible to isolate domestic value-added in exports (or GDP in exports), which equals the sum of the first five terms in Figure 2.2 and describes the characteristics of a country's production of exported goods and services in terms of total domestic factor content in exports. It should be remembered that according to Koopman et al. (2014), the GDP in exports in sector *j* contains only the value added originated in that sectors, whereas the value added from other sectors is not included. Thus, the GDP in exports of sector *j* reflects the capacity of the national economy to produce and export domestic value added in sector *j*'s goods and services, both directly and indirectly, as sector *j* intermediates embedded in other sectors' exports[51].

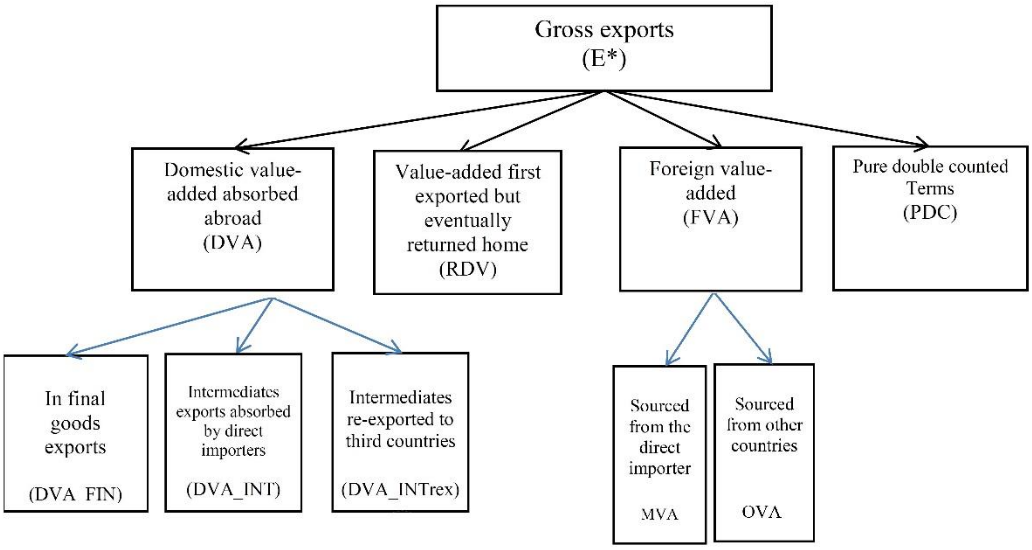
It should be noted that the gross trade decomposition as presented in Koopman et al. (2014) is only done at the aggregate level[52]. Although this approach improves our understanding of countries' trade relationships and the value added content of total exports, it provides no insight into the structure of single bilateral flows and production networks.

2.3.2 Accounting frameworks to disentangle gross exports at bilateral and bilateral sector level

A detailed decomposition of trade flows at the sector, bilateral or bilateral sector level is the subject of a work by Wang, Wei and Zhu (2013) which generalizes the framework by Koopman et al. (2014) and enhances our knowledge of the bilateral links between countries shaping the geography of the production networks as shown in Section 2.4. The methodology

[50] Koopman et al. (2014) specify that the sum of (7), (8) and (9) is equal to VS, whereas the components from (3) to (6) are part of VS1 and, similar to Daudin et al. (2011), (4) is labelled VS1*. Koopman et al. (2014) also show that VS1 is generally greater than indirect value added exports (3) and that their VS1* differs from the one by Daudin et al. (2011). Indeed, in Koopman et al. (2014), this index includes domestic content returned home as embodied in intermediate goods imports, rather than only domestic value added in final goods imports.
[51] Among the applications reported by Koopman et al. (2014) to illustrate the potential of their approach, these authors propose to use GDP in exports at sectoral level in order to calculate the value-added measure of Revealed Comparative Advantage. In Sections 2.4.1 and 2.4.2, this suggestion will be followed to implement an analysis of the trade specialization of Italy and other countries.
[52] Koopman et al. (2014) use the sector level decomposition for the calculation of domestic value added that is ultimately absorbed abroad in order to obtain the value-added measure of Revealed Comparative Advantage. However, they do not explicit the algebraic steps to compute the different components at sector level.

by Wang et al. (2013) decomposes gross trade flows at any level of disaggregation into four main components (Figure 2.3) since they separate the pure double-counted items from the main value added components, unlike Koopman et al. (2014). Each of the four major parts (DVA, RDV, FVA and PDC) is further disentangled into finer components[53].



<u>Figure 2.3</u> Bilateral Gross Exports Accounting adapted from Wang et al. (2013, pp. 23-24)

In order to briefly present the decomposition proposed by Wang et al. (2013), I focus on a source country *s* that produces and exports to G countries intermediate and final goods in N different sectors and refer to the main decomposition equation of country *s* bilateral exports to country *r*[54]:

[53] Wang et al. (2013) decompose gross exports into sixteen components. Figure 2.3 is an adaptation that takes account of the most significant components for this work.
[54] The reader can consult Wang et al. (2013) for the detailed algebraic derivation of their decomposition.

$$
\begin{aligned}
E_{sr} = {} & \overset{\boxed{1}}{(V_s B_{ss})' \# Y_{sr}} + \overset{\boxed{2}}{(V_s L_{ss})' \# (A_{sr} B_{rr} Y_{rr})} + \overset{\boxed{3}}{(V_s L_{ss})' \# \left(A_{sr} \sum_{t \neq s,r}^{G} B_{rt} Y_{tt} \right)} \\
& + \overset{\boxed{4}}{(V_s L_{ss})' \# \left(A_{sr}\, B_{rr} \sum_{t \neq s,r}^{G} Y_{rt} \right)} + \overset{\boxed{5}}{(V_s L_{ss})' \# \left(A_{sr} \sum_{t \neq s,r}^{G} B_{rt} Y_{tr} \right)} \\
& + \overset{\boxed{6}}{(V_s L_{ss})' \# (A_{sr} B_{rr} Y_{rs})} + \overset{\boxed{7}}{(V_s L_{ss})' \# \left(A_{sr} \sum_{t \neq s,r}^{G} B_{rt} Y_{ts} \right)} \\
& + \overset{\boxed{8}}{(V_s L_{ss})' \# (A_{sr} B_{rs} Y_{ss})} + \overset{\boxed{9}}{(V_s L_{ss})' \# \left[A_{sr}\, B_{rs} \left(Y_{sr} + \sum_{t \neq s,r}^{G} Y_{st} \right) \right]} \\
& + \overset{\boxed{10}}{[V_s\, (B_{ss} - L_{ss})] \# (A_{sr} X_r)} + \overset{\boxed{11}}{(V_r B_{rs})' \# Y_{sr}} + \overset{\boxed{12}}{(V_r B_{rs})' \# (A_{sr} L_{rr} Y_{rr})} \\
& + \overset{\boxed{13}}{(V_r B_{rs})' \# (A_{sr} L_{rr} E_{r*})} + \overset{\boxed{14}}{\left[\sum_{t \neq r,s}^{G} (V_t B_{ts})' \right] \# Y_{sr}} \\
& + \overset{\boxed{15}}{\left[\sum_{t \neq r,s}^{G} (V_t B_{ts})' \right] \# (A_{sr} L_{rr} Y_{rr})} \\
& + \overset{\boxed{16}}{\left[\sum_{t \neq r,s}^{G} (V_t B_{ts})' \right] \# (A_{sr} L_{rr} E_{r*})} \qquad (4)
\end{aligned}
$$

where L_{ss} is the N x N local Leontief inverse matrix that can be computed as:

$$
L_{ss} = (I - A_{ss})^{-1} \qquad (5)
$$

and # is the so-called element-wise matrix multiplication operation that can be used to multiply two matrices element by element[55].

The 16 terms in equation (4) can be defined as follow:

- term 1 is DVA in final goods exported by country *s* and absorbed by the bilateral importer (country *r*);

[55] In order to perform this operation, VB and VL matrices are transposed using, in the notation, the symbol ʹ .

- term 2 is DVA in intermediate goods exported by country *s* and absorbed by the country *r*, (DVA_INT in Figure 2.3);
- term 3 is DVA in intermediate goods exported by country *s* and re-exported by the direct importer to third countries (*t*) where they are used to produce final goods for the domestic market;
- term 4 is DVA in intermediate goods exported by country *s* and re-exported by the direct importer to third countries (*t*) where they are used to produce final goods for other foreign markets;
- term 5 is DVA in intermediate goods exported by country *s* and re-exported by the direct importer to third countries *(t*) where they are used to produce intermediate goods for other foreign markets;
- term 6 is DVA in intermediate goods exported by country *s* and re-exported by the direct importer to *s* that is ultimately absorbed at home as final goods imported from *r*;
- term 7 is DVA in intermediate goods exported by country *s* and re-imported as final goods from third countries *t*;
- term 8 is DVA in intermediate goods exported by country *s* and re-imported as intermediate goods;
- term 9 is PDC from domestic sources due to the production of final good exports by country *s*;
- term 10 is PDC from domestic sources due to the production of intermediate good exports by country *s*;
- term 11 is FVA sourced from the direct importer and included in intermediate goods used by country *s* to produce exported final goods;
- term 12 is FVA sourced from the direct importer and included in intermediate goods used by country *s* to produce exported intermediate goods;
- term 13 is PDC from foreign sources due to the production of final good exports by country *r*;
- term 14 is FVA sourced from third countries and included in intermediate goods used by country *s* to produce exported final goods;
- term 15 is FVA sourced from third countries and included in intermediate goods used by country *s* to produce exported intermediate goods;

- term 16 is PDC from foreign sources due to the production of final good exports by all third countries *t*.

In order to facilitate the exposition and the empirical analysis in Section 2.4, it is useful to merge these 16 terms in the most significant components presented in Figure 2.3 and introduce the acronyms used by Wang et al. (2013) which will be adopted in the next section:

- DVA_FIN is the acronym used for term 1 and DVA_INT for term 2;
- DVA_INTrex corresponds to the sum of terms 3,4 and 5;
- RDV corresponds to the sum of terms 6,7 and 8;
- PDC is the sum of terms 9,10,13 and 16;
- MVA is the sum of terms 11 and 12;
- OVA is the sum of terms 14 and 15.

Moving on to the economic interpretation of this decomposition framework, the principal point to note is the perspective from which these authors measure the DVA. Indeed, at sector level, domestic value added can be decomposed from both a producer's and a user's perspective. In the first case, DVA in sector *j* gross exports includes all the forward linkages across downstream countries/sectors to which sector *j* supplied intermediate inputs and measures the value added created by country s in the sector *j* and exported directly or indirectly, as embedded in other sectors' gross exports. Thus, when adopting this perspective the focus is on the sector of origin of the domestic value added. Conversely, according to the user's perspective, DVA in sector *j* gross exports summarizes all the backward linkages across upstream countries/sectors that are suppliers of intermediate inputs to sector *j* and can include value added from all home supplier sectors. In this case, the focus is on the export sector. These two approaches play different roles in economic analysis. The forward perspective is more consistent with the literature on factor content of trade because it focuses on domestic production factors employed in sector *j*, directly and indirectly exported[56]. The backward perspective is more suitable for observing the supply networks of specific sectors because the DVA in sector *j* gross exports synthesizes the production linkages within the home country and the contribution of all upstream domestic sectors to the production of sector *j*'s exports. In other words, it measures the full amount of the domestic factors that the national productive system embodies in those sectoral exports. In the decomposition proposed by Wang et al. (2013), both

[56] Koopman et al. (2014) adopt this approach to obtain the GDP in sectoral exports and compute Revealed Comparative Advantage in value added. I will follow this approach in Section 2.4.2.

DVA and RDV are based on backward linkages[57]. Moreover, as Cappariello and Felettigh (2015) explicitly observe, "in interpreting the results from the decomposition by Koopman et al (2014) one has to keep in mind that this strand of literature measures value added on a domestic rather than a national basis". Therefore, domestic value added in a country's exports provides information on "where" that value added has been produced but not on the nationality of the producers. A firm that off-shores its entire production and sales will not contribute to the home country's GDP. The same holds for the framework by Wang et al. (2013).

Having clarified these points, it is now useful to briefly present the economic interpretations of the more relevant components. At bilateral level, among the DVA components, it is possible to distinguish the domestic value added in intermediate goods re-exported by the direct importer to other foreign countries (DVA_INTrex, the so-called "indirect value added", the sum of terms 3, 4 and 5 in equation (4))[58]. It can be considered a proxy for the joint participation of the bilateral trade partners in a global production network since it contains the exporter's value added that passes through the direct importer for a (or some) stage(s) of production before reaching third countries in the form of intermediate or final goods. Thus, the direct importer is a node of a productive global network that also involves the exporter, which is in an upstream position compared with its importer. The FVA is decomposed into the share that comes from the direct importer (MVA, the sum of terms 11 and 12 in equation (4)) and those that originates from third countries (OVA, the sum of terms 14 and 15 in equation (4)). In particular, the MVA share can be interpreted as an indicator for the level of productive integration between two partner countries. Indeed, if country *s* is the exporter and country *r* is the direct importer, the MVA share captures the country *r*'s value added exported to the partner country *s* that returns in *r* in the form of final or intermediates goods. In other words, country *s* is both a supplier of goods and, in a previous stage, a processing hub for country *r*. These two components provide a clear intuition of the current complex network of supply and production. Finally, at bilateral level, the PDC share of country *s* in exports to *r* has a wider informative content than at country level. The higher the PDC share is, the higher the FVA share in the intermediate goods from *r* that are partially transformed by *s* and re-exported to *r* as intermediate goods where they are processed in final or intermediate goods for exports. That is

[57] Wang et al. (2013), p. 23, Figure 1a, Note

[58] As Borin and Mancini (2015) pointed out DVA_INTrex is domestic value added in intermediates re-exported by the direct importer and *ultimately* absorbed in other foreign countries. Indeed, DVA_FIN and DVA_INT could also contain a share of domestic value added exported by the direct importer to third countries for further processing stage but this DVA is then reimported and ultimately absorbed by the direct importer.

to say, country *r* exports intermediate goods to *s* with a relevant share of FVA. Then country *s* enters into the production network but only once (for one stage of production), whereas that network passes several times through country *r*, at different stages of production. Therefore, country *r* (the direct importer) is more involved in the processing of final goods than country *s* (the exporter). We expect to register higher PDC shares in bilateral exports from advanced economies to new industrialized countries (e.g. US exports to China) than in symmetric flows (e.g. Chinese exports to US).

In addition to Wang et al. (2013), other authors propose single breakdowns of bilateral exports. An example is Nagengast and Stehrer (2014) who present two alternative methodologies to measure value added in bilateral trade, according to the perspective of the country in exam: the "source-based" approach focuses on the country where the value added originates whereas the "sink-based" approach adopts the perspective of the country that ultimately absorbs the value added in its final demand. Nevertheless, as pointed out by Borin and Mancini (2015), neither methodology can properly account for all the domestic value added exported in a bilateral flow. Borin and Mancini (2015) also identify some weaknesses of the decomposition by Wang et al. (2013) and propose two breakdowns of bilateral exports, refining the original framework by Koopman et al. (2014) and extending it in the spirit of Nagengast and Stehrer (2014). Using a "source-based" approach or a "sink-based" perspective alternately, these authors provide a clearer definition and a coherent methodology for disentangling gross exports in a straightforward way.

The proliferation of accounting frameworks shows how a solid methodology to estimate value added share in a country's exports is a necessary first step toward a better understanding of the nature and extent of global supply and production networks. The debate is more than ever still open especially with regard to bilateral level decomposition. In this essay, I have decided to adopt the most influential methodologies by Koopman et al. (2014) and Wang et al. (2013) which represent the main point of reference in the current debate. Moreover, both Koopman et al. (2014) and Wang et al. (2013) apply their decomposition frameworks to global input-output databases, i.e. the GTAP database and WIOD database respectively, to illustrate potential usefulness of their decomposition results by a series of examples that utilize different subsets of the overall decompositions. Some of these empirical applications have been the benchmark for Section 2.4.

2.3.3 The World Input-Output Database (WIOD)

The World Input–Output Database (WIOD) is an outcome of a European project carried out by a consortium of 12 research institutes headed by the University of Groningen and is publicly available for free at www.wiod.org[59]. Timmer et al. (2015) argue that WIOD has a number of distinguishing features when compared with other data initiatives (see Appendix B) which brought me to adopt this data source to implement my analysis.

First and foremost, WIOD offers a higher level of harmonization of statistical data across countries. Indeed, it relies on national supply and uses tables (SUTs) rather than national input–output tables (IOTs) as basic building blocks. SUTs are the core statistical sources from which statistical institutes derive national input–output tables by applying additional assumptions on the domestic production. These assumptions can differ from one country to another and national input-output tables absorb and hide these differences. Using SUTs, WIOD can rely on additional information and apply more appropriately the same assumptions to all countries in the dataset. Not only SUTs, which are of the product-by-industry type, provide information on both national products and industries, but SUTs can easily be combined with trade statistics that are product-based and employment statistics that are industry-based. Most notably, IOTs are typically based on the strong and unrealistic assumption of import proportionality, according to which a product's import is equally shared between all use categories. WIOD does not rely on this assumption, but it makes use of the classification of detailed products in international trade statistics (UN COMTRADE database) and allocates imported goods to intermediate use, final consumption use or investment use. Although in the next step, i.e. within each end-use category, allocation is based on the proportionality assumption due to a lack of additional data also in WIOD, it is important to acknowledge the great deal of effort made by this database to take full advantage of all the available information[60].

[59] From 2009 to 2012, the project has been funded by the European Commission as part of the 7th Framework Programme. The new version of the database (available from November 2016) was financially supported by the Dutch Science Foundation (NWO) and European Commission Services.

[60] Koopman et al. (2012) have observed that countries engaged in a massive amount of processing trade, such as China and Mexico, could have a different intensity in the use of imported inputs in processing exports than do domestic final sales (and normal exports). In particular, goods and services destined for the local market seem to embed a higher share of domestic value added whereas processing exports embed a higher share of foreign value added. It has to be pointed out that in the WIOD database these two different technologies are collapsed into a single I-O table, leading to an underestimation of the foreign value added in exports that has to be kept in mind in when interpreting the data for China and Mexico. At present, TiVA is the only dataset where the two different production technologies are kept separate, providing a more precise representation of value added trade.

Moreover, WIOD provides a high level of data quality because it is based on official and publicly available data from statistical institutes which are subject to a more reliable checking and validation procedure than data generated for specific research purposes.

In addition, WIOD provides a time-series of world input-output tables (in millions of current dollars) that can be used to trace development over time whereas other data initiatives (i.e. IDE-JETRO, GTAP and TiVA) have been compiled only for particular benchmark years and, in order to pursue and satisfy all these strengths and offers high quality data, WIOD restricts the number of covered countries and sectors compared with other datasets (see Table B1, Appendix B). In particular, the first version of WIOD (2013 release) was made available in 2013 for the period 1995-2011[61]. It covers 40 countries, which include all 27 members of the EU (as of 1 January 2007) and 13 other major economies (see Table C1, Appendix C), which together represent more than 85% of world gross domestic product (GDP) in 2008 (at current exchange rates). For the remaining non-covered part of the world economy, WIOD estimates a model, called the "rest of the world" (RoW) region. The full list of the 35 sectors[62]in 2013 release of WIOD is presented in Appendix C (Table C2). In November 2016, a new version of the dataset was made available which covers some more countries (43) and sectors (58) for the period 2000-2014. However, due to partly different construction criteria, this 2016 release is not directly comparable with the previous one[63] and the version that better fits the research issues must be chosen.

This essay adopts the 2013 release of WIOD mainly due to the time span. Indeed, including data for the 1995-1999 period, the first version of the database is able to better detect differences in the trade specialization and in the supply and production networks due to increasing incidence of the emerging economies as intermediate or final goods processers, assemblers or producers, starting in the early 2000s. In particular, with regard to trade specialization, the 2013 release of WIOD enables a better comparison with the previous literature in gross value, which at the end of the '90s registers some changes in the distribution of the Italian comparative advantages.

[61] A preliminary version was made available in April 2012 and covered the same countries and sector as the 2013 release for the period 1995-2009.

[62] The exports of goods and services connected to international tourism are recorded in WIOD tables as a separate entry ("Purchases on the domestic territory by non-residents"), a sort of memo item that cannot be treated as a separate 36th sector due to missing pieces of information.

[63] For all the details and the main methodological changes in the WIOD 2016 release, see Timmer et al. (2016).

2.4 The case of manufacturing in Italy: descriptive and empirical analyses

Having clarified the methodologies of reference to measure value added exports, I present a comprehensive descriptive analysis of the comparative advantages by shaping the pattern of specialization of Italy (Section 2.4.1) and its main "competitors" (Section 2.4.2). I then illustrate their sectoral export structure in order to define the role of countries within the global supply and production networks (Section 2.4.3) and deepen the analysis by going into the bilateral dimension and identifying the main source countries of foreign value added (Section 2.4.4) and the bilateral links between Italy and the main destination markets of its exports (Section 2.4.5).

2.4.1 The Italian trade specialization pattern with value added data

Since international fragmentation of production can affect indicators based on traditional gross trade data by leading to a misrepresentation of the actual specialization of countries[64], this section empirically investigates how comparative advantages differ when calculated using domestic value added in exports instead of gross exports. This analysis allows us to observe how the specialization of countries increasingly depends on configurations of the whole supply network, both inside and outside national borders, and on interconnections in the production processes linking different countries.

The empirical literature measures trade specialization using international trade data and a wide range of indicators and econometric techniques. The first and still most extensively used measure is the Revealed Comparative Advantages (RCA) Index of Balassa (1965)[65] which is built on one single variable (gross export values). The index measures the level by which exports of a particular product (or sector) by a country relative to its total exports exceed the exports of the same product (or sector) by all counties of reference area, relative to their total exports. The RCA index takes the following form:

$$\mathrm{RCA_{ij}} = \frac{\frac{x_{\mathrm{ij}}}{x_{\mathrm{wj}}}}{\frac{\mathrm{X_i}}{\mathrm{X_w}}} \qquad \in [0, \infty) \tag{6}$$

[64] Baldone et al. (2007) argue that with trade in intermediate goods, traditional empirical measures of comparative advantage may be misleading because traded goods embody "advantages" specific to different countries.

[65] The RCA index uses gross exports data as a proxy for domestic value added in terms of national production factors contained in the exported goods. It refers to the traditional neoclassical approach by Heckscher (1919) and Ohlin (1933) affirming that a country's international specialization is determined by its relative endowment of production factors.

where x_{ij} and x_{wj} are, respectively, the exports of the product (or sector) *j* from country *i* and the world exports w of product *j*, whereas X_i e X_w are, respectively, the total exports of country *i* and the world total exports. It ranges from 0 to infinity. When RCA_{ij} ranges from 1 (its demarcation value) to infinity, it "reveals" a comparative advantage in sector *j* of country *i* which can be defined as being specialized in the export of that sector. Otherwise, from zero to 1, RCA_{ij} suggests a comparative disadvantage and the country is categorized as not being specialized in that particular sector. However, the Balassa index has been criticized in the literature for various reasons. First, the same sectoral value may have a different meaning for different countries which leads to difficulty in comparing country index values for a given sector. Second, it is evident that the results are asymmetrically distributed around its demarcation value. As argued by many authors (Iapadre, 2001; Laursen, 2015), this asymmetry creates problems in econometric analysis applications because it implies that using RCA gives much more weight to values above 1 compared to observations below 1.

Among the several alternatives suggested to address these issues[66], I decided to measure the trade specialization pattern using the Revealed Symmetric Comparative Advantage (RSCA) index proposed by Dalum, Laursen and Villumsen (1998)[67] and defined as:

$$\mathrm{RSCA_{ij}} = \frac{\mathrm{RCA_{ij}} - 1}{\mathrm{RCA_{ij}} + 1} \quad \in [-1,1] \tag{7}$$

The index is a quasi-logarithmic transformation of the Balassa index, ranges from -1 to 1 and is symmetric about the value zero. Values below zero indicate a revealed comparative disadvantage and values above zero, a revealed comparative advantage. This transformation leaves the rank-order of sector invariant, generates a normal distribution for the results and allows for a more effective comparison between countries and sectors[68]. Moreover, the decision to adopt this index is due to other reasons. First, not only the RSCA is easy to construct and its interpretation is intuitive, but recent analysis of the Balassa RCA index and the alternatives measures of international trade specialization used in the literature (Laursen, 2015), focusing both on the theoretical properties and empirical evidence, concludes that RSCA - on balance -

[66] Vollrath (1991) suggests taking the logarithmic transformation of the RCA. Hoen and Oosterhaven (2006) propose an Additive Revealed Comparative Advantage (ARCA) index. Yu et al. (2009) suggest a Normalized Revealed Comparative Advantage (NRCA) index. See Iapadre (2001, 2011) for an accurate review and discussion of different measures of comparative advantage and their appropriateness.

[67] The index will only be briefly presented in this paper while the reader can consult Dalum, Laursen and Villumsen (1998).

[68] This feature will be particularly important in Section 2.4.2.

is the best measure of comparative advantage. Second, Deb and Basu (2011) empirically tested the consistency of the RCA indices with the Heckscher-Ohlin theory of comparative advantage and found that both the RSCA index and Log-of-Balassa index generated favourable results. Third, Deb and Hauk (2015) also analyse the consistency of the RCA indices with the Ricardian theory on comparative advantage. They confirm the results obtained by Deb and Basu (2011) and conclude that the index of Balassa, RSCA and Log-of-Balassa are also all equally consistent with the Ricardian model. Finally, they obtain the same results after incorporating domestic value-added in exports of a country.

In this section, trade specialization is assessed by computing the RSCA index both in gross value and in value added for the 14 manufacturing sectors listed in WIOD (see Appendix C) for three reference years: 1995, 2007 and 2011[69]. To calculate the index in value added, I apply the mathematical framework proposed by Koopman et al.(2014)[70] and, as anticipated in Section 2.3.2, I follow their suggestion to use the "domestic value added in exports" (or GDP in exports) component[71]. As pointed out by Koopman et al. (2014), this component summarizes the content of domestic factors in the production of final and intermediates exported goods, removing the distortion of double counting and the foreign value added of intermediate inputs contents in gross exports[72]. It does not depend on where the exports are absorbed[73]. Therefore, the RSCA indicator calculated with this measure allows the trade specialization of a country to be evaluated in a specific sector by taking into account only the value added generated by the domestic production factors employed in the given sector[74]. The GDP in exports of sector *j* measures the sectoral value added exported both directly in the form of sector *j*'s intermediate and final goods and indirectly as embedded in the exports of all downstream sectors. In line with the notation in (6), the RSCA in value added is computed considering x_{ij} and x_{wj} as, respectively, the GDP in exports of the sector *j* from country *i* and the world (w) GDP in exports of sector *j*. X_i and X_w are, respectively, the GDP in exports of country *i* for all sectors and the

[69] I choose 2007 as the intermediate year to highlight any countertrends arisen since the start of the economic crisis in 2008.
[70] I have implemented the methodology using Matlab software and autonomously deriving the codes used for the calculation.
[71] I would like to point out that the "domestic value added in export" is the sum of five out of the nine components: (I) the domestic value added in direct final goods exports; the domestic value added in intermediates exports (II) absorbed by direct importers or (III) re-exported to third countries; the domestic value added in intermediates that returns within the country of origin (IV) via final imports or (V) via intermediate imports.
[72] While Koopman et al. (2014) carried out their analysis using the RCA index, I adopt the RSCA index that allows for a more effective comparison between countries and sectors.
[73] Other authors (Borin and Mancini, 2017) prefer to compute RCA excluding terms IV and V.
[74] This measure is hence coherent with the theoretical framework that underlies the RCA index (see note no. 51).

total global GDP in exports. Table 2.1 presents the results of the two series of RSCA indexes (with gross and value added exports) for the Italian manufacturing sectors.

Table 2.1 RSCA indicators in value added and gross value for the Italian manufacturing sectors

ISIC rev. 3 code	Sectors[1]	RSCA in value added			RSCA in gross value		
		1995	2007	2011	1995	2007	2011
19	Leather, leather products and footwear [2]	0.611	0.645	0.656	0.614	0.638	0.657
29	Machinery, not elsewhere classified	0.251	0.348	0.365	0.361	0.415	0.421
26	Other non-metallic mineral	0.357	0.346	0.298	0.448	0.390	0.352
17, 18	Textiles and textile products	0.363	0.305	0.226	0.315	0.289	0.204
27, 28	Basic metals and fabricated metal	0.133	0.194	0.215	0.058	0.163	0.233
36, 37	Manufacturing, not elsewhere classified [3]; recycling	0.354	0.220	0.214	0.409	0.236	0.161
25	Rubber and plastics	0.124	0.091	0.065	0.315	0.206	0.194
20	Wood and products of wood and cork	0.117	0.095	0.032	-0.288	-0.173	-0.134
15, 16	Food, beverages and tobacco	-0.110	-0.047	0.009	-0.125	0.013	0.064
24	Chemicals and chemical products	-0.138	-0.106	-0.065	-0.104	-0.020	0.036
21, 22	Pulp, paper, printing and publishing	-0.177	-0.073	-0.067	-0.222	-0.121	-0.074
34,35	Transport equipment	-0.213	-0.172	-0.149	-0.117	-0.042	-0.055
30-33	Electrical and optical equipment [4]	-0.233	-0.160	-0.178	-0.291	-0.301	-0.288
23	Coke, refined petroleum and nuclear fuel	-0.063	-0.257	-0.477	-0.225	-0.090	-0.080

Source: author’s calculations on WIOD data, 2013 release.
Note: (1) Sectors listed by the decreasing value of the RSCA value added in 2011;(2) Leather clothes is excluded from this sector; (3) It includes furniture; (4) It includes computers and office equipment, radios, televisions and telecommunication equipment.

At a first glance, the Italian pattern of specialization suggested by RSCA with gross exports data seems to be confirmed also when considering value added exports. The RSCA indexes in value added are clearly over zero in all sectors of the Italy's traditional trade specialization (*Leather, leather products and footwear*; *Machinery, n.e.c.*; *Manufacturing, n.e.c. and recycling*, including furniture; *Other non-metallic mineral*, including building materials and ceramics, *Textiles and textile products* and *Basic metals and fabricated metal*). The same holds for the main sectors of comparative disadvantage and especially for *Electrical and optical equipment* and *Transport equipment*[75].

[75] The negative assessment for these two sectors is worsened by the fact that, since 2000, both these sectors recorded globally the greatest production growth rates among the manufacturing sectors (Centro Studi Confindustria, 2014). In particular, this report points out that in the period 2000-2013, the electronic industry's production increased by over 100% at global level, while computers and office machines and heavy transport equipment (planes, trains, ships) had a positive variation greater than 70 % and the automotive sector increased by about 50%, reflecting a positive dynamic of international demand. However, Italy appears to be bucking the trend. The production in the computer and office equipment was practically zero in 2013 and it has more than halved in electronics and in the automotive sector, signaling a decline in production capacity in those sectors with the greatest growth in global demand.

In the index magnitude, a first important difference between gross and value added RSCA appears: Italy's trade specialization in almost all sectors of comparative advantage is in fact less prominent considering only the domestic value added content in exports (i.e., the exports net of foreign value added and double counting). This is a first piece of evidence that the Italian exported manufactured goods contain a relevant share of foreign intermediate inputs[76], having reorganized the production process along supply networks out of its national borders[77].

In more detail, in the three reference years, the production of *Leather, leather products and footwear* remains the first sector of comparative advantage of the Italian economy, even accordingly to RSCA in value added, consistently with traditional analysis. Considering that the sector figures among those that are most affected by international fragmentation of production, with a relevant transformation of its production and sales structure (a reduction in the number of firms and employees in Italy and in other advanced countries and the emerging of new countries that have developed the production of these sectors' goods, in particular in Asia), strong specialization can be linked to the results of some sectoral analysis. In particular, Milone (2015) reports that in the last two decades, the Italian firms in the *Leather, leather products and footwear* sector have modified their strategic positioning, placing themselves in the upper segment of the market (in which a greater value is attributed to Italian style and brand recognition)[78] and have outsourced abroad some stages of production with low value added. At the same time, Italian small and medium enterprises in the *Leather, leather products and footwear* sector have been able to join global supply chains thanks to the partnership with big international brands based in Italy. This successful restructuring process allows to keep the sector at the top of the rankings by comparative advantage.

The manifold segment of *Machinery* (including appliances) - which manufactures a very diverse range of machinery and equipment serving the most disparate types of production - also appears among the sectors of greatest comparative advantage of Italy, even taking into account

[76] As Cappariello and Felettigh (2015) argue, one might expect the sharp increase in commodities prices between 1999 and 2011, in particular energy raw materials, to introduce an upward bias in the foreign value added content measured at current prices (as in WIOD). However, looking at the foreign value added content of exports net of the component originated in the commodities sector abroad, Cappariello and Felettigh (2015) can safely assume that for Italy the increase in foreign value added shares is not just driven by a hike in resource prices.
[77] Therefore, this result is in line with Johnson and Noguera (2012) who argue that the VAX ratio is lower in manufacturing than in agriculture and services because manufacture made more use of inputs from non-manufacturing sectors (see Section 2.2.2).
[78] This trend was already well established in the mid-90s, as documented by Saladini (1998). He states that the persistence of Italy's specialization in the *footwear* sector reflected a repositioning of the national manufacturing industry towards a higher qualitative level and higher unit value of production, compared with emerging countries.

only the domestic value added in export. This evidence, along with the *Machinery*'s export size[79], confirms that this sector can be considered one of the main strengths of the Italian pattern of specialization. In particular, the *Machinery* sector has increased its specialization between 1995 and 2011. This trend, confirmed by the value added data, partly mitigates the “anomaly” of Italy's specialization among major industrial countries, due to its stronger comparative advantages in labour-intensive low-skill sectors[80]. Furthermore, the *Machinery* sector has gained weight at the expense of some other traditional sectors. Indeed, in line with the latest analyses on the Italy's trade specialization based on gross statistics (Santomartino, 2014; Montalbano and Nenci, 2011), the RSCA indexes in value added show, since the ‘90s, a weakening of Italian specialization in some of the sectors considered among the most representative of Italian exports (*Manufacturing, n.e.c. and recycling*, including furniture; *Textiles and textile products* and *Other non-metallic mineral*, including building materials and ceramics). This decreasing long-term trend in comparative advantages with value added data can be considered an evident sign of a lower capacity of the national economy to produce and export domestic value added in these manufacturing sectors, which give strong support to the outcomes based on gross exports data. For *Textiles and textile products*, the decreasing specialization between 1995 and 2011 reflects changes in global production patterns and especially the substantial reallocations towards low-wage countries, namely China and India. Despite increased international outsourcing and import penetration, in Italy the sector’s restructuring process keeps within the country production activities which are highly value added generating (Schütz and Palan, 2016).

A significant common feature of the three years of analysis is that the *Wood and products of wood and cork* sector (which excludes furniture) figures among the areas of Italy's trade despecialization according to conventional trade statistics while, since 1995, it presents positive values of RSCA in value added. The comparison between gross and value added RSCA suggests that in this sector, the domestic value added embedded in exports appears more substantial than expected with traditional data. A possible explanation is that this sector indirectly exports a large share of its value added through exports of other sectors that incorporate in their products intermediate goods produced in the *wood and cork* industry.

[79] *Machinery* takes the most relevant role in Italian gross exports, representing about 20% of exported manufacturing goods both in 1995 (19.8%) and 2011 (19%).
[80] The goods produced by *Machinery* sectors, with the exception of household appliances that fall into consumer goods, belong to the category of capital goods; in Pavitt classification, they are placed, with some exceptions, among the high-skilled and high-tech products.

Nevertheless, the RSCA in value added shows a decreasing trend suggesting a weakening of this comparative advantage.

Conversely, in recent years, the *Chemicals and chemical products* sector displays a trend towards specialization, revealing in 2011 a comparative advantage that clearly emerges using gross data, but not yet with RSCA in value added. Although *Chemicals and chemical products* is one of the sectors with a higher R&D content, this result suggests that its exports still contain a significant share of foreign value added and the domestic value added embedded in exports appears less significant than expected with traditional data.

Special attention should be paid to *Coke, refined petroleum and nuclear fuel*, an industry characterized by strong economies of scale: the RSCA index in gross value shows that the sector is characterized by the biggest comparative disadvantage in Italian manufacturing. Furthermore, the comparison with RSCA in value added not only confirms the despecialization of Italy in this area, but it points to a trend featuring a strong decline in the domestic value added content in sectoral exports, in favour of foreign value added content[81].

These remarks on the increasing incidence of the foreign value added component can be extended to the *Other non-metallic minerals* field (which includes the production of building materials and ceramics). Indeed, observing the traditional RSCA index, the sector proves to be one of the most important sectors of specialization in all years of analysis, whereas the RSCA index in value added reveals an increasing despecialization. Similar conclusions can be applied to the *Rubber and plastics* sector. These outcomes are exactly the opposite of what has happened in *Wood and products of wood and cork* sector. In other words, in the *Other non-metallic mineral* and *Rubber and plastics* sectors, the gross exports contain a relevant share of value added from other sectors that is not considered in the domestic value added in exports and a small part of this value added is exported as embedded in other sectors' exports.

In general, although there is a low degree of disaggregation of sectors in the 2013 release of WIOD[82,83], this first descriptive analysis suggests that looking at the trade specialization "through the lenses of value added" largely confirms the picture of Italian comparative advantages surmised from gross export data[84]. Nevertheless, the Italian specialization pattern

[81] See footnote no. 74.
[82] The new 2016 version of WIOD does not offer a relevant increase in the level of sectoral disaggregation in manufacturing. It presents 17 manufacturing sectors rather than the 14 presented in the 2013 release.
[83] Using a higher disaggregation of sectors, some traditional analysis pointed out a wider variability in within-product specialization (De Benedictis, 2005).
[84] Several empirical studies (Lanza and Quintieri, 2007; Amighini, Leone and Rabellotti, 2011) stress that a proper analysis of Italy's position in international markets should also consider the qualitative repositioning of exported goods towards greater quality. Indeed, in order to respond to the increasing competitive pressure exerted by low-

outlined with value added RSCA is not completely aligned to that arising from the traditional gross export data. When comparing RSCA in gross and value added, some differences emerge that provide some additional information on the specific characteristics of each sector in terms of both domestic and foreign inter-industry production networks. Thus, combining gross and value added indexes can improve our interpretation of conventional trade statistic used to measure trade specialization, confirming from a macro perspective some sectoral trends already observed in previous firm level studies.

Finally, to offer a comprehensive interpretation of the analysis presented in this section, it could be useful to combine an analysis of the sectoral composition of exports with an examination of trade performance and competitive stance on the global markets. Although it goes beyond the specific purpose of this essay, I would like to briefly refer to the results of some recent studies which use the market share in world exports to offer a synthetic assessment of the Italian trade performance and competitiveness. Using traditional trade data from 2003 to 2011, Mazzeo and Proietti (2014) ascribe the decreasing trend of the Italian market share to its trade specialization. However, moving on to a value added approach, in a preliminary analysis focusing on manufacturing sectors and using the WIOD 2013 release, Felettigh and Oddo (2016) demonstrate that the negative effect on the dynamics of Italian market shares is due to changes in GVC participation rather than to shifts in its trade specialization[85]. This outcome, together with the growing specialization in the *Machinery* sectors observed in Table 2.1, partly mitigates the negative judgment generally attributed to the "anomaly" of Italian trade specialization. Moreover, it emphasizes that due to the changed nature of industrialization (Baldwin, 2011) and trade (Grossman and Rossi Hansberg, 2008), policy measures that aim to improve trade specialization and performance should consider that "no country is an island", but is part of a complex network of competitive and collaborative relationships.

---

cost producers, Italian companies have adopted this strategy, meaning that Italian exports do not really compete with East Asian countries because they are positioned in different segments of the market (Amighini and Chiarlone, 2005; Montalbano and Nenci, 2012). However, an analysis of exports quality goes beyond the aims of this essay.

[85] In addition to the analysis of trade specialization, studying the participation and positioning of Italy within the sectoral GVCs could be useful to detect in more detail the role of Italy in specific sectors. Although this kind of study goes beyond the aims of this essay, reference can be made to the works by Amador et al. (2014), Accetturo and Giunta (2016), Borin and Mancini (2017).

2.4.2 International competitors of Italy in its specialization sectors

Additional elements that are useful for assessing Italian trade specialization at international level can be drawn by comparing Italy's RSCA index (in both gross and value added terms) analysed above with that of Italy's competitors in its main specialization sectors. This second level of analysis allows us to observe whether the structure of international competitors changes when we consider trade specialization with value added data rather than with traditional gross statistics. To implement the international comparison, I compute the RSCA indexes for all 40 countries listed in WIOD and select the five countries with the highest positive value of RSCA for each sector in which Italy registers a comparative advantage in 2011 according to the index in value added (see Table 2.1). In each sector, the top five countries can be considered the main competitors of the Italian exports. Table 2.2 and Table 2.3 present the RSCA indexes in gross value and value added for Italy and the top five competitors in 1995 and 2011, respectively (Italy's position in the international rankings of countries shown in brackets).

Looking at Italy's competitors, it is interesting to note that in 1995 *Textiles and textile products, Wood and products of wood and cork* and *Machinery* are the sectors in which no significant changes in terms of both main competitors and their position were registered, moving from RSCA in gross terms to RSCA in value added. Conversely, important shifts affect the *Basic metals and fabricated metal* sector where only two countries among the top five in gross terms (Brazil and Slovak Republic) are confirmed with value added data. This suggests that in these basic industrial sectors the traditional measure of comparative advantage is strongly influenced by the contribution of imported intermediate inputs. As expected, the rankings in value added bring to the top the countries with the greatest weight of domestic value added, exported both directly and indirectly though other sectors' exports.

At the end of the period (Table 2.3), in the *Food, beverages and tobacco, Textiles and textile products* and *Leather and leather products* sectors no changes in the top five competitors are registered moving between the two series of data[86]. Some interesting differences appear with the 1995 ranking. In 2011 Indonesia enters among the top five competitors in the *Food, beverages and tobacco* sector with both gross and value added index, replacing Estonia and Lithuania respectively, whereas in the *Leather and leather products* sector Brazil replaces India in the rankings of countries according to RSCA in gross terms and Slovenia in the ranking by

[86] As many studies shown, the sectors has been among the first to be fragmented at international level. The absence of large changes in the top five countries reflects an ongoing consolidation of comparative advantage.

RSCA in value added. In *Textiles and textile products*, Turkey, China and Portugal remain among the top five competitors also in 2011, whereas India and Romania replaces Indonesia and Cyprus in both series of RSCA. In particular, India's progression is remarkable since in 1995 the country occupied eleventh place for RSCA in gross terms and thirteenth place for RSCA in value added. It is noteworthy that in the *Textiles and textile products* sector Italy has gained six (seven) positions compared with 1995 rankings in gross (value added) data, although Italy's RSCA in both gross and value added has declined. Therefore, this outcome is a sign of a decreasing specialization of some of the countries who preceded Italy in the 1995 rankings rather than a growing specialization of Italy.

Conversely, in 2011, the most relevant shifts affect the sector of *Basic metals and fabricated metal,* where only Japan remains among the top five competitors also with value added data. All the other competing countries (Turkey, Bulgaria, Australia and Finland) reduce their comparative advantage moving to RSCA in gross export to RSCA in value added while newly industrialized countries (such as South Korea, Slovakia and Slovenia) emerge among the top five competitors, suggesting a great weight of the domestic value added in their exports. This outcome suggests two considerations. First, as in Section 2.4.1, the main differences between the values and the rankings by RSCA in gross and value added terms affect these basic manufacturing sectors, which produce intermediate inputs for other industries, both within and outside the home country. Therefore, considering the whole input-output structure, through the methodology proposed by Koopman et al. (2014), is a better way of detecting these sectoral characteristics and appropriately assessing the sectoral specialization.

Table 2.2 **Trade specialization indicators of Italy's main competitors in its comparative advantage sectors: gross versus added value RSCA - Year: 1995**

Food, beverages and tobacco		Textiles and textile products		Leather, leather products and footwear	
RSCA in gross value		**RSCA in gross value**		**RSCA in gross value**	
Denmark	0.559	Turkey	0.758	Portugal	0.709
Ireland	0.559	China	0.643	China	0.674
Brazil	0.511	Indonesia	0.623	Indonesia	0.587
The Netherlands	0.450	Portugal	0.587	Romania	0.578
Estonia	0.435	Cyprus	0.543	India	0.556
ITALY (24)	**-0.125**	**ITALY** (14)	**0.315**	**ITALY** (3)	**0.614**
RSCA in value added		**RSCA in value added**		**RSCA in value added**	
Ireland	0.545	Turkey	0.754	Portugal	0.765
Estonia	0.540	Portugal	0.606	Indonesia	0.673
Denmark	0.529	China	0.601	China	0.597
Lithuania	0.522	Indonesia	0.548	Slovenia	0.582
Brazil	0.465	Cyprus	0.542	Romania	0.580
ITALY (26*)	**-0.110**	**ITALY** (14)	**0.363**	**ITALY** (3)	**0.611**

Wood and products of wood and cork		Rubber and plastics		Other non-metallic mineral	
RSCA in gross value		**RSCA in gross value**		**RSCA in gross value**	
Latvia	0.823	Taiwan	0.425	Indonesia	0.740
Indonesia	0.779	India	0.420	Czech Republic	0.496
Finland	0.707	Luxembourg	0.396	Portugal	0.453
Estonia	0.706	China	0.297	Slovak Republic	0.447
Canada	0.615	Slovenia	0.284	Turkey	0.445
ITALY (27)	**-0.291**	**ITALY** (7)	**0.192**	**ITALY** (4)	**0.448**
RSCA in value added		**RSCA in value added**		**RSCA in value added**	
Latvia	0.838	Luxembourg	0.338	Indonesia	0.532
Indonesia	0.727	Taiwan	0.323	Portugal	0.430
Finland	0.630	Slovenia	0.288	Czech Republic	0.384
Estonia	0.629	China	0.181	China	0.371
Canada	0.543	Germany	0.174	Turkey	0.342
ITALY (19)	**0.117**	**ITALY** (9)	**0.124**	**ITALY** (5)	**0.357**

Basic metals and fabricated metal		Machinery, nec		Manufacturing, nec ; recycling	
RSCA in gross value		**RSCA in gross value**		**RSCA in gross value**	
Romania	0.403	Germany	0.313	Indonesia	0.627
Slovak Republic	0.402	Japan	0.261	Taiwan	0.455
Russia	0.313	Finland	0.239	Estonia	0.437
Luxembourg	0.306	Denmark	0.235	Romania	0.420
Brazil	0.289	Sweden	0.199	Denmark	0.389
ITALY (19)	**0.058**	**ITALY** (1)	**0.361**	**ITALY** (5)	**0.409**
RSCA in value added		**RSCA in value added**		**RSCA in value added**	
Slovak Republic	0.228	Germany	0.355	Estonia	0.481
Brazil	0.208	Denmark	0.299	Romania	0.472
Japan	0.186	Finland	0.251	Slovenia	0.455
Czech Republic	0.165	Sweden	0.228	Denmark	0.430
Slovenia	0.111	Japan	0.196	Indonesia	0.394
ITALY (5)	**0.133**	**ITALY** (4)	**0.251**	**ITALY** (8)	**0.354**

* Italy's position in the rankings of countries by RSCA index. Source: author's calculations on WIOD data, 2013 release.

<u>Table 2.3</u> Trade specialization indicators of Italy's main competitors in its comparative advantage sectors: gross versus added value RSCA - Year: 2011

Food, beverages and tobacco		Textiles and textile products		Leather, leather products and footwear	
RSCA in gross value		**RSCA in gross value**		**RSCA in gross value**	
Brazil	0.568	Turkey	0.613	Romania	0.600
Indonesia	0.469	China	0.500	Portugal	0.589
The Netherlands	0.434	India	0.329	China	0.544
Denmark	0.413	Portugal	0.309	Indonesia	0.341
Ireland	0.291	Romania	0.308	Brazil	0.317
ITALY (19)	**0.064**	**ITALY** (8)	**0.204**	**ITALY** (1)	**0.657**
RSCA in value added		**RSCA in value added**		**RSCA in value added**	
Indonesia	0.485	Turkey	0.677	Romania	0.640
The Netherlands	0.475	China	0.501	Portugal	0.638
Ireland	0.459	India	0.394	China	0.515
Brazil	0.438	Portugal	0.370	Brazil	0.347
Denmark	0.411	Romania	0.324	Indonesia	0.341
ITALY (21*)	**0.009**	**ITALY** (7)	**0.226**	**ITALY** (1)	**0.656**

Wood and products of wood and cork		Rubber and plastics		Other non-metallic mineral	
RSCA in gross value		**RSCA in gross value**		**RSCA in gross value**	
Estonia	0.866	Poland	0.403	Portugal	0.547
Latvia	0.866	Slovenia	0.393	Turkey	0.517
Finland	0.674	Czech Republic	0.326	Bulgaria	0.452
Lithuania	0.647	Indonesia	0.323	Estonia	0.369
Portugal	0.623	Hungary	0.300	Spain	0.356
ITALY (26)	**-0.134**	**ITALY** (12)	**0.194**	**ITALY** (7)	**0.352**
RSCA in value added		**RSCA in value added**		**RSCA in value added**	
Latvia	0.790	Czech Republic	0.452	Turkey	0.497
Estonia	0.768	Slovenia	0.373	Portugal	0.467
Lithuania	0.633	Poland	0.291	Czech Republic	0.429
Slovak Republic	0.578	South Korea	0.242	Poland	0.394
Romania	0.571	China	0.229	Bulgaria	0.386
ITALY (19)	**0.032**	**ITALY** (15)	**0.065**	**ITALY** (7)	**0.298**

Basic metals and fabricated metal		Machinery, nec		Manufacturing, nec; recycling	
RSCA in gross value		**RSCA in gross value**		**RSCA in gross value**	
Turkey	0.322	Germany	0.327	India	0.751
Bulgaria	0.280	Finland	0.306	Estonia	0.352
Australia	0.264	Slovenia	0.300	Poland	0.309
Japan	0.252	Hungary	0.241	Lithuania	0.238
Finland	0.236	Japan	0.238	Turkey	0.191
ITALY (6)	**0.233**	**ITALY** (1)	**0.421**	**ITALY** (7)	**0.161**
RSCA in value added		**RSCA in value added**		**RSCA in value added**	
Japan	0.279	Hungary	0.511	India	0.588
South Korea	0.267	Germany	0.393	Lithuania	0.445
Germany	0.173	Finland	0.367	Poland	0.318
Slovak Republic	0.171	Slovenia	0.277	Estonia	0.291
Slovenia	0.169	Austria	0.266	Czech Republic	0.236
ITALY (3)	**0.215**	**ITALY** (4)	**0.365**	**ITALY** (6)	**0.214**

*Italy's position in the rankings of countries by RSCA index. Source: author's calculations on WIOD data, 2013 release.

Second, if we compare Table 2.2 with Table 2.3, it is noteworthy that several Eastern European countries (not only Slovak Republic and Slovenia, but also Czech Republic, Hungary and Poland) appear among the top five competitors in 2011, especially in the rankings by RSCA in value added. Their rise as international competitors of Italy in most of its comparative advantage sectors can be interpreted in the light of the processes of outsourcing and relocation of activities in these countries by many European manufacturing firms (mainly the German ones), which led to the so-called "Factory Europe" (see Baldwin, 2006, 2014).

Indeed, as well documented by this author, firms belonging to the most industrialized European countries have chosen some European neighbours with a lower cost of inputs but with similar specialization, to implement - partially or sometimes totally - their production processes. This interesting evidence suggests that in a world with international fragmentation of production, the rankings of countries according to RSCA in value added may bring to the top not exclusively countries that could compete in the same final markets, but also countries that are production hub and main “partners” in this sectoral global production network.

Focusing on Italy, in *Machinery* it maintains the strongest comparative advantage in the rankings of countries according to RSCA in gross terms and the fourth position with value added data and it climbs to the top in *Leather and leather products in both series of indexes*. Moreover, in 2011 Italy moved up in *Basic metals and fabricated metal* (+13 positions in gross terms, +2 in value added), *Food, beverage and tobacco* (+5 position in gross terms; +5 positions in value added). Conversely, Italy moved down in *Rubber and plastics* (-5 in gross, -6 in value added) whereas in the *Wood and products of wood and cork* sector Italy continues to maintain a significant gap between the rankings by RSCA in gross terms (26th place) and those by RSCA in value added (9th place). The former is lower than the latter both in 1995 and in 2011 suggesting how in this basic industry, Italy’s contribution in terms of domestic value added is higher than expected, due to the relevant share of domestic value added directly or indirectly exported[87]. In general, the evidence suggests that, when looking at the Italian specialization sectors in both 1995 and 2011, its major “competitors” at international level are mainly the newly industrialized countries rather than more advanced economies, with the exception of the *Machinery* sectors[88].

[87] This outcome confirms the remarks presented in Section 2.4.1.

[88] This outcome confirms and extends the analysis with gross trade data for the period 2000-2002 by De Nardis and Traù (2005).

Overall, this analysis shows that the measurement of trade specialization of Italy and its main "competitors" is clearly influenced by the reorganization of production at international level, by the degree of participation of each country in these global networks, and by a number of sectoral characteristics.

2.4.3 The export structure in value added of Italy and other selected countries

This section describes similarities and differences between countries in their role within the international organization of production and in their participation in global supply and production networks, by looking at the different components of each country's exports[89]. The specific export structure of Italy and of other selected countries is obtained by implementing the decomposition of gross exports into its value added components according to the sectoral level breakdown proposed by Wang et al. (2013)[90]. To this purpose, the results are aggregated at country sectoral level. It should be recalled that within this accounting framework, the DVA in gross exports summarizes all the backward linkages across upstream countries and sectors (not the forward linkages as in Section 2.4.1 and 2.4.2) and can include value added from all home supplier sectors (see Section 2.2.2).

Section 2.4.2 presented Italy's main competitors according to comparative advantages whereas in this section, Italy is compared with the major world exporters in manufacturing goods. In 1995, the top three manufacturing exporters were Germany, USA and Japan, but in 2011 they were overtaken by China[91]. The analysis focuses on *Machinery* and *Leather, leather products and footwear* sectors, the main specialization sectors of Italy and highlights specific sectoral characteristics.

If we focus on *Machinery* - which has the most significant role in Italian gross exports, representing about 20% of exported manufacturing goods both in 1995 (19.8%) and in 2011 (19%) - Italy was the fourth world exporter in 1995 and in 2011[92] with gross exports data.

---

[89] Further information on the participation and position of countries within the international production networks could be recovered using different indicators proposed in the literature, e.g. the GVC participation and position indexes (Koopman et al., 2011; see footnote n. 46) or the index of "upstreamness" and "downstreamness" (Antràs et al., 2012; Antràs and Chor, 2013).

[90] I have implemented the methodology using Matlab software and autonomously deriving the codes used for the calculation, both at sectoral-country and at bilateral-sector level.

[91] Italy ranks sixth and seventh in the world rankings by total gross manufacturing exports, in 1995 and 2011 respectively.

[92] In 1995, Germany, Japan (which are among the top five competitors also in the rankings by comparative advantages) and USA preceded Italy in the order. In 2011, China substituted Japan.

Looking at the export structure (Table 2.4), all the selected countries present a reduction in the share of the DVA component that is more marked between 1995 and 2007 than between 2007 and 2011. This result reveals a greater use of imported intermediate goods because of a gradual increase in the international fragmentation of production and in the participation in global production networks which has partially slowed down since the economic crisis. Italy, China and Germany have the highest dependence of their *Machinery* exports on foreign inputs, recording the greatest FVA share among the selected countries.

While the Italian FVA share shows weak growth throughout the period, both China and Germany's shares register a significant increase. For China, this trend reflects its role of processing hubs for many advanced economies whereas the increasing FVA share in Germany is partially due to the offshoring of some production stages in plants localized in Eastern European countries as previously mentioned in Section 2.4.2.

Table 2.4 Value added decomposition of gross exports in the Machinery sector - selected countries

Country	Year	GROSS EXPORTS (in millions of US$)	DVA TOT	DVA DVA_FIN	DVA DVA_INT	FVA	RDV	PDC
			in % of gross exports					
China	1995	5086.86	**84.89**	57.41	27.48	**13.46**	**0.29**	**1.37**
	2007	89957.12	**74.20**	50.17	24.03	**21.48**	**0.75**	**3.57**
	2011	143627.93	**75.46**	47.97	27.49	**19.51**	**1.34**	**3.70**
Germany	1995	85294.94	**81.99**	55.47	26.52	**14.41**	**1.31**	**2.30**
	2007	193411.11	**71.73**	42.12	29.60	**20.99**	**1.41**	**5.87**
	2011	203747.30	**70.82**	39.87	30.95	**22.14**	**1.31**	**5.73**
Italy	1995	43490.32	**79.36**	54.96	24.39	**18.02**	**0.44**	**2.18**
	2007	95961.24	**74.25**	43.70	30.55	**20.37**	**0.65**	**4.72**
	2011	94241.83	**74.40**	42.10	32.30	**20.52**	**0.55**	**4.53**
Japan	1995	63814.57	**93.06**	66.67	26.39	**5.64**	**0.71**	**0.59**
	2007	77476.23	**83.54**	44.97	38.58	**12.25**	**0.93**	**3.28**
	2011	93808.69	**82.99**	43.30	39.69	**13.23**	**0.84**	**2.94**
USA	1995	60630.41	**82.63**	53.71	28.91	**10.31**	**4.81**	**2.25**
	2007	116173.97	**76.92**	47.33	29.59	**14.07**	**4.92**	**4.09**
	2011	136486.95	**78.70**	46.54	32.16	**13.90**	**3.81**	**3.59**

Source: author's calculations on WIOD data, 2013 release.

On the contrary, Japan maintains the highest DVA throughout the period but with a remarkable change in its export structure with a considerable decrease in DVA_FIN and a rise in the domestic value added in intermediate and unfinished goods (DVA_INT). Indeed, in 2011, Japan is no longer mainly a source of finished goods, but it has become an important supplier of parts and components in the production of other countries. In more recent years, China registers the highest DVA share in final goods among the selected countries.

Together with Japan, the USA also presents a low FVA share. However, compared with the former which produces its exports with a domestic contribution of over 80%, the USA has a less prominent DVA share and the highest RDV share among the five countries[93]. This means that in the *Machinery* sector, the USA is the country that makes greater use of foreign manufacturing systems to perform some stages of productions and to assemble goods ultimately consumed at home. In other words, among the selected countries, the USA has the most internationalized organization of production for its domestic consumption and its production stages are in more upstream positions compared with the other countries. On the contrary, Italy has the lowest RDV share, especially in 2011, that reflects a downstream position in the global production networks.

I then analyse the decomposition of gross *Leather, leather products and footwear* exports and compare these results with the evidence that has emerged from the *Machinery* sector, to highlight specific sectoral characteristics. In Italy *Leather, leather products and footwear* represents a share of exported goods that is much lower than the *Machinery* one. Indeed, in 1995, sectoral exports account for 5.51% of manufacturing gross exports whereas in 2011, they account for 4.26%. Nevertheless, Italy was the first world exporter in 1995 and the second in 2011, preceded by China. Small changes characterize the Italian trend in all the gross exports components (Table 2.5) and the main shift is the decreasing DVA_INT share in favour of the FVA share. This outcome confirms the remarks in Section 2.4.1 regarding the restructuring process undertaken by Italian companies in the sector.

Overall, the four main components have more moderate variations than those recorded in the *Machinery* sector. This reflects the fact that the *Leather, leather products and footwear* sector - along with other unskilled labour-intensive manufacturing sectors - was among the first to be affected by the international fragmentation of production which started in the ‘80s. In more recent years, the phenomenon has been gradually consolidated without significant changes in the structure of exports. At the same time, Table 2.5 presents a DVA share that is

[93] I would like to mention that RDV is a share of domestic value added in exports (see Section 2.3.1). The difference between DVA and RDV is where this value added is absorbed: DVA represents the share of domestic value added in exports that is absorbed abroad, whereas RDV captures the share of domestic value added in intermediate goods exports that turns back through imports and is finally absorbed in the home country.

greater than in *Machinery* sector, suggesting that the exports of *Leather, leather products and footwear* products embody a more significant contribution from domestic production factors.

<u>Table 2.5</u> Value added decomposition of gross exports in the Leather sector - selected countries

Country	Year	GROSS EXPORTS	DVA			FVA	RDV	PDC
			TOT	DVA_FIN	DVA_INT			
		(in millions of US$)	in % of gross exports					
China	1995	9431.04	**81.05**	61.22	19.84	**17.94**	**0.13**	**0.88**
	2007	31394.06	**83.22**	72.06	11.16	**15.90**	**0.15**	**0.73**
	2011	51506.11	**85.32**	73.65	11.67	**13.88**	**0.22**	**0.58**
Germany	1995	2709.87	**74.65**	55.57	19.08	**19.78**	**2.39**	**3.18**
	2007	5292.73	**66.62**	55.12	11.51	**27.99**	**1.39**	**4.00**
	2011	4274.92	**68.43**	55.03	13.40	**26.21**	**1.39**	**3.96**
Italy	1995	12069.86	**82.65**	62.29	20.36	**15.27**	**0.49**	**1.59**
	2007	19401.94	**79.55**	63.12	16.43	**17.65**	**0.66**	**2.14**
	2011	20998.83	**79.09**	62.44	16.65	**18.26**	**0.57**	**2.08**
Japan	1995	266.69	**90.89**	44.52	46.37	**4.01**	**3.71**	**1.39**
	2007	219.92	**88.69**	51.38	37.31	**7.32**	**1.69**	**2.30**
	2011	227.44	**87.79**	52.74	35.05	**8.82**	**1.22**	**2.16**
USA	1995	967.37	**82.85**	74.17	8.68	**14.17**	**2.02**	**0.96**
	2007	869.17	**80.07**	70.04	10.03	**16.32**	**2.21**	**1.40**
	2011	834.53	**81.86**	71.58	10.28	**15.44**	**1.48**	**1.23**

Source: author's calculations on WIOD data, 2013 release.

As for *Machinery*, Japan maintains the highest DVA throughout the period, but with an opposite trend: a considerable increase in DVA_FIN and a symmetrical fall in DVA_INT. However, the DVA_INT share remains strongly above the share of the other top world manufacturing exporters, signalling a significant contribution of Japanese intermediate leather goods in the production of final goods by third countries. On the contrary, the USA has the less prominent DVA_INT share, suggesting its low participation in the international production networks of *Leather, leather products and footwear*.

China presents an increasing DVA share and a decreasing FVA share, signalling that the country manufactures some parts and components at home which in the mid '90s were purchased abroad. Its domestic supply chain is becoming more complete and only a small part of its exports embodies imported inputs.

As for *Machinery*, also in *Leather, leather products and footwear* Germany is the country with the highest FVA share (above 25% both in 2007 and 2011), revealing a greater dependence of sectoral exports on imported inputs.

2.4.4 The main source countries of Italy in the supply chains with value added data

In light of the growing importance of foreign value added content in exports observed previously, this section presents an extensive analysis of the composition of the FVA in terms of countries that are suppliers of intermediate inputs in a country's exports in order to detect any change that has taken place in the organization of international supply chains. At the same time, linking this analysis with an examination of the comparative advantages (Sections 2.4.1 and 2.4.2) allows us to observe if the dynamics of comparative advantages can be seen in part as the results of the country's ability to modify its national and global production networks in order to maintain or improve its specialization.

Wang et al. (2013)'s decomposition framework mentioned in Section 2.3.2 can be used to trace the FVA in sectoral exports by source countries[94]. Although Wang et al. (2013) do not explain the algebra used to compute this measure, it can be obtained from the main gross bilateral exports decomposition equation (4). Indeed, it is possible to compute FVA in bilateral sectoral exports by country s to country r by rearranging terms 14 and 15 as follows:

$$FVA_{sr} = \hat{V}\widehat{B_s}\#^\circ Y_{sr} + \hat{V}\widehat{B_s}\#^\circ(A_{sr}L_{rr}Y_{rr}) \tag{8}$$

where $\hat{V}$ is a G x GN block matrix of the direct value added share, where the elements of the main diagonal are blocks (not single entries) given by the row vectors of value added of the G countries (va_s, va_r, …, va_G; see Appendix A) and $\widehat{B_s}$ is a GN x GN block Leontief matrix, where the blocks of the main diagonal are obtained through the diagonalization of the sub-matrix of B of dimension GN x N that considers all the B column referring to the exporter country s. The symbol #° means that each element of the *j-th* row of the $\hat{V}\widehat{B_s}$ matrix has to be multiplied for the *j-th* row of the multiplier (respectively Y_{sr} and $A_{sr}L_{rr}Y_{rr}$ that are all 1 x G column vectors). Thus, FVA_{sr} is a N x G matrix where the element f_{iG} gives the FVA from country G in sector *i* exports from country *s* to *r*. Summing up for all the G-1 importer countries, we can obtain the total FVA in country *s*'s sectoral exports by source countries.

With the aim of identifying the productive ties of both Italy and other main exporter countries with their foreign sources of inputs, I select the top five suppliers of FVA for each country in each reference year (1995, 2007, 2011). I report the sum of the FVA shares of the

[94] See Section 3.2 in Wang et al. (2013) for their application of this measure.

top five suppliers as an indicator of the concentration of the geographical origin of imported inputs. Moreover, the tables provide the share of FVA by all the EU countries in the dataset[95] which, when analysing single EU exporter countries, can be considered as a proxy for the integration of the production networks within the EU[96]. As in Section 2.4.3, the focus is on Italy and other selected countries (namely Germany, USA, Japan and China) and on the *Machinery* and *Leather, leather products and footwear* sectors.

Among the main foreign source countries of value added in the Italian *Machinery* exports (Table 2.6), Germany is the leading supplier throughout the period. However, the most striking feature is the increasing role of China and, to a lesser extent Russia, in the Italian international supply chain and the corresponding decline of EU countries (Germany included). Excluding China, Italy strengthens its comparative advantage in this sector (see Table 2.1) with no radical changes in its main suppliers. Nevertheless, the weight of the top five suppliers on the whole FVA decreases by about 10% during the period, suggesting a lower concentration of the geographical origin of intermediate and unfinished goods in 2011 compared to 1995. The decrease of the FVA share of the top five suppliers is not constant, but a slight reversal of the trend is registered in 2011 compared to 2007, a feature common to all analysed advanced countries (see Table 2.7, 2.8, 2.10). This phenomenon could be interpreted as a sign of a consolidation of the supply chains since the economic crisis.

Table 2.6 Main source countries of FVA in Italian Machinery exports
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**18.02**		**20.37**		**20.52**	
Germany	3.78	(1)	3.47	(1)	3.20	(1)
China	0.23	(13)	1.01	(5)	1.54	(2)
France	2.24	(2)	1.56	(2)	1.42	(3)
Russia	0.69	(6)	0.78	(7)	1.32	(4)
USA	1.56	(3)	1.23	(3)	1.22	(5)
UK	1.20	(4)	1.12	(4)	0.77	(7)
Belgium	0.75	(5)	0.52	(9)	0.49	(9)
EU	11.25		11.05		9.88	
Top 5 supplier	9.52		8.39		8.68	
% of FVA	52.83		41.20		42.33	

Source: author's calculations on WIOD data, 2013 release.

95 The WIOD 2013 release covers 27 EU countries. See Appendix C.
96 The EU share considers in each year all the 27 EU countries (26, when the exporter is an EU country) and not only the countries that in the specific year are members of the UE. In this way, this avoids the increase of the FVA share from the EU countries being attributed to the process of enlargement of the EU, rather than to greater/smaller productive integration.

Table 2.7 Main source countries of FVA in German Machinery exports
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**14.41**		**20.99**		**22.14**	
China	0.22	(17)	1.29	(5)	2.17	(1)
USA	1.45	(2)	1.67	(1)	1.76	(2)
Italy	1.23	(3)	1.53	(3)	1.62	(3)
France	1.51	(1)	1.56	(2)	1.41	(4)
UK	1.14	(4)	1.30	(4)	1.06	(5)
Japan	0.86	(5)	0.98	(6)	0.90	(7)
EU	8.57		11.16		10.79	
Top 5 suppliers	6.19		7.35		8.01	
% of FVA	42.98		35.04		36.20	

Source: author's calculations on WIOD data, 2013 release.

Table 2.8 Main source countries of FVA in US Machinery exports
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**10.31**		**14.07**		**13.90**	
China	0.31	(10)	1.77	(2)	2.35	(1)
Canada	1.47	(2)	1.85	(1)	1.75	(2)
Mexico	0.55	(5)	1.05	(5)	1.17	(3)
Japan	1.83	(1)	1.10	(3)	1.01	(4)
Germany	0.89	(3)	1.10	(4)	0.94	(5)
UK	0.59	(4)	0.58	(6)	0.46	(7)
Italy	0.34	(9)	0.43	(7)	0.34	(8)
EU	3.30		3.72		3.23	
Top 5 suppliers	5.34		6.86		7.22	
% of FVA	51.79		48.78		51.95	

Source: author's calculations on WIOD data, 2013 release.

As for Italy, China performs a surprising progression as foreign supplier of value added in *Machinery* exports (moving from 17th place in 1995 to 1st place in 2011) for Germany as well (Table 2.7). The main difference between Italy and Germany is the EU countries' contribution: the FVA share sharply increased during the period, confirming the strengthening of its EU productive links especially with the Eastern European countries, as mentioned in the previous sections. The fact that Italy ranks third for the FVA share and shows an upturn, contributing to the growth of the EU share in German exports is worthy of note. Finally, the share of the top five suppliers in the total FVA is lower than Italy's: German's supply chain seems to be more fragmented since a larger number of countries are a strategic source in the production of its exports.

Moving from European exporter's supply chains to the USA one (Table 2.8) emphasises the strong regional focus of international production networks, already observed in other studies (Amador et al., 2014), a feature closely related to the fact that trade overall is still highly regional. Our results highlight, once again, the inseparable link between international trade and domestic production. When looking at Table 2.7, it is therefore not surprising that the main suppliers of FVA for the US *Machinery* exports include the NAFTA partner countries (Canada and Mexico). Moreover, the increasing FVA share of Mexico combined with that of China (the first source of FVA in 2011) can be attributed to their most recent role of processing hubs for many advanced economies in manufacturing sectors, performing mainly intermediate stages of production by processing imported inputs for re-exporting. Some studies have documented the specialization of those countries in assembly activities and led the researchers to differentiate the estimate of the input-output coefficients in computing value added trade when processing trade is prevalent (Koopman et al., 2012).

To fully understand the great importance of the productive links between US and China, bear in mind that the US figures at the top of the rankings as a supplier of FVA in the Chinese *Machinery* exports (Table 2.9). The same trend characterizes the EU share and especially those of Germany and Italy from 1995 to 2007. Conversely, from 2007 to 2011, the FVA share of all most industrialized economies faced a downturn because of the phenomenon of reshoring intermediate stages of production to the home country due to the economic crisis. Once again, the regional organization of global manufacturing production appears when looking at the main source countries in the Chinese exports, with Asia as an emerging hub alongside Europe and North America. Indeed, several Asian countries (Japan, South Korea and Taiwan) result among the top five suppliers of the Chinese *Machinery* exports.

Similar remarks about the prominent regional dimension of the supply chains can also be made for the Japanese exports in the *Machinery* sector where China, South Korea, Indonesia and Taiwan appear among the main source countries of FVA (Table 2.10). From 1995 to 2011, China and Indonesia showed an increasing trend whereas South Korea and Taiwan fell in the rankings. The Japanese supply chain has a considerable level of concentration. The EU share in Japanese exports is the lowest compared to the share in USA and Chinese exports, signalling weak productive links between Japan and Europe in this sector.

Table 2.9 **Main source countries of FVA in Chinese Machinery exports**
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**13.5**		**21.5**		**19.5**	
USA	1.50	(2)	2.50	(2)	2.20	(1)
Japan	3.46	(1)	3.03	(1)	2.17	(2)
Australia	0.54	(6)	1.13	(5)	1.77	(3)
Germany	0.75	(5)	1.81	(3)	1.42	(4)
South Korea	0.96	(4)	1.46	(4)	1.15	(5)
Taiwan	1.05	(3)	1.12	(6)	0.76	(6)
Italy	0.28	(10)	0.50	(9)	0.41	(11)
EU	2.57		4.97		3.72	
Top 5 suppliers	7.72		9.92		8.71	
% of FVA	57.38		46.21		44.66	

Source: author's calculations on WIOD data, 2013 release.

Table 2.10 **Main source countries of FVA in Japanese Machinery exports**
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**5.64**		**12.2**		**13.2**	
China	0.29	(4)	1.91	(1)	2.71	(1)
USA	1.35	(1)	1.68	(2)	1.44	(2)
South Korea	0.45	(2)	0.81	(3)	0.87	(3)
Australia	0.22	(7)	0.54	(5)	0.81	(4)
Indonesia	0.19	(9)	0.38	(7)	0.49	(5)
Germany	0.31	(3)	0.65	(4)	0.49	(6)
Taiwan	0.24	(5)	0.48	(6)	0.44	(8)
Italy	0.10	(13)	0.18	(12)	0.13	(13)
EU	1.10		2.10		1.57	
Top 5 suppliers	2.64		5.59		6.32	
% of FVA	46.82		45.63		47.77	

Source: author's calculations on WIOD data, 2013 release.

The evolution of the top five foreign suppliers of value added in the Italian *Leather, leather products and footwear* exports is presented in Table 2.11. As for *Machinery*, Germany is also the leading supplier of FVA to Italy in this sector revealing a productive link between the countries in a traditional labour intensive manufacturing sector as well. The most remarkable feature of the table is the rapid rise of China (which in a few years may overtake Germany), Russia and Brazil and the corresponding decline of France, UK and Australia. It highlights how Italy maintains its comparative advantage in this sector by modifying its international supply chain: only Germany and the USA remain among the top five suppliers. In addition, compared to the Italian supply chain in the *Machinery* sector (Table 2.6), the share of the top five suppliers in the *Leather, leather products and footwear* exported products is lower, signalling a broader network of countries suppliers in Italian sectoral exports.

More stable is the foreign supply chain in German exports (Table 2.12), in which only China emerges rising from 16th place in 1995 to 1st place in 2011 and mainly eroding Italy's share. The fall in the value added from Italy also seems to be the reason underlying the decreasing EU share in German exports that, nevertheless, remains above the EU share in Italian exports (Table 2.11), confirming a stronger production link of Germany with the European countries.

Although China becomes a significant supplier during the first decade of the 2000s for both Italy and Germany, the country was the first foreign supplier in the US *Leather, leather products and footwear* exports (Table 2.13) as early as 1995. In the period of analysis, China triples its contribution to the detriment of the other suppliers with the only exception of Mexico which shows extraordinary growth and rises from 10th to 3rd place. Overall, the USA sectoral supply chain becomes more and more concentrated (about 60% of the FVA comes from the top five suppliers in 2011).

On the contrary, the supply chain of the Chinese Leather exports is more and more fragmented (only about 34% of the FVA comes from the top five suppliers in 2011), where the top five suppliers in 1995 show a relevant decrease in their contribution (e.g. Japan remains in second place throughout the entire period but it more than halves its share of value added). In the 2000s, Brazil also emerges among the top five suppliers in Chinese exports.

Finally, looking at the Japanese supply chain in the *Leather, leather products and footwear* sector, Germany and Italy lose positions in favour of the USA, China and other regional suppliers such as Indonesia and South Korea. In particular, at the end of the period, Italy exits not only from the top five but also from the top ten major suppliers of FVA in Japanese exports.

However, compared with the supply chains in the *Machinery* sectors, the Italian trade specialization in *Leather, leather products and footwear* is more clearly reflected in its position among the top five suppliers in the supply networks of all the countries examined, at least in one out of the three years.

<u>Table 2.11</u> Main source countries of FVA in Italian Leather and footwear exports
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**15.27**		**17.65**		**18.26**	
Germany	2.13	(1)	1.92	(1)	1.67	(1)
China	0.28	(13)	0.83	(6)	1.52	(2)
USA	1.48	(3)	1.24	(2)	1.47	(3)
Russia	0.55	(8)	0.60	(8)	1.19	(4)
Brazil	0.42	(10)	0.99	(5)	1.17	(5)
France	1.64	(2)	1.18	(3)	0.98	(6)
UK	0.90	(4)	1.03	(4)	0.72	(7)
Australia	0.60	(5)	0.42	(11)	0.36	(11)
EU	7.66		7.81		6.51	
Top 5 suppliers	6.76		6.36		7.02	
% of FVA	44.24		36.02		38.44	

Source: author's calculations on WIOD data, 2013 release.

<u>Table 2.12</u> Main source countries of FVA in German Leather and footwear exports
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**14.41**		**20.99**		**22.14**	
China	0.22	(16)	2.83	(2)	4.29	(1)
Italy	4.81	(1)	3.28	(1)	2.57	(2)
USA	1.34	(3)	1.63	(3)	1.51	(3)
France	1.59	(2)	1.41	(5)	1.22	(4)
UK	1.01	(6)	1.51	(4)	1.22	(5)
Nederland	1.12	(4)	1.20	(6)	1.21	(6)
Austria	1.05	(5)	0.86	(7)	0.74	(7)
EU	13.30		13.62		11.69	
Top 5 suppliers	9.91		10.66		10.82	
% of FVA	68.80		50.77		48.86	

Source: author's calculations on WIOD data, 2013 release.

<u>Table 2.13</u> Main source countries of FVA in US Leather and footwear exports
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**14.17**		**16.32**		**15.44**	
China	2.08	(1)	4.52	(1)	5.85	(1)
Canada	1.09	(3)	1.26	(2)	1.02	(2)
Italy	1.28	(2)	1.21	(3)	0.88	(3)
Mexico	0.48	(10)	0.68	(4)	0.59	(4)
Germany	0.65	(7)	0.65	(5)	0.48	(5)
Brazil	0.73	(5)	0.62	(6)	0.42	(6)
Japan	0.79	(4)	0.50	(7)	0.41	(7)
EU	4.58		3.88		2.93	
Top 5 suppliers	5.97		8.32		8.81	
% of FVA	42.13		51.01		57.08	

Source: author's calculations on WIOD data, 2013 release.

Table 2.14 **Main source countries of FVA in Chinese Leather and footwear exports**
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**17.9**		**15.9**		**13.9**	
USA	2.18	(3)	1.70	(1)	1.57	(1)
Japan	2.38	(2)	1.39	(2)	0.96	(2)
Brazil	0.32	(12)	0.73	(7)	0.83	(3)
South Korea	2.70	(1)	1.16	(3)	0.73	(4)
Australia	0.50	(7)	0.49	(8)	0.64	(5)
Italy	1.64	(5)	0.80	(5)	0.54	(7)
Taiwan	1.87	(4)	0.81	(4)	0.50	(9)
EU	3.88		3.36		2.44	
Top 5 suppliers	10.77		5.86		4.73	
% of FVA	60.03		36.88		34.06	

Source: author's calculations on WIOD data, 2013 release.

Table 2.15 **Main source countries of FVA in Japanese Leather and footwear exports**
Unit: % of gross export, (n) position in the rankings of foreign suppliers of value added in sectoral exports

Year	1995		2007		2011	
FVA share of gross exports	**4.01**		**7.3**		**8.8**	
China	0.30	(2)	1.04	(1)	1.71	(1)
USA	0.75	(1)	0.86	(2)	0.88	(2)
Australia	0.16	(7)	0.36	(3)	0.54	(3)
South Korea	0.24	(3)	0.35	(4)	0.43	(4)
Indonesia	0.14	(9)	0.26	(6)	0.41	(5)
Germany	0.20	(5)	0.27	(5)	0.23	(7)
Italy	0.23	(4)	0.20	(7)	0.17	(11)
EU	0.98		1.18		1.00	
Top 5 suppliers	1.72		2.88		3.97	
% of FVA	42.95		39.33		44.99	

Source: author's calculations on WIOD data, 2013 release.

2.4.5 Supply and production links between Italy and its main partners

The decomposition by Wang et al. (2013) provides a broader knowledge of the bilateral links between countries that shape the geography of the production networks. In particular, the picture presented in Section 2.4.3 and 2.4.4 can be enhanced by a specific analysis of the bilateral trade flows at industry level because at this level some components acquire a remarkable economic meaning and enable commercial and productive linkages underlying export flows to be better detected.

To this purpose, as anticipated in Section 2.3, two of these components interest us most in this analysis. The first is the DVA_INTrex which contains the DVA in intermediate goods not absorbed by the direct importer which reaches third markets embedded in the direct importer's exports. Therefore, the direct importer is a commercial bridge to indirectly export the exporter's intermediate goods to third countries. The second relevant component is the MVA which is the share of value added in intermediate and final goods exports that came from the direct importer and then turns back to its country of origin. The higher the MVA share is, the greater the role of the exporter in processing inputs on behalf of the importer.

As in the previous sections, the focus is on the *Machinery* and *Leather*, *leather products and footwear* sector. I analyse Italian exports to its main destination markets, according to gross exports in 2011. For both sectors, the main destination markets for Italian exports are China, France, Germany, Russia and the USA[97].

When observing the export structure of the Italian *Machinery* sector to each of its main destination markets (Table 2.16), it is evident that the exports flow with Germany conceals greater supply and productive links with Italy. Indeed, a relevant share (about one-fifth in 2011) of the Italian value added in exports to Germany is not absorbed by the direct importer, but is shipped to third countries (DVA_INTrex).

Table 2.16 Value added decomposition of Italian gross exports in Machinery to its main destination markets

Main foreign markets	Year	BILATERAL GROSS EXPORTS in millions of US$	BILATERAL GROSS EXPORTS in % of total exports	DVA: DVA_FIN	DVA: DVA_INT	DVA: DVA_INTrex	FVA: MVA	FVA: OVA	RDV	PDC
				in % of gross bilateral exports						
China	1995	1469.17	*3.38*	71.26	6.94	**1.67**	**0.25**	19.39	0.04	0.46
	2007	4686.40	*4.88*	27.09	31.37	**16.02**	**0.96**	18.35	0.37	5.83
	2011	9431.76	*10.01*	29.37	33.49	**11.83**	**1.55**	19.18	0.25	4.33
France	1995	4187.52	*9.63*	53.62	16.92	**8.45**	**2.20**	15.51	0.76	2.54
	2007	8015.04	*8.35*	44.88	16.79	**12.22**	**1.56**	18.82	0.98	4.73
	2011	8076.80	*8.57*	45.20	16.72	**12.12**	**1.41**	19.03	0.89	4.64
Germany	1995	5008.55	*11.52*	49.53	16.40	**12.91**	**3.47**	13.06	0.89	3.74
	2007	8107.28	*8.45*	39.85	11.85	**21.68**	**2.90**	14.14	1.42	8.16
	2011	9443.00	*10.02*	40.24	12.50	**20.99**	**2.71**	14.66	1.14	7.76
Russia	1995	1504.84	*3.46*	45.53	25.63	**7.91**	**0.68**	17.20	0.65	2.40
	2007	3621.91	*3.77*	39.91	25.95	**8.56**	**0.84**	20.96	0.47	3.31
	2011	5377.52	*5.71*	40.79	25.24	**8.12**	**1.40**	20.43	0.74	3.29
USA	1995	3546.89	*8.16*	51.16	23.83	**4.75**	**1.63**	17.18	0.09	1.37
	2007	7553.30	*7.87*	44.31	24.86	**5.72**	**1.38**	21.46	0.09	2.18
	2011	7178.73	*7.62*	44.92	23.67	**6.36**	**1.35**	21.28	0.09	2.34

Source: author's calculations on WIOD data, 2013 release.

[97] Germany is the main market for Italian *Machinery* exports, followed by China, France, the USA and Russia whereas in *Leather*, *leather products* and footwear, the USA is at the top of the rankings followed by China, Russia, France and Germany. Thus, with the term "main destination markets" I refer to the main importers.

The MVA share is also higher in the Italian bilateral exports to Germany signalling that in the *Machinery* sector Italy is an important processing hub especially for Germany rather than for the other countries in the table which include some of the major world exporters. Therefore, it is not surprisingly that exports to Germany record a relevant share of PDC because intermediate goods cross the border multiple times due to the productive linkages described above. This outcome reflects the central position of Germany in European manufacturing which has already been underlined by other studies using standard data (Veugelers R., 2013) and its great ability to become China's privileged partner in a number of productions including mechanics (Foresti and Trenti, 2011).

Table 2.17 Value added decomposition of Italian gross exports in Leather, leather products and footwear to its main destination markets

Main foreign markets	Year	BILATERAL GROSS EXPORTS		DVA			FVA		RDV	PDC
		in millions of US$	in % of total exports	DVA_FIN	DVA_INT	DVA_INTrex	MVA	OVA		
				in % of gross bilateral exports						
China	1995	575.35	*4.77*	25.30	31.11	**26.13**	**0.21**	11.15	0.52	5.59
	2007	1104.39	*5.69*	22.74	25.90	**30.46**	**0.56**	11.36	0.96	8.02
	2011	2324.59	*11.07*	47.87	17.09	**14.27**	**1.37**	15.11	0.41	3.88
France	1995	1301.95	*10.79*	76.85	3.16	**2.91**	**1.73**	14.37	0.27	0.70
	2007	2104.95	*10.85*	72.77	2.63	**4.21**	**1.23**	17.25	0.64	1.27
	2011	1649.48	*7.86*	72.60	2.63	**3.91**	**1.02**	18.07	0.56	1.21
Germany	1995	2239.87	*18.56*	69.15	7.52	**6.07**	**2.15**	13.28	0.40	1.44
	2007	1757.87	*9.06*	68.70	1.67	**9.15**	**1.87**	15.36	0.71	2.54
	2011	1500.07	*7.14*	70.05	1.99	**7.05**	**1.67**	16.61	0.59	2.04
Russia	1995	541.14	*4.48*	74.22	7.44	**1.30**	**0.59**	15.84	0.20	0.41
	2007	1662.63	*8.57*	77.30	2.41	**0.54**	**0.66**	18.88	0.04	0.17
	2011	2050.48	*9.76*	76.58	2.52	**0.57**	**1.31**	18.77	0.06	0.19
USA	1995	2508.11	*20.78*	52.02	27.54	**3.52**	**1.55**	14.45	0.07	0.85
	2007	3509.05	*18.09*	63.48	14.03	**2.70**	**1.33**	17.65	0.05	0.76
	2011	2466.42	*11.75*	55.71	20.79	**3.13**	**1.56**	17.85	0.05	0.90

Source: author's calculations on WIOD data, 2013 release.

When looking at the MVA share in Table 2.17, it is evident that also in the *Leather, leather products and footwear* sector, Italy participates more in the production network of Germany than of other countries. However, in terms of commercial linkages, China is the main country where Italian intermediate inputs are processed and assembled in more complex intermediate goods or in final goods destined for third countries. This result confirms and supports the remarks in Section 2.4.1 on the restructuring process of this sector in the Italian productive system and in other studies that discuss the emergence of China in the *Leather*,

leather products and footwear sector (Milone, 2015) and, more in general, in all sectors related to the fashion industry (De Nardis and Traù, 2005; Schütz and Palan, 2016). On the contrary, the structure of Italian exports to Russia is dominated by a higher share of DVA_FIN, suggesting that it is mainly a consumer market for Italian products.

2.5 Synthesis of outcomes and conclusions

The accounting frameworks used to decompose gross exports recently proposed by some influential methodological works (Koopman et al. 2014; Wang et al., 2013) can be used to estimate the domestic value added content of exports for some selected countries, Italy included, but also provide useful insights into the organization of their supply and production networks. In Sections 2.4.1 and 2.4.2, I have offered an analysis of the RSCA indexes calculated in value added for both Italy and its main competitors at the industry level. In a world with an increasing fragmentation of production, this value added index provides a more adequate assessment of trade specialization. In Section 2.4.3, I analysed the sectoral export structure to define the role of countries within the global supply and production networks. Sections 2.4.4 and 2.4.5 have widened this analysis by examining the bilateral dimension and identifying the main source countries of foreign value added (suppliers) in country exports and the bilateral links between Italy and the main destination markets (consumers) of its exports.

The main results for Italy can be summarized as follows:

- First, the descriptive analysis of Italy's comparative advantages measured in value added largely confirms the pattern of trade specialization described in the literature based on traditional gross statistics. Specifically, *Leather, leather products and footwear* and *Machinery* are confirmed to be the main sectors of Italian trade specialization and both sectors have increased their comparative advantage over time. *Coke, refined petroleum and nuclear fuel* remains the industry in which Italy records the largest despecialization. A decline in the intensity of specialization is instead noted in some traditional industries (*Manufacturing, n.e.c. and Recycling,* including furniture, *Textiles and textile products* and *Other non-metallic mineral,* including building materials and ceramics). However, focusing on the domestic value added in exports, the Italian specialization pattern is not completely aligned to the one arising from gross trade data. In particular, RSCA in value added determines a different rank of some sectors of specialization and brings to light a greater specialization in those sectors which export indirectly a large share of value added, through the exports of other sectors (*Wood and products of wood and cork* in the case of Italy). Thus, traditional analysis tends to underestimates the role of these sectors in the composition of exports in the country. Therefore, the analysis of trade specialization with value added data gives a more accurate assessment of the importance of the individual sectors throughout the productive system of the country, taking advantage of the input-output approach that considers productive linkages among all national sectors. Finally, combining an analysis of the sectoral composition of exports with the results of recent studies on Italian trade performance and competitiveness and moving from traditional data to a value added approach, the negative effect on the dynamics of Italian market shares turns out to be due to changes in GVC participation rather than to its trade specialization. This outcome, together with the growing specialization in the *Machinery* sectors observed in my analysis, partly mitigates the negative judgment generally attributed to the "anomaly" of Italian specialization and emphasizes that policy measures that aim to improve trade specialization and performance should consider that each country is part of a complex network of competitive and collaborative relationships.

- Second, when comparing Italy with its main "competitors" at international level, using value added data as well, Italy remains the country with the most relevant comparative advantages in the *Leather, leather products and footwear* sector. In the other sectors, the analysis indicates the growing role of some new EU members as international "competitors" in the creation of value added in exports. This outcome is consistent with the process of outsourcing and relocation of activities in these countries by many European manufacturing firms which is well documented in the literature. Thus, the rankings of countries by RSCA in value added bring to the top countries that compete with each other in the same final markets, but also countries that are processing, assembly and production hub within a global production network. Compared with traditional analysis, the "lenses of value added" highlight that the role of many countries is increasingly configured to act as global "partners" in the production processes fragmented at the international level, rather than only as "competitors" in the conventional sense.
- Moving on to sectoral analysis, the structure of the Italian exports in the *Machinery* sector appears similar to the German one but with a less prominent RDV share, reflecting a more downstream position and a lower level of internationalization of the production of exported goods of Italy. Italy has strengthened its comparative advantage without making substantial

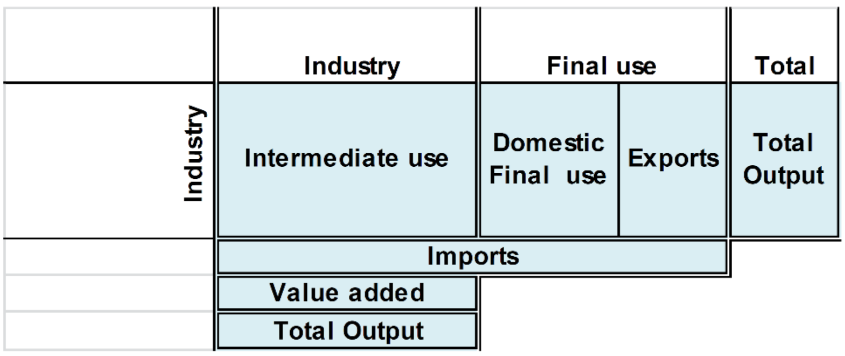
shifts in its international suppliers, except for China, and maintaining strong supply links with the European countries. In particular, when considering the bilateral dimension, Italy presents solid productive integration with Germany, which also represents an important commercial bridge to third markets. Moving on to the *Leather, leather products and footwear* sector, small changes have affected the structure of Italian exports from 1995 to 2011, confirming the consolidation of the international fragmentation of production in this field which is well documented in sectoral studies. In addition to China, in recent years Russia and Brazil have also emerged as main foreign suppliers of value added in Italian exports. Moreover, Italy has strengthened its supply and productive linkages with China, which enable to Italian intermediate goods to reach third markets, at the expense of European countries. In both sectors, the outcomes are in line with the literature. However, the advantage of using new export accounting methodologies is that they provide an effective way of summarizing the main features of the sectoral productive networks between countries and monitoring their trends, making it possible to quickly check items usually obtained through multiple analysis. Moreover, from a conceptual point of view, "the lenses of value added" replace the traditional customers and suppliers analysis with a more detailed wisdom that inserts the bilateral trade and production links into multilateral networks.

Overall, even though it uses export decomposition methods, the value added approach has the advantage of strengthening the perception of the level of productive integration (and interdependence) among countries, rather than that of fragmentation and of favouring a vision of the countries in terms of partnerships and not only competition. Both items could be relevant for policymaking.

To conclude, it is useful to bear in mind that by combining different methodologies we can take full advantage of the informative potential of the new value added datasets, obtaining a very large amount of results that deserve to be carefully interpreted. This promising field of study is relatively young and therefore much more work needs to be done in order to improve our understanding of the international fragmentation of production "through the lenses of value added". This will certainly be part of my future research agenda.

Appendix A - National and world input-output tables: concepts and basic notation

A national input-output table (IOT) is a schematic representation of all flows of final and intermediate goods and services between producers and consumers within a country. It is usually constructed according to industry outputs (industry × industry table)[98], as in Figure A.1. It provides detailed information on the supply and use of goods, covering all sectors in the economy and showing how output from one sector becomes input to another. This structure of the inter-industrial relationships is summarized in the inter-industry square matrix (or intermediate matrix) where row entries represent outputs from a given sector and column entries represent inputs to a sector. The inter-industry matrix is flanked by a "final demand" column in order to record the use of final goods within the country. To consider the relationship with foreign counties, the input-output table is completed with an "exports" column and an "imports" row. They present, respectively, the value of the final and intermediate goods absorbed abroad or bought from abroad and domestically absorbed. "Total output" is the sum by rows of the inter-industry matrix and "final demand" and "exports" columns. The "value added" vector results from the difference between "total output" and the sum by columns of the inter-industry matrix and "imports" row and indicates the value added by the use of domestic labour and capital services to the value of the intermediate inputs. In a IOT nothing is said about the specific countries of destination of exports or the countries of origin of imports.



<u>Figure A.1</u> Schematic outline of national input-output table (IOT), from Timmer et al. (2012)

[98] They can either show flows of final and intermediate goods and services defined according to product outputs (product × product table), but use of this kind of table is less common.

To overcome this shortcoming, empirical literature started to compile inter-country input-output (ICIO) tables. Figure A.2 presents a schematic outline of an ICIO table in the simple case of a world with only three regions and a description of the main blocks that form an ICIO table. This tool combines both national and international flows of products of several countries and sectors in one single table, making the information on the country of origin of each good or service explicit. This information is contained in the sub-matrix of intermediate inputs and final goods. Along the rows, the use of products is broken down according to their country and sector of destination and it is now clear how the exports of a country are being used abroad (by which industry or final end user). In the columns, on the other hand, it shows from which country and industry the product was produced and from which foreign industry the imports originate.

		Country A Intermediate *Industry*	Country B Intermediate *Industry*	Rest of World Intermediate *Industry*	Country A Final domestic	Country B Final domestic	Rest of World Final domestic	Total
Country A	*Industry*	Intermediate use of domestic output	Intermediate use by B of exports from A	Intermediate use by RoW of exports from A	Final use of domestic output	Final use by B of exports from A	Final use by RoW of exports from A	Output in A
Country B	*Industry*	Intermediate use by A of exports from B	Intermediate use of domestic output	Intermediate use by RoW of exports from B	Final use by A of exports from B	Final use of domestic output	Final use by RoW of exports from B	Output in B
Rest of World (RoW)	*Industry*	Intermediate use by A of exports from RoW	Intermediate use by B of exports from RoW	Intermediate use of domestic output	Final use by A of exports from RoW	Final use by B of exports from RoW	Final use of domestic output	Output in RoW
		Value added	Value added	Value added				
		Output in A	Output in B	Output in RoW				

Figure A.2 Schematic outline of ICIO table (three regions), from Timmer et al. (2012)

In order to clarify the information in the main blocks that form an ICIO table and introduce the basic notation used to describe the relationships between the different blocks, I consider the general case of G countries producing and exporting intermediate inputs and final good in N sectors that can be represented with the scheme reported in Figure A.3.

<table>
<tr><td colspan="3" rowspan="3"></td><th colspan="10">Intermediate use</th><th colspan="4">Final use</th><th rowspan="3">Total output</th></tr>
<tr><td colspan="3">Country s</td><td colspan="3">Country r</td><td>…</td><td colspan="3">Country G</td><td rowspan="2">Country s</td><td rowspan="2">Country r</td><td rowspan="2">…</td><td rowspan="2">Country G</td></tr>
<tr><td>Sector 1</td><td>…</td><td>Sector N</td><td>Sector 1</td><td>…</td><td>Sector N</td><td>…</td><td>Sector 1</td><td>…</td><td>Sector N</td></tr>
<tr><th rowspan="10">Intermediate inputs</th><td rowspan="3">Country s</td><td>Sector 1</td><td colspan="3" rowspan="3">Z_{ss}</td><td colspan="3" rowspan="3">Z_{sr}</td><td rowspan="3">…</td><td colspan="3" rowspan="3">Z_{sG}</td><td rowspan="3">Y_{ss}</td><td rowspan="3">Y_{sr}</td><td rowspan="3">…</td><td rowspan="3">Y_{sG}</td><td rowspan="3">X_s</td></tr>
<tr><td>…</td></tr>
<tr><td>Sector N</td></tr>
<tr><td rowspan="3">Country r</td><td>Sector 1</td><td colspan="3" rowspan="3">Z_{rs}</td><td colspan="3" rowspan="3">Z_{rr}</td><td rowspan="3">…</td><td colspan="3" rowspan="3">Z_{rG}</td><td rowspan="3">Y_{rs}</td><td rowspan="3">Y_{rr}</td><td rowspan="3">…</td><td rowspan="3">Y_{rG}</td><td rowspan="3">X_r</td></tr>
<tr><td>…</td></tr>
<tr><td>Sector N</td></tr>
<tr><td>…</td><td>…</td><td colspan="3">…</td><td colspan="3">…</td><td>…</td><td colspan="3">…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td rowspan="3">Country G</td><td>Sector 1</td><td colspan="3" rowspan="3">Z_{Gs}</td><td colspan="3" rowspan="3">Z_{Gr}</td><td rowspan="3">…</td><td colspan="3" rowspan="3">Z_{GG}</td><td rowspan="3">Y_{Gs}</td><td rowspan="3">Y_{Gr}</td><td rowspan="3">…</td><td rowspan="3">Y_{GG}</td><td rowspan="3">X_G</td></tr>
<tr><td>…</td></tr>
<tr><td>Sector N</td></tr>
<tr><th colspan="3">Value added</th><td colspan="3">va_s</td><td colspan="3">va_r</td><td>…</td><td colspan="3">va_G</td></tr>
<tr><th colspan="3">Total output</th><td colspan="3">$(X_s)'$</td><td colspan="3">$(X_r)'$</td><td>…</td><td colspan="3">$(X_G)'$</td></tr>
</table>

Figure A.3 Schematic outline of ICIO table with G countries and N sectors

If we focus on country *s* (exporter) and on the relationship between *s* and one of its direct importer, country *r*, we can define the following:

- Z_{ss} is the N x N matrix of intermediate inputs produced and used in country *s*;
- Z_{sr} is the N x N matrix of intermediate inputs produced in country *s* and used in country *r*; thus, the N x 1 vector of gross sectoral exports of intermediate goods from *s* to all other G countries (Z_{s*}) can be computed as the sum by row of the Z_{sr} matrices with $r \neq s$;
- Y_{ss} is the N x 1 vector of final goods produced and consumed in country *s*;
- Y_{sr} is the N x 1 vector of final goods produced in country *s* and exported to *r*; thus, the N x 1 vector of gross sectroral exports of final goods from *s* to all other G countries can be obtained as:

$$Y_{s*} = \sum_{r \neq s}^{G} Y_{sr} \qquad (A1)$$

Y is the GN x 1 vector of final goods the entire ICIO scheme;

- X_s is the N x 1 column vector of the gross output of country *s* and it is obtained as the sum by row of Z_{ss}, Z_{sr} with $r \neq s$ and Y_{sr} with $r \neq s$; $(X_s)'$ is the transposition of X_s in a row vector of dimension 1 x N; X is the GN x 1 vector of the gross output of the entire ICIO scheme;

- va_s is the 1×N vector of value added generated in country s and it can be computed by subtracting by each element of (X_s)' the sum by column of G matrices that report the produced or imported intermediate inputs used by s in its production processes (Z_{ss}, Z_{rs}, …, Z_{Gs}).

Within this ICIO scheme, the well-known fundamental equation states that each unit of gross output can be either consumed as a final good or used as an intermediate good, both in country s and abroad:

$$X_s = \sum_{r}^{G} (A_{sr} X_r + Y_{sr}) \qquad \text{(A2)}$$

where A_{sr} is the N x N matrix of coefficients for intermediate inputs produced in s and used in the production of r, which is computed by dividing the elements in each column of intermediate matrix Z_{sr} by the corresponding element of the total sectoral gross output row vector (X_r) and describes how much intermediate inputs produced and exported by country s are needed to produce a unit of output in country r. A is the GN x GN matrix of coefficients for intermediate inputs of the entire ICIO scheme. By restricting the summation to all r ≠ s, we can obtain the country s's gross exports to the world (see equation (1) in Section 2.3.1).

From equation (A2) we can to derive the basic relationship between gross output (X) and final demand (Y):

$$X = AX + Y = (I - A)^{-1} Y = BY \qquad \text{(A3)}$$

where B denotes the GN x GN Leontief inverse matrix, in which each N x N block, e.g. B_{sr} indicates how much of each country s's gross output of a certain good is required to produce one unit of country r's final production.

Appendix B - Datasets

The inadequacy of official trade statistics to provide the data required to analyse the extension, features and impact of the international fragmentation of production and trade in value added drove researchers to compile their own databases.

Among these initiatives, there are various attempts to merge international trade statistics with a collection of national input-output tables from the Global Trade Analysis Project (GTAP) into a world input-output table (e.g. Johnson and Noguera, 2012; Koopman et al., 2014) and some global input-output dataset, i.e. the Asian International Input–Output Tables constructed by Institute of Developing Economies–Japan External Trade Organization (IDE-JETRO); Eora (Lenzen et al., 2013); the TiVA database by OECD–WTO and the World Input–Output Database (WIOD).

Table B1 summarizes the main features of these datasets in terms of countries, sectors and time coverage.

Table B.1 **Dataset for research on value added exports**

Dataset	Key features	Website
EORA	Multi-region input-output table database for 129 regions and 120 sectors, in a time series spanning the period 1990–2011	http://www.worldmrio.com/
Global Trade Analysis Project Database (GTAP)	Input-output tables for 140 regions, 57 sectors, 8 factors of production, for 3 base years (2004, 2007 and 2011)	https://www.gtap.agecon.purdue.edu
IDE-JETRO Asian Input-Output Tables	Regional tables covering 10 East Asian countries, namely China, Indonesia, Korea, Malaysia, Taiwan, the Philippines, Singapore, Thailand and Japan, and the United States of America, at five-year intervals between 1985 and 2005, published at 24/76 or 78 sectors	http://www.ide.go.jp
OECD Input-Output Tables	Input-output tables for OECD countries and major emerging markets, covering the years from 1995 to 2011 and 34 sectors	http://www.oecd.org /trade/input-outputtables.htm
World Input-Output Database (WIOD), 2013 release	Global tables covering 27 members of the EU (as from 1 January 2007) and 13 other major economies for the period 1995–2011, and 35 sectors	http://www.wiod.org
World Input-Output Database (WIOD), 2016 release	Global tables covering 28 members of the EU (as from 1 July 2013) and 15 other major economies, for the period 2000-2014, and 56 sectors	http://www.wiod.org
WTO-OECD TiVA Database (Trade in Value Added)	Value-added exports and other measures of global supply chain activity for 57 countries in 1995, 2000, 2005, 2008, 2009, 2010 and 2011	http://stats.oecd.org

Source: updated from Johnson (2014) by consulting the mentioned websites

Appendix C - WIOD 2013 release: countries and sectors' coverage

Table C.1 **Country Coverage of WIOD (Release 2013)**

European Union	North America / Latin America / Asia and Pacific
Austria	**North America**
Belgium	Canada
Bulgaria	United States
Cyprus	
Czech Republic	**Latin America**
Denmark	Brazil
Estonia	Mexico
Finland	
France	
Germany	
Greece	**Asia and Pacific**
Hungary	Australia
Ireland	China
Italy	Indonesia
Latvia	India
Lithuania	Japan
Luxembourg	Russia
Malta	South Korea
Netherlands	Turkey
Poland	Taiwan
Portugal	
Romania	
Slovak Republic	
Slovenia	
Spain	
Sweden	
United Kingdom	

Table C.2 **Industry Coverage of WIOD (Release 2013)**

ISIC Rev. 3 Code	Industry	Categories
AtB	Agriculture, Hunting, Forestry and Fishing	Primary sectors
C	Mining and Quarrying	
15t16	Food, Beverages and Tobacco	Manufacturing sectors
17t18	Textiles and Textile Products	
19	Leather, Leather and Footwear	
20	Wood and Products of Wood and Cork	
21t22	Pulp, Paper, Paper , Printing and Publishing	
23	Coke, Refined Petroleum and Nuclear Fuel	
24	Chemicals and Chemical Products	
25	Rubber and Plastics	
26	Other Non-Metallic Mineral	
27t28	Basic Metals and Fabricated Metal	
29	Machinery, n.e.c.	
30t33	Electrical and Optical Equipment	
34t35	Transport Equipment	
36t37	Manufacturing, n.e.c.; Recycling	
E	Electricity, Gas and Water Supply	Service sectors
F	Construction	
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	
H	Hotels and Restaurants	
60	Inland Transport	
61	Water Transport	
62	Air Transport	
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	
64	Post and Telecommunications	
J	Financial Intermediation	
70	Real Estate Activities	
71t74	Renting of M&Eq and Other Business Activities	
L	Public Admin and Defence; Compulsory Social Security	
M	Education	
N	Health and Social Work	
O	Other Community, Social and Personal Services	
P	Private Households with Employed Persons	

References

Accetturo A. and Giunta A. (2015), Value Chains and the Great Recession: evidence from Italian and German firms, Bank of Italy, Occaional Paper No. 304

Ali-Yrkkö, J. (2010). Nokia and Finland in a Sea of Change. ETLA kirjasarja B, 244.

Amador J., Cappariello R., Stehrer R. (2014), Global value chains: a view from the euro area, Banco de Portugal Working Paper

Amighini A., Leone M. and Rabellotti R. (2011), Persistence versus change in the International specialization pattern of Italy: how much does the “districts effect” matter?, Regional Studies, Vol. 45, No. 3, pp. 381-401.

Antràs P., Chor D., Fally T. and Hillberry R. (2012), Measuring the Upstreamness of Production and Trade Flows, The American Economic Review, Vol. 102, No. 3, pp. 412-416.

Antràs P. and Chor D. (2013), Organizing the global value chain, Econometrica, Vol. 81, No. 6, pp. 2127-2204.

Arndt S. and Kierzkowski H. (ed.) (2001), Fragmentation: New Production and Trade Patterns in the World Economy, Oxford: Oxford University Press.

Athukorala P. C. and Yamashita N. (2008), Patterns and determinants of production fragmentation in world manufacturing trade, in Globalisation, Regionalism and Economic Interdependence, Cambridge: Cambridge University Press, pp. 45-72.

Balassa B. (1965), Trade Liberalization and ‘Revealed’ Comparative Advantage, The Manchester School, Vol. 33, No. 2, pp. 99–123.

Baldone S., Sdogati F. and Tajoli L. (2007), On some effects of international fragmentation of production on comparative advantages, trade flows and the income of countries, The World Economy, Vol. 30, No.11, pp. 1726-1769.

Baldwin R. (2006), Globalization: the great unbundling(s), Chapter 1, in Globalization challenges for Europe, Secretariat of the Economic Council, Finnish Prime Minister’s Office, Helsinki.

Baldwin R. (ed.) (2009), The great trade collapse: Causes, Consequences and Prospects, CEPR.

Baldwin R. (2011), Trade and industrialisation after globalisation's 2nd unbundling: How building and joining a supply chain are different and why it matters, NBER Working Paper, n. 17716.

Baldwin R. (2014), Factory-free Europe? A two unbundling perspective on Europe’s 20th century manufacturing miracle and 21st century manufacturing malaise**,** The Graduate Institute Geneva, Working Paper n. 80.

Baldwin R. and Venables, A. J. (2013), Spiders and snakes: offshoring and agglomeration in the global economy, Journal of International Economics, 90(2), 245-254.

Borin A. and Mancini M. (2015), Follow the value added: bilateral gross export accounting, Bank of Italy, Working Paper No. 1026.

Borin A. and Mancini M. (2017, *forthcoming*), Participation In Global Value Chains: Measurement Issues And The Place Of Italy, Journal of Economic Policy

Cappariello R. and Felettigh A. (2015), How does foreign demand activate domestic value added? A comparison among the largest euro-area economies, Bank of Italy, Working Paper No. 1001.

Centro Studi Confindustria (2014), In Italia la manifattura si restringe. Nei paesi avanzati le politiche industriali puntano sul territorio, Scenari Industriali n. 5, Roma.

Dalum B., Laursen K. and Villumsen G. (1998), Structural Change in OECD Export Specialization Patterns: De-specialization and “Stickiness”, International Review of Applied Economics, Vol. 12, No. 3, pp. 423-443.

Daudin G., Rifflart C. and Schweisguth D. (2011), Who Produces for Whom in the World Economy?, Canadian Journal of Economics, Vol. 44, No. 4, pp. 1409-1538.

Deb K. and Basu P. (2011), Indices of Revealed Comparative Advantage and their consistency with the Heckscher-Ohlin theory, Foreign Trade Review, Vol. 45, No. 3, pp. 3-28.

Deb K. and Hauk Jr W. R. (2015), RCA indices, multinational production and the Ricardian trade model, International Economics and Economic Policy, Vol. 13, No. 45, pp. 1-25.

De Benedictis L. (2005), Three Decades of Italian Comparative Advantages, The World Economy, Vol. 28, No. 11, pp. 1679-1709.

De Benedictis L., Gallegati M. and Tamberi M. (2009), Overall trade specialization and economic development: countries diversify, Review of World Economics, Vol. 145, No. 1, pp. 37-55.

De Nardis S. and Traù F. (2005), Il modello che non c’era. L’Italia e la divisione internazionale del lavoro industriale, Rubbettino.

De la Cruz J., Koopman R., Wang Z. and Wei S. (2011), Estimating foreign value-added in Mexico’s manufacturing exports, Washington, DC: US Internat. Trade Commission, Off. of Economics.

Egger H. and Egger P. (2001), Cross-border sourcing and outward processing in EU manufacturing, North American Journal of Economics and Finance, Vol. 12, No. 3, pp. 243–256.

Egger H. and Egger, P. (2005), The determinants of EU processing trade, The World Economy, Vol. 28, No. 2, pp. 147-168.

European Commission (2014), For a European Industrial Renaissance, COM/2014/014

Faini R. and Sapir A. (2005), Un Modello Obsoleto? Crescita e specializzazione dell’economia italiana” in Boeri T., Faini R., Ichino A., Pisauro G. and Scarpa C. (eds.), (2005) Oltre il declino, Il Mulino.

Felettigh A. and Oddo G. (2016), Market share in manufacturing value added: is the picture different?, Bank of Italy, Working Paper No. 336.

Feenstra R. (1998), Integration of Trade and Disintegration of Production in the Global Economy, Journal of Economic Perspectives, Vol. 12, No. 4, pp. 31–50.

Foresti G. and Trenti S. (2011), Struttura e performance delle esportazioni: Italia e Germania a confronto, Intesa Sanpaolo, Servizio Studi e Ricerche, Torino.

Grossman G. M. and Rossi-Hansberg E. (2008), Trading tasks: A simple theory of offshoring, The American Economic Review, 98(5), 1978-1997.

Hanson G. H. (2012), The rise of middle kingdoms: emerging economies in global trade, Journal of Economic Perspectives, Vol. 26, No. 2, pp. 41-64.

Helg R. and Tajoli, L. (2005), Patterns of international fragmentation of production and the relative demand for labor, The North American Journal of Economics and Finance, Vol. 16, No. 2, pp. 233-254.

Hoen A. R. and Oosterhaven J. (2006), On the Measurement of Comparative Advantage, Annals of Regional Science, Vol. 40, pp. 677–91

Hummels D., Ishii J. and Yi K. (2001), The Nature and Growth of Vertical Specialization in World Trade, Journal of International Economics, Vol. 54, pp. 75-96.

Iapadre L. (2001), Measuring International Specialization, International Advances in Economic Research, Vol. 7, n. 2, pp. 173-183.

Iapadre L. (2011), Trade and Employment in Italy, OECD Trade Policy Working Papers, n. 126.

Irwin D. (1996), The United States in a New World Economy? A century's perspective, American Economic Review, Vol. 86, No. 2, pp. 41-46.

Istat (2015), Rapporto sulla Competitività dei Settori Produttivi, on line at www.istat.it

Johnson R. (2014), Five Facts about Value-Added Exports and Implications for Macroeconomics and Trade Research, Journal of Economic Perspectives, Vol. 28, No. 2, pp. 119-142.

Johnson R. and Noguera G. (2012a), Accounting for Intermediates: Production Sharing and Trade in Value Added, Journal of International Economics, Vol. 82, No. 2, pp. 224–236.

Johnson R. and Noguera G. (2012b), Fragmentation and Trade in Value Added over Four Decades, NBER Working Paper, n. 18186.

Jones R. W. and Kierzkowski H. (1990), The Role of Services in Production and International Trade: A Theoretical Framework, in, in Jones R.W. and Krueger A. (ed.), The Political Economy of International Trade, Oxford: Blackwells.

Koopman R., Powers W., Wang Z. and Wei S. (2011), Give Credit Where Credit Is Due: Tracing Value Added in Global Production Chains, NBER Working Paper, n. 16426.

Koopman R., Wang Z. and Wei S. (2012), Estimating domestic content in exports when processing trade is pervasive, Journal of Development Economics, Vol. 99, No. 1, pp. 178-189.

Koopman R., Wang Z. and Wei S. (2014), Tracing Value-added and Double Counting in Gross Exports, American Economic Review, Vol. 104, No. 2, pp. 459-494.

Kraemer K. L., Linden, G. and Dedrick, J. (2011), Who captures value in the Apple iPad and iPhone?, Personal Computing Industry Center (PCIC) Working Paper, University of California, Irvine.

Krugman P. (1996), Does third world growth hurt first world prosperity?, Harvard Business Review, Vol. 72, Issue 4, pp. 113-121.

Lafay J. (1992), The measurement of Revealed Comparative Advantages, in International Trade Modelling, Chapman & Hall, London, pp. 209-234.

Laursen K. (2015), Revealed comparative advantage and the alternatives as measures of international specialization, Eurasian Business Review, Vol. 5, No. 1, pp. 99-115.

Lenzen M., Moran D., Kanemoto K. and Geschke A. (2013), Building Eora: a Global Multi-Region Input-Output Database at High Country and Sector Resolution, Economic Systems Research, Vol. 25, No. 1, pp.20-49.

Leontief W. W. (1936), Quantitative input and output relations in the economic systems of the United States, The Review of Economics and Statistics, Vol. 18, No. 3, pp. 105-125

Linden G., Kraemer K. L. and Dedrick J. (2009), Who captures value in a global innovation network?: the case of Apple's iPod, Communications of the ACM, Vol. 52, No. 3, pp. 140-144.

Los B., Timmer M. and de Vries G. (2015), How global are global value chains? A new approach to measure international fragmentation, Journal of Regional Science, Vol. 55, No. 1, pp. 66–92.

Mariotti S. and Mutinelli M. (2012), Italia multinazionale 2012, Rubbettino.

Mazzeo E. and Proietti A. (2013), Le quote di mercato dei principali paesi europei: aggiornamento dell’esercizio di constant market share analysis, Rapporto ICE 2012-2013 “L’Italia nell’economia internazionale”.

Milone C. (2015), Mercato pelle e calzature del futuro tra sfide sociali ed economia mondiale, Editrice Assomac.

Miroudot S., Lanz R. and Ragoussis A. (2009), Trade in Intermediate Goods and Services, OECD Trade Policy Papers, No. 93, OECD Publishing, Paris.

Miroudot S. and Ragoussis A. (2009), Vertical Trade, Trade Costs and FDI, OECD Publishing, OECD Trade Policy Papers, n. 89.

Montalbano P. and Nenci S. (2012), The Trade Specialization of China, India, Brazil, and South Africa: A Threat to Whom?, The International Trade Journal, Vol. 26, No. 5, pp. 363-384.

Nagengast A. and R. Stehrer (2014), Collateral Imbalances in Intra-European Trade? Accounting for the Differences between Gross and Value Added Trade Balances, Working Paper Series, No. 1695.

Nunn N. (2007), Relationship-Specificity, Incomplete Contracts, and the Pattern of Trade, Quarterly Journal of Economics, Vol. 122, No. 2, pp. 569-600.

Saladini M. (1998), Le esportazioni italiane di calzature e il contributo dei principali distretti produttivi, “Rapporto sul Commercio Estero”, ICE.

Santomartino V. (2014), Il modello di specializzazione commerciale dell’economia italiana: evoluzione recente e confronto con gli altri principali paesi dell’Area dell’euro, Rapporto ICE 2013-2014 “L’Italia nell’economia internazionale”.

Schütz M. H. and Palan N. (2016), Restructuring of the international clothing and textile trade network: the role of Italy and Portugal, Journal of Economic Structures, Vol. 5, No. 1, pp. 1-29.

Spencer B. J., (2005), International outsourcing and incomplete contracts, Canadian Journal of Economics, Vol. 38, Issue 4, 1107–1135.

Stehrer R. (2012), Trade in value added and value added in trade, WIOD Working Paper n.8.

Stehrer R. (2013), Accounting Relations in Bilateral Value Added Trade, The Vienna Institute for International Economic Studies, Working Papers n. 101.

Tempest R. (1996), Barbie and the World Economy, Los Angeles Times, September 22, A1 and A2.

Timmer M. (ed.) (2012), The World Input-Output Database (WIOD): Contents, Sources and Methods, WIOD background document available at www.wiod.org

Timmer M., Los B., Stehrer R. and de VriesG. J. (2016), An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release, GGDC research memorandum number 162.

Varian H. R. (2007), An iPod has global value. Ask the (many) countries that make it, New York Times, 28.

Veugelers R. (ed.) (2013), Manufacturing Europe’s future, Bruegel Blueprint Series, Vol. XXI.

Vollrath T.L. (1991), A theoretical evaluation of alternative trade intensity measure of Revealed Comparative Advantage, Weltwirtshaftliches Archiv, Vol. 127, No. 2, pp. 265-280.

Wang Z., Wei S. and Zhu K. (2013), Quantifying International production sharing at the bilateral and sector levels, NBER Working Paper, n. 19677.

World Bank Open Data, On line at http://data.worldbank.org/

WTO and IDE-JETRO (2011), Trade Patterns and Global Value Chains in East Asia: from trade in goods to trade in tasks, World Trade Organization, Geneva.

Xing Y. and Detert N. C. (2010), How the iPhone widens the United States trade deficit with the People's Republic of China, ADBI Working Paper No. 257.

Yeats A. J. (1998), Just how big is global production sharing?, World Bank Policy Research Working Paper, (1871).

Yu R., Cai J. and Leung P. S. (2009), The normalized revealed comparative advantage index, Annals of Regional Science, Vol. 43, No. 1, pp. 267–282.

DOTTORATO IN ECONOMIA
UNIVERSITÀ DEGLI STUDI ROMA TRE

3. The effect of the euro on trade using value added trade data.

Abstract

More than a decade after the euro was first established, assessment of the impact of the euro on bilateral trade between Eurozone countries remains at the top of the debate. This essay inserts itself into this debate by providing two original contributions. First, it investigates the euro's effect on trade from a value added perspective under the international fragmentation of production framework. The analysis focuses on the main value added components of gross exports at aggregate and sectoral level using a "gravity-like" approach on a panel dataset of 39 countries in the period 1995 to 2011. Second, following Baier and Bergstrand (2009), it uses the nearest three neighbours matching estimator developed by Abadie and Imbens (2006) to control for non-linearity-with-self selection. While the "gravity-like" approach leads to a negative impact of the euro, matching estimates show a positive trade effect of the euro with both gross and value added exports data. The gravity approach does not seem to be the proper technique for assessing this effect in the presence of fragmentation of production and the analysis confirms the difficulties involved in unequivocally detecting the euro's trade effect.

JEL Classification: F13, F14, F33

Keywords: euro, gravity model, matching econometrics, value added trade data

3.1 Introduction

The Eurozone is the world largest monetary and currency union. It accounts for about 17% of world income and more than 337.5 million people in 19 countries of the 28 member states of the European Union now use the euro (source: Eurostat). The economic crisis broke out in 2008 and its economic and political consequences brought the assessment of the impact of the euro on different fields of the economic activities of member countries, including trade back to the top of the academic and political debate. This issue is of interest for the Eurozone member states and has entered into discussions of the pros and cons of joining the Eurozone for countries that are candidates for such membership as well.

Until relatively recently, the empirical evidence on the boost to trade due to the formation of a currency union was limited. A new stream of literature has emerged and thrived starting with the work of Rose (2000) which found that a common currency was a powerful stimulant to trade, enhancing it by more than 235%, that is, countries in a currency union trade three times more. Many critical elements have been found in Rose's study making it severely (upward) biased and a rich empirical literature follows to better quantify the trade effects of a currency union. Moreover, as data on the Eurozone countries gradually became available, some scholars focused their attention specifically on the euro's impact on trade, providing a wide range of results. Although the size of the euro's trade effects seems to be controversial, a consensus estimate suggests that the euro has increased intra-euro area trade by 5% to 10% on average (Baldwin et al., 2008).

In line with Rose (2000), most of these works have employed the gravity model[99] as the main tool used to investigate the partial effect of a currency union on bilateral gross trade flows, taking advance of the considerably theoretical advancement on the modelling of trade flows started at the turn of the 21st century (Anderson and van Wincoop, 2003; Baier and Bergstrand, 2007). Nevertheless, some authors have suggested the adoption of alternative empirical strategies to evaluate the effects of currency unions on trade. In particular, Persson (2001) argued that, using the log-linear gravity equation, the estimate could be biased if the relationship

[99] In its first conceptualization, Tinbergen (1962) proposed an econometric model formulated along the lines of Newton's law of universal gravitation where trade flows were directly related to the economic size of the countries involved and inversely related to the distance between them. Since then, the gravity equation has been repeatedly used to empirically analyse bilateral trade. Inspired by Anderson (1979), three decades of theoretical work have shown that the gravity equation can be derived from different theoretical frameworks, providing the "theory" that underlies the "empirical relationship". At present, the basic idea behind the gravity analysis is that two countries will trade more or less with each other depending on a number of factors related to geographical, cultural and institutional proximity. The literature on gravity model has been surveyed recently by Anderson (2011), De Benedictis and Taglioni (2011) and Head and Mayer (2014).

between trade and its explanatory variables is non-linear and if member countries are not randomly selected. To address this non-linearity-with-self selection, he used matching techniques on Rose (2000)'s dataset and found that the "Rose effect" is clearly lower (between 15% and 66%) and statistically insignificant. More recently, the matching techniques have found application as an alternative to standard gravity estimates, starting with the innovative work of Baier and Bergstrand (2009) on the effects of free trade agreements on international trade that takes advantage of progress in the matching econometrics literature and especially the technique proposed by Abadie and Imbens (2006).

At the same time, a broad literature arose that aimed to study the effects of the ongoing international fragmentation of production on the trade pattern of countries, measuring trade in value added terms[100]. This progress started to be incorporated in the gravity literature since Baldwin and Taglioni (2014) argued that a gravity analysis based on gross exports alone might perform poorly in a world of global value chains in which parts and components trade is relevant. Altomonte et al. (2015) were the first to propose a gravity approach to studying bilateral value added exports rather than gross trade flows and especially to investigate the correlation between value added trade flows and the presence of multinational business groups. Kowalski et al. (2015) adopted a gravity approach to estimate the impact on GVC participation of different policy factors that could influence productive integration among countries. More recently, Osnago et al. (2016) used a gravity model to analyse the relationship between cross-border production linkages and "deep" Preferential Trade Agreements. However, at present the theoretical works on the appropriate use of value added trade data rather than gross data in a gravity model are still in their infancy[101].

Starting from these findings, the econometric analysis presented in this essay offers a twofold original contribution to the debate on the euro's impact on trade between Eurozone member states. First, in the spirit of Altomonte et al. (2015), it proposes a "gravity-like" approach to studying the euro's effect on bilateral trade but focuses on the main value added components of gross exports. In particular, the standard gravity controls resulting from the regressions with value added components are compared with the existing literature using gross exports data to check if value added components modify the conventional wisdom on the fundamental determinants of bilateral trade flows. To obtain value added exports data, I use the

[100] See the second essay of this dissertation for a review.

[101] Noguera (2012), Johnson and Noguera (2016) and Aichele and Heiland (2016) are the first very preliminary steps in this field.

World Input Output Database (2013 release) and focus on different value added components of the bilateral gross export flows derived from the methodology recently proposed by Wang et al. (2013). Second, following Baier and Bergstrand (2009), this essay employs the nearest three neighbours matching estimator developed by Abadie and Imbens (2006) (henceforth A-I matching estimator) to control for non-linearity-with-self selection that could bias the gravity estimates. Two common alternative non-parametric techniques - Propensity score matching (PSM) and PSM-Difference in Differences - are tested as well (see Appendix G). To the best of my knowledge, this work is the first to assess the euro's effect on trade using both value added trade data and the A-I matching estimator besides standard gravity estimates.

The empirical analysis provides the following results. The "gravity-like" estimates with value added components are consistent with the findings of the gravity literature that underline a negative or not significant impact of the euro on gross trade flows (see, among others, De Sousa, 2002; Berger and Nitsch, 2005; Bun and Klassen, 2007; Baldwin and Taglioni, 2007; Santos Silva and Tenreyro (2010); Rotili, 2014; Frigueiredo et al. 2016). Conversely, A-I matching estimates that control for non-linearity-with-self selection present opposite results showing a positive effect of the euro on bilateral trade, with both gross and value added exports data. This could suggest that the gravity approach is not the proper technique for assessing the impact of a common currency on trade in presence of fragmentation of production.

The structure of the essay is as follows. Section 2 presents a survey of the most relevant studies investigating the impact of a common currency on trade, focusing specifically on the euro. Since most of this literature has been already ably reviewed and synthesized by some prominent scholars (Baldwin, 2006; Baldwin et al., 2008; Head and Mayer, 2014), the purpose of the section is not to review all the studies on this topic but just cover the findings that are most relevant to this essay and the most recent advances. Section 3 addresses the estimation methodologies and contains a description of variables and a presentation of the data source as well. Section 4 shows the empirical outcomes of the ex-post analysis of the partial effect of the euro on trade and Section 5 concludes.

3.2 The common currency effect on trade: a review of the literature

In his theory of optimal currency area, Mundell (1961) argues that an increase in trade volume would be the main benefit when nations join a currency union[102]. Important contributions have followed[103], suggesting several theoretical arguments in favour of the positive impact of the common currency adoption on bilateral trade. First, the common currency should have a trade-promoting effect thanks to its contribution to a reduction in transaction, administration and information costs as well as the removal of uncertainty on exchange rate volatility between member countries (Flam, 2008). Thus, with a common currency, trade can increase thanks to trade "creation" since agents can trade under conditions that are less costly and less insecure compared with the situation in which two different currencies are used. Moreover, in a world with international fragmentation of production where intermediate goods cross borders multiple times before being assembled and sold as a final good, the direct impact of a small reduction in transaction costs could increase trade flows in a non-linear way (Sadeh, 2014). Second, the lower costs of exporting could stimulate exports of existing firms and foster previously non-exporting firms to start exporting within the common currency area, increasing the variety of exported products (Melitz, 2003; Baldwin et al. 2008; Helpman et al., 2008). Therefore, if these products were previously imported from other non-member countries, the increasing trade within the common currency area could result from the "diversion" of imports from non-member to member countries.

This section offers an overview of the most relevant works that examine the impact of a common currency on trade. Following a review of the early literature which analyses several currency unions other than the Eurozone (Section 3.2.1), Section 3.2.2 focuses specifically on the studies that investigate the euro's effect on trade.

3.2.1 The pre-euro literature

Encouraged by the formation of the euro currency union in 1999, a new strand of literature on the boost to trade due to the formation of a monetary and currency union has emerged starting with the pioneering study of Rose (2000). Within a gravity framework and using data for bilateral trade between 186 countries over a 50-year period from 1948 to 1997, Rose (2000) shows that a common currency was a powerful stimulant to trade, enhancing it by

[102] Conversely, the main costs of a single currency are the giving up of monetary and exchange rate policy.
[103] For an extensive discussion, see Broz (2005).

more than 235%[104] which is more than tripling trade. However, many critical elements, both methodological and regarding sample representativeness, have been found in this work making it severely (upward) biased[105]. Nevertheless, it gave rise to an increasing amount of studies on the common currency trade effect in the first years of the euro's life and a demonstration of its strong impact on the field is the fact that the author of this work has given his name to the aggregate trade effect of a common currency, the so-called "Rose effect". Summarizing the main problems in Rose (2000) is useful for introducing the more relevant aspects of the methodologies for the estimation of the euro's trade effect that will be used in this essay.

As regards the econometric errors in the gravity equation estimate, Rose (2000) commits the three more common mistakes labelled by Baldwin (2006) as the "gold", "silver" and "bronze" medal errors that have been repeated in subsequent studies as well. Using pooled ordinary least squares (OLS) to estimates the gravity equation on panel data, Rose (2000) falls into the "gold" medal mistake: the impact of the common currency results biased because of the inclusion of the omitted variables in the common currency dummy. This error was quickly recognized and partially corrected by Rose and van Wincoop (2001) who put in their regression time-invariant country-specific fixed effects, as proposed by Anderson and Van Wincoop (2001). However, this solution eliminates only part of the bias (the Rose effect fell to 91%[106]) because the omitted variables reflect factors that vary over time and time-varying country dummies are therefore needed (Baldwin, 2006). The "silver" medal error has been identified and corrected by Pakko and Wall (2001) who demonstrate that the main source of the bias in Rose (2000)'s result was due to the dependent variable: Rose used the averaging of the two-way bilateral trade flows rather than the unidirectional trade flow as suggested by the international trade theory. Preserving the directional flows and imposing direction-specific pair dummies, Pakko and Wall (2001) find that the "Rose effect" is negative and not significantly different from zero. As noted by Baldwin (2006), Rose (2000) also commits the "bronze" medal mistake by deflating trade flows by means of the US Consumer Price Index, but in the gravity equation there is no price illusion since all prices are measured with a common numeraire. Baldwin and Taglioni (2006) show that adding time dummies eliminates the bias due to the "bronze" medal error. Beyond the Baldwin's medals, an additional methodological weakness in Rose (2000) concerns the omission of variables correlated with the currency union dummy;

[104] The coefficient on the common currency dummy was 1.12 ($e^{1.12}$ -1 =2.35).
[105] For a presentation of the main early critiques, see Nitsch (2002).
[106] The coefficient on the common currency dummy was 0.65 ($e^{0.65}$- 1 = 0.91).

Rose himself in Glick and Rose (2002) addresses this issue using pair fixed effects which reduce the estimated "Rose effect" from 3.7 to 1.9 times more trade among counties in a currency union. Afterwards, this empirical strategy was strongly recommended by Baldwin and Taglioni (2007) especially for analyses that concern unidirectional trade flows and especially export flows. More recently, the inclusion of country-pair fixed effects has been confirmed as the "the most promising approach" to face with endogeneity related to currency unions (Head and Mayer, 2014). At present, the suggested empirical methodology to estimate the impact of policy variables on trade in a gravity framework is to adopt time-varying exporter and importer fixed effects and country-pair fixed effects on a panel data (Head and Mayer, 2014).

As regards model misspecification, Persson (2001) provides strong evidence of a significant non-linear impact of a currency union on trade since the effect of the currency union is dependent on typical gravity equation covariates[107], as McCallum (1995) and Alesina and Barro (2000) had argued[108]. Therefore, according to Persson (2001), standard estimates using the log-linear gravity equation are biased when non-linearity exists. Moreover, when countries that join a common currency are not randomly selected and are systematically different from the other countries, self-selection could bias the estimates as well. Persson (2001) proposed using matching technique - and specifically the propensity score estimator - to control for this non-linearity-with-self section, using as a control group countries that are not "treated" and have similar characteristics to the "treated" countries. On the original Rose (2000) dataset, he finds the "Rose effect" to be between 15% and 66% but statistically insignificant[109].

Finally, a relevant shortcoming in the work of Rose (2000) concerns the database: according to Baldwin et al. (2008) and Frankel (2010), the countries sharing a common currency are not a representative sample because Rose's database is dominated by very small, very poor and very open economies which heavily inflated his estimates[110]. It may not be a secondary issue since more recent studies (Rose, 2016) point out that the span of the dataset seems to affect the estimates of the currency union effect on trade, as reported below in this section.

[107] Rose (2000) himself has tried to assess this hypothesis including squared output and pre-capita output terms in one of its numerous regressions; a drop of the "Rose effect" occurs.
[108] More recently, Katayama and Melatos (2011) have also demonstrated the non-linear impact of currency unions on bilateral trade.
[109] Kenen (2002) has confirmed part of the basic results in Persson (2001) and Baldwin et al. (2008) argue that in the pre-euro literature, the cleanest estimates are those that use matching techniques because they control for the major critiques of Rose (2000).
[110] Moreover, Baldwin (2006) points out that most of the countries in Rose (2000)'s dataset are often leaving currency unions not joining them, giving no useful information for the Eurozone.

3.2.2 Studies on the impact of the euro

As data on the Eurozone countries progressively became available, some scholars started to focus their attention specifically on the euro's impact on trade. Micco et al. (2003) provided the first evaluation of the euro's trade effect followed by de Nardis and Vicarelli (2003), Flam and Nordstrom (2003, 2006, 2007), Bun and Klasssen (2007), Baldwin and Taglioni (2007), Berger and Nitsch (2008), de Nardis et al. (2007) and Gil-Pareja et al. (2008). These studies offered a wide range of (positive, negative or no impact) results, using different datasets in terms of years, country covered and types of currency unions, different specifications of the gravity equation and different econometric techniques. Most of this literature has been ably reviewed and synthesized by Baldwin (2006) and Baldwin et al. (2008), highlighting the common misspecifications and econometric errors that flaw a relevant number of the published estimates - starting from Baldwin's "medals" - but also the most interesting advances proposed by each works to enhance our understanding of the euro's trade effect. For the purposes of this essay, it is noteworthy that some of these initial studies perform regressions on sectoral data as well as aggregate data and prefer to focus on trade in goods instead of total trade. Their outcomes pointed out that the euro's trade effect is tangible in sectors with differentiated products (Taglioni, 2002; Baldwin et al., 2005; Flam and Nordstrom, 2003) or in sectors characterized by scale economies and/or imperfect competition (Flam and Nodstrom, 2006). In addition, it should be carefully considered that moving from other currency unions to the Eurozone, Baldwin et al. (2008) stress the need to make the effort to disentangle the trade impact of the euro from the effect of other policy measures to foster EU economic integration since EU membership is a prerequisite for joining the Eurozone. Due to the time-varying nature of both Eurozone and EU integration policies, Baldwin et al. (2008) argue that a proper estimation of the effect of the euro requires the inclusion of a EU dummy variable and time trends though time-varying country dummies[111] which is became a standard in the field and one that I will follow in the empirical analysis. Using a panel approach with both dyadic and time-varying exporter and importer fixed effects, as suggested by the newer methodological advances, Baldwin et al. (2008) conclude their work by confirming that the aggregate trade effect of the euro is positive but small, and that the consensus estimate suggests an impact of between 5% and 10% on average. However, they also emphasize that another decade or so of

[111] Baldwin et al. (2008) remark on the difficulty in identifying an accurate proxy for non-euro integration measures. They make an attempt using the Mongelli index of EU integration (Mongelli et al., 2005) to control for the impact of the Single Market measures. Using the lasts data and empirical techniques, they conclude that the euro's trade effect is about 2%.

data is required for a comprehensive understanding of the euro's impact on trade. In addition, they claim that referring to "the" impact of the euro on trade could be a simplification because, as the initial literature showed, this effect could be different across sectors and countries.

More recent papers on the euro's trade effects point out some relevant issues driven by the need to assimilate not only the advances in the field of econometrics, but also the contributions of the literature to the international fragmentation of production. Indeed, as discussed in both the first and second essay in this dissertation, this phenomenon has modified the nature of trade flows and the kind of traded goods and services.

In econometric research, Santos Silva and Tenreyro (2010) take advantage of one of the more recent methodological innovations introduced by themselves (Santos Silva and Tenreyro, 2006), proposing to use a non-linear Poisson maximum-likelihood estimator which estimates the gravity equation in levels, rather than the traditional linear-in-logs estimator as the pooled OLS. According to these authors, this method faces the econometric problems emerging from both heteroskedastic residuals in log-linear gravity equations and the prevalence of zero bilateral trade flows. As is easily deducible, the latter is mainly present in a dataset covering small countries or in sectoral analysis. Appling this estimator to a sample of 22 OECD countries covering the years 1993-2007, Santos Silva and Tenreyro (2010) find that the euro has a negligible effect on trade. Nevertheless, Head and Mayer (2014) argue that "rather than selecting the Poisson PML as the single 'workhorse' estimator of gravity equations, it should be used as part of a robustness-exploring ensemble" and a large number of recent papers follow this suggestion (see, for example, Rotili, 2014; Gil-Pareja et al., 2016). Other recent works propose different methodological approaches. De Camarero et al. (2014) apply panel cointegration techniques to a dataset with 26 OECD countries for the period 1967–2008 in order to consider the adoption of the euro as a progression of policy changes. They show that the euro's trade effect is small, but still positive. Figueiredo et al. (2016) apply quantile regressions for panel data. They use different dataset in terms of country coverage for the period 1993 - 2007. Their results show that even with this approach the euro's effect on trade remains bleak. Simultaneously, the work by Baldwin and Taglioni (2014) was the first attempt to incorporate the issues of the international fragmentation of production in the gravity framework. In particular, they present empirical evidence that a gravity analysis based on gross exports alone may perform poorly in a world in which parts and components trade is relevant. In fact, in the standard formulation of the gravity equation, bilateral trade is regressed on the GDPs of both exporter and importer (the mass variables), together with bilateral distance and other controls.

Since this formulation derives from a consumer expenditure equation (Anderson 1979; Bergstrand 1985, 1989, 1990), it is appropriate for explaining gross trade in final consumer goods: the GDP of the importer country is a good proxy for the demand shifter in the consumer expenditure equation and the GDP of the exporter nation is a good proxy for the supply available on its side. However, when international trade in intermediate goods dominates, Baldwin and Taglioni (2014) suggest a better empirical specification of the gravity equation for the studies that proxy for the production and demand variables with GDP. Although at present the fixed effect approach has become the standard to control for mass variables correctly and thus newer researches are unaffected by their critique, Baldwin and Taglioni (2014) have received merit for reviving an original intuition by Flam and Nordstom (2006). Indeed, Flam and Nordstom (2006) were the first to provide estimates of the euro's effect on parts and components trade, compared with trade in final goods in order to observe the possibility that the formation of the Eurozone is encouraging the fragmentation of production among member countries. They find a positive and significant impact of the euro for semi-finished and finished product (but not for raw materials)[112] and suggest that it could be the driver that underlies the large positive effect of the euro on aggregate exports. In this vein, Rotili (2014) resorts to the recent World Input Output Dataset (WIOD)[113,114] which combines international trade statistics, input-output tables and national accounts in order to disentangle gross exports in final and intermediate goods and better assess the impact of production fragmentation on trade between Eurozone member countries. She finds that the euro has positively affected bilateral exports among Eurozone members, with a larger effect on intermediate flows relative to final exports, but only on a subset of the WIOD's countries including 19 advanced economies. The estimates become negative or not statistically significant when moving to the entire span of countries in the WIOD. Moreover, Kelejian et al. (2012) integrate the spatial analysis in the gravity framework to control for spatial correlation and account for third country effects in estimating the effects of the euro on trade. They find almost no significant effect of the euro on bilateral trade flows among Eurozone countries.

[112] Due to the data constraints, Flam and Nordstom (2006) tried to proxy parts and components trade with raw materials and semi-finished products by applying a basic product decomposition.
[113] For a brief review of WIOD, see Appendix B in the second essay of this dissertation. For a complete description of the database and its construction, see Timmer (2012).
[114] Rotili (2014) uses the first (preliminary) release of WIOD, published on April 2012 and covering 40 countries (EU-27 plus Turkey, Canada, USA, Mexico, Japan, Korea, Taiwan, Australia, Brazil, Russia, India, Indonesia and China) for the period 1995-2009.

The latest work on the euro effect on boosting trade is provided by Glick and Rose (2016) who updated their 2002 article adopting newer and consensus estimation techniques. Using a dataset that covers more than 200 countries between 1948 and 2013 and a panel approach with both dyadic and time-varying exporter and importer fixed effects, Glick and Rose (2016) conclude that the euro has had a relevant positive effect on trade of about 50%. Moreover, they provide evidence that the Eurozone seems to have a different impact from other currency unions - confirming the previous result by Havranek (2010) - and that each currency union tends to have its own effect on trade. Therefore, focusing on the euro, Glick and Rose (2016) claim that "observations need to be modelled differently from other currency union observations". This outcome, which includes fifteen years of data for the Eurozone, is strong support for analysis that specifically focuses on the euro's effect on trade, like the one in this essay. Glick and Rose's work (2016), which is the result of a long period of study and investigation of the matter by its authors, will be a relevant point of reference for my analysis.

Finally, although the fragmented nature of the literature on the trade effects of common currency (in terms of datasets, specification of the model and econometric techniques) makes systematic comparison difficult, some scholars have proposed meta-analyses. The first are Rose and Stanley (2005) who present an early meta-analysis on this subject using a combined sample of 34 studies on both the Eurozone (7 papers) and other currency unions. Their analysis reports a general impact between 30 and 90%, embedding estimates from -0.378 (Pakko and Wall, 2001) to 1.38 (Melitz, 2002). Havranek (2010) updates this work with new studies, 21 of which focus on the euro, extending the sample to 61 papers up until 2006[115]. Separating the effects of the euro and other currency unions, this author shows that the differences are important and thus that it is more appropriate to assess these two strands of literature distinctly. Head and Mayer (2014) have performed a well-known meta-analysis on a large set of variables used in the gravity framework to model international trade. For the "common currency" variable, they report a mean effect of 0.79 over 104 estimates, corresponding to a doubling of trade, but they warn the reader that this result should not be interpreted as a preferred estimate of the causal effects of the policy variable because, by and large, the 104 estimates fail to address the endogeneity issue[116]. More recently, Rose (2016) has quantitatively summarized the euro

[115] It is interesting to note that Havranek (2010) detects a strange publication bias led by the authorship of the papers: those by Rose and co-authors tend to report higher (positive) euro trade effects whereas papers co-authored by Baldwin are more likely to find smaller results.

[116] Although the essence of meta-analysis is to use all available studies, including biased and misspecified results, some scholars - especially Baldwin (2006) - severely doubt the usefulness of summary statistic emerging from

literature showing how much the estimates vary across the 45 papers currently circulating (25 of which are published). Renewing the argument expressed by Frankel (2010), Rose's explanation is that estimates of the euro's trade effects vary because researchers use different samples of countries and years to estimate this impact. According to Rose (2016), excluding observations, especially by country, bias downward the estimates of the time-varying country fixed effects - which catch the Anderson and van Wincoop (2003)'s "multilateral resistance" terms - and thus leads to a downward bias in the euro's effect on trade. Summarizing, it would seem that the estimates are very sensitive to the country choice. Therefore, I expect to find an impact of the euro that is lower in comparison with Glick and Rose (2016), due to the limited number of countries in the WIOD 2013 release.

3.3 Estimating the euro's trade effect: methodology and data

As shown extensively in Section 3.2, the gravity equation is the workhorse for estimating the euro's effect on gross trade. Nevertheless, due to the international fragmentation of production, applied research suggests quantifying more appropriately trade using value added data rather than gross data. This essay undertakes this task by using a twofold empirical strategy: a "gravity-like" approach and a matching estimator approach. Both the approaches are briefly presented in this section.

3.3.1 A "gravity-like" approach

At present, how trade policy affects value added trade is an appealing and largely unexplored territory (Kaplan et al., 2016). Recently, Aichele and Heiland (2016) have investigated how trade policy affects value added trade, deriving a structural equation for value added trade within a gravity approach. This work is in line with Noguera (2012) and Johnson and Noguera (2016) who were the first to propose a multi-sector structural gravity model with input-output linkages to analyse the divergence between value added and gross trade over time. Indeed, these authors argue that the standard gravity equation cannot fully explain the pattern of bilateral value added trade because bilateral value added flows do not depend only on bilateral trade costs but also on costs with third countries through which value added transits

meta-analysis for policy purposes when these analyses include estimates that are entirely lacking credibility due to methodological mistakes.

from source to destination. Moreover, Kowalski et al. (2015) argued that “the gravity approach focuses on why countries trade with each other rather than why countries engage in production networks”. Being aware that the traditional gravity approach needs in-depth theoretical work to properly explain bilateral value added trade[117], the first part of the subsequent empirical analysis assumes that the use of the standard fixed effect specification of the gravity equation which solves the well-known “third-countries” effect problem (Anderson and van Wincoop, 2003) could also soften the bias induced by the costs with third countries through which value added transits from source to destination (Noguera, 2012). Comparing the outcomes for value added trade with those of gross trade, I will show the high consistency of the two estimates thus demonstrating that the bias of my “gravity-like” estimates should be considered largely not relevant. However, acknowledging the inability of the gravity equation – at least at the current state of the empirical literature – to remove the bias, I also provide additional non-parametric estimates of the euro effect which are by definition not affected by the same bias and also let us include non-linearities in the relationship between euro and trade flows.

Moreover, I show the results of a wide variety of estimators used to implement this “gravity-like” approach as a base for comparison with the existing literature using gross export data. This study is similar to Altomonte et al. (2015) but differs from it in several ways. First, I focus on the euro’s impact on trade rather than on multinationals. Second, I perform a panel and not a cross-section analysis. Third, I show some sectoral estimates in addition to the aggregate ones. In particular, since sectoral estimates could be affected by the presence of zero export flows, I also run the gravity equation in levels rather than in logs using the Poisson pseudo-maximum likelihood estimator (PPML) proposed by Da Silva and Tenreyro (2006) with country-pair and time fixed effects as a robustness check.

Starting with a traditional gravity framework, in the first step, the trade effect of the euro is estimated using the standard gravity variables in order to verify the sign and magnitude of the standard gravity controls using value added components. Two specifications of the gravity equation are estimated.

In the first specification - which recovers the original equation used by Glick and Rose (2002) but uses bilateral export flows rather than trade flows - bilateral exports are regressed on the GDPs of both exporter and importer, bilateral distance and other controls. Time fixed effects are added to capture cyclical trends. The gravity equation is as follow:

[117] This theoretical research goes beyond the scope of this essay.

$$\ln exp_{ijt} = \alpha + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \gamma EURO_{ijt} + \delta EU_{ijt} + \vartheta \ln DIST_{ij} + \rho Z_{ijt} + \theta_t + \varepsilon_{ijt} \quad (1)$$

where *i* denotes the exporting country, *j* denotes the importing country and *t* denotes time. More specifically, $\ln exp_{ijt}$ is the log of the bilateral export flows from *i* to *j* at time *t*; α is the intercept; $\ln GDP_{it}$ and $\ln GDP_{jt}$ denote the log of the nominal gross domestic product in country *i* and *j*, respectively, in year *t*, which is considered as proxy of the economic size of the exporting and importing countries; $EURO_{ijt}$ is the dummy variable for common Eurozone membership, which takes the value 1 if both countries are Eurozone member states at time *t* and 0 otherwise. Thus, the coefficient of main interest is γ that represents the (partial) euro's effect on the bilateral exports among the Eurozone countries. EU_{ijt} is the standard binary variable for common EU membership and assumes the value 1 if both countries are EU member states at time t and 0 otherwise; $DIST_{ij}$ denotes the bilateral distance between the country pair; the vector of controls (Z) includes other standard determinants from the gravity literature and specifically a dummy variable if the countries share a common language and a dummy variable if countries share a land border; θ_t represents the time-specific effect that accounts (controls) for cyclical influences and ε_{ijt} is a normally-distributed error term.

Following Glick and Rose (2016), the second "gravity-like" specification keeps the dyadic controls of Equation 1 and substitutes the all time-varying country variables (such as GDPs) with a complete set of time varying exporter $(\omega_{it})$and importer (τ_{jt})dummy variables, to control for multilateral resistance terms (Anderson and van Wincoop, 2003) . The gravity equation becomes as follow:

$$\ln exp_{ijt} = \alpha + \gamma EURO_{ijt} + \delta EU_{jt} + \vartheta \ln DIST_{ij} + \rho Z_{ijt} + \omega_{it} + \tau_{jt} + \varepsilon_{ijt} \quad (2)$$

In the third step, I use the benchmark specification of the gravity equation that includes country-pair fixed effects (η_{ij}), in addition to country-time fixed effects, to account simultaneously for unobserved bilateral heterogeneity in the model by using panel data other than multilateral resistance terms (see, for example, Baldwin, 2006; Baier and Bergstrand, 2007; Gil-Pareja et al., 2016; Head and Mayer, 2014). The gravity equation becomes as follow:

$$\ln exp_{ijt} = \alpha + \gamma EURO_{ijt} + \delta EU_{jt} + \omega_{it} + \tau_{jt} + \eta_{ij} + \varepsilon_{ijt} \quad (3)$$

3.3.2 A matching-estimator approach

Due to the lack of a sound theoretical foundation of the gravity equation with value added data, I examine alternative methodologies to compare the results with those obtained using the "gravity-like" approach. In particular, the second original contribution of this essay is to present non-parametric matching estimators of the euro's trade effects as well as "gravity-like" estimates.

Matching estimators are one of the tools that the literature on policy evaluation has adapted from experimental medicine by adopting medical terminology and considering the policy in the same way as a medical treatment. In this essay, the treatment is the Eurozone membership and the sample can be disentangled in the treatment group, formed by the country pairs in which both countries adopt the euro, and the control group, where one or both countries in the pair do not adopt the euro. Therefore, it is possible to measure the average treatment effect (ATE) that is the average of the euro's trade effect on both treated and untreated country pairs. Generally, policymakers could be more interested in the average treatment effect on a pair of Eurozone countries, i.e. the treated (ATT) rather than in the ATE.

As Persson (2001) pointed out, the log-linear regression could not provide accurate estimates of the ATT when selection into treatment group is not random (self-selection) and there is a non-linear relationship between the EURO dummy variable and other covariates in the gravity equation. In particular, the ATT could be different from the ATE. The traditional estimates of the euro's trade effect using gravity equation are affected by both problems. It is not surprising that selection in the Eurozone is not random[118] since the formation of this common monetary and currency union is part of a large and common strategy shared by all and only EU members - the Economic and Monetary Union (EMU) - that was introduced by the Treaty on the European Union, also called the Maastricht Treaty. Therefore, the selection is limited to EU member states. Moreover, not all EU countries wanted to participate in the Eurozone. Thirdly, both the EU and the Eurozone are not "a once-and-forever change in the European trading environment" (Baldwin et al., 2008; p.34). The EU is committed to an enlargement process within the European continent. To join the European Union, a state must fulfil certain economic and political conditions. Afterwards, the new EU member state must meet other conditions to adopt the common currency. At present, only 19 out of 28 EU members are in the Eurozone.

[118] More in general, empirical literature shows that country pairs in a currency union are not random (Alesina, Barro and Tenreyro, 2002; Nitsch, 2004; Baldwin, 2006).

As regards the bias due to non-linearity, as already stated in Section 3.2, Persson himself (2001) provided evidence of a non-linear impact of a common currency on trade, previously argued by other scholars. More recently, Katayama and Melatos (2011) have confirmed the non-linear impact of currency union on bilateral trade.

The matching techniques can address both these problems but it is important to have a control group that is as comparable as possible to the treatment group in terms of all relevant covariates influencing trade in order to "simulate" that the treatment is assigned randomly. That is the so-called "unconfoundedness" or "selection on observable" assumption[119]. According to Baier and Bergstrand (2009), the theory underling the gravity trade relationship can be the reference for selecting the covariates to use in the matching procedure. In particular, three decades of theoretical work suggest that bilateral trade flows are dependent on the economic size of the countries, distance and some factors related to geographical, cultural and institutional proximity. It is noteworthy that Baldwin at al. (2008) stress that in assessment of the euro's effect on trade, the cleanest definition of the control group is represented by the members of the EU that are not inside the Eurozone. Indeed, according to these authors, the EU membership - which is a prerequisite to join the common currency union - is "an extremely complex thing" that it is in part "unobservable to the econometrician". Therefore explicitly selecting the control group among the EU countries allows us to consider countries as comparable as possible with Eurozone countries because not only all EU countries have fulfilled the same economic and political conditions to become members of the Union but afterwards, they continue to share the implementation of several economic, regulatory and institutional measures. This strategy also has its own caveats since some of the EU members which do not take part in the Eurozone actually do not satisfy the pre-requisites to be included (for example, most of the Central and Eastern European Countries). This could be not necessarily the case for some of the non-EU members. On the contrary, when using a broader control group that includes countries like China, Brazil or Taiwan, we must implicitly assume that the unobserved factors influencing Chinese bilateral trade have the same distribution as those influencing bilateral trade between Eurozone countries. On the other hand, this strategy could help to fulfil the overlapping assumption (see below) and enlarge the sample of countries to be used as control groups. Considering that both the positions have pros and cons in implementing the matching exercise, I follow the suggestions of both Baier and Bergstrand (2009) and Baldwin et al. (2008) and

---

[119] Other names have been used in the literature to refer to this assumption, e.g. "conditional mean independence" or "ignorability of treatment".

perform two set of estimations. Indeed, the matching procedure requires selecting the control group and comparing the characteristics of the observation registered some time prior to the treatment and not simultaneously to the treatment. Thus, I adopt the first year of the dataset, 1995, as the year of reference for all covariates. Moreover, in order to implement this procedure and have similar units in the control group to match with those in the treatment group, the covariates cannot perfectly predict participation in the treatment. Therefore, I cannot insert the common EU membership in 1995 as a relevant covariate to use for selection on observables because all the country pairs with common Eurozone membership in 1999 ($EURO_{ij1999}=1$) consist of two countries with common EU membership in 1995 ($EU_{ij1995}=1$) and there is no observation with $EU_{ij1995}=0$ and $EURO_{ij1999}=1$, that is the common EU membership in 1995 predicts treatment status perfectly. In order to circumvent this problem, in a first case, I apply the matching technique to the complete dataset and in a second case, in order to adopt the cleanest definition of the control group according to Baldwin et al. (2008), a smaller dataset restricted to the country pairs with common EU membership in 1995 is also used.

In both cases, I use the same covariates reported in Equation (1), except for the EU_{ijt} dummy variable. To test the "selection on observable" assumption, I compare the distribution of the covariates for the treated and untreated country pairs, both before and after matching. In the first case, I expect to observe that the distribution for the untreated pairs differs from those of the pairs of Eurozone countries while, after matching, the two distributions should be indistinguishable (or very similar, at least).

In addition, there are two more assumptions to consider when applying matching techniques. The first one is the "overlap" assumption which supposes that the sample is large enough to include both treated and untreated observations. The complete WIOD dataset ensures that this assumption is not violated since it covers both Eurozone member countries and a large number of non-member countries. When the estimate is performed on the dataset restricted to 15 EU member states in 1995, the number of untreated observations is lower and this assumption risks being violated. The second one is the stable-unit-treatment-value assumption (SUTVA) ensuring simultaneously two hypotheses that in the bilateral trade context become: (i) the Eurozone membership is identical for all treated country-pairs; (ii) the bilateral trade between two treated countries (two Eurozone members) does not influence the trade of the untreated pairs. This hypothesis could be violated if the formation of the Eurozone leads to a trade diversion effect. However, we are confident that trade diversion should not be considered as one of the most important effects of the euro. Moreover, the empirical literature has found strong evidence of the absence of trade diversion (Baldwin, 2006; Baldwin et al., 2008; Esposito, 2016)

In the literature on the effect of the currency union on trade, Persson (2001) was the first to use a matching technique. The analysis presented in this essay differs from Persson (2001) because it applies a matching procedure to estimate the Rose effect of a specific currency union, i.e. the Eurozone, rather than many currency unions. Moreover, according to Baier and Bergstrand (2009), the specification of the estimator function used by Persson (2001) lacked theoretical foundations. To address this shortcoming, I follow Baier and Bergstrand (2009). Therefore, in the empirical exercise, a limited number of covariates are selected according to the theoretical development in the trade gravity literature in order to match each treated country pair with untreated pairs and the nearest three neighbours matching estimator proposed by Abadie and Imbens (2006) is applied[120]. This estimator adopts the technique of matching with replacement, allowing each unit to be used as a match more than once in order to form the control group[121]. Thanks to this distinctive characteristic, Baier and Bergstrand (2009) prefer the nearest three neighbours matching estimator to the alternative propensity-score estimator which performs matching on only one characteristic because this reduction in dimension leads to a less precise matching procedure.

To the best of my knowledge, this is the first work to use this kind of empirical technique to assess the euro's effect on trade between Eurozone countries[122].

3.3.3 Data description and sources

To obtain value added export data, I use the WIOD 2013 release which covers 40 countries and 35 sectors of activity (2-digit, according to the ISIC nomenclature rev.3), including 14 manufacturing sectors, for the years 1995-2011 (see Appendix C in the second essay for full lists of countries and sectors)[123]. This span in terms of country and years is the reference used to construct the panel for the empirical analysis.

---

[120] As anticipated in the Introduction, estimates are also implemented using two common alternative non-parametric techniques: Propensity score matching (PSM) and PSM-Difference in Differences. Details and results are reported in Appendix G.

[121] Three or four matches seem to include sufficient information without matching unlike individuals and there is little gain from using more matches (Abadie et al., 2004).

[122] Following Baier and Bergstrand (2009), Montalbano and Nenci (2014) have provided an ex ante assessment of the average partial impact of the European Neighbourhood Policy on the Euro-Mediterranean Free Trade Area process using the A-I matching estimator

[123] For a complete description of the database and its construction, see Timmer (ed., 2012). In November 2016, a new version of the dataset was made available which covers more countries (43) and sectors (58) for the period

In the panel, each country is considered as both exporter and importer. The permutations of 39 countries[124] into country pairs yields 1482 (39*38) bilateral export flows. The total number of observations is 25.194 (1482*17 years) for each dependent variable.

The dependent variables of the various estimates are the nominal value of annual bilateral gross exports and value added components, measured in millions of current US dollars. The value added components of the bilateral gross export flows are derived by applying the methodology recently proposed by Wang et al. (2013). In particular, the analysis focuses on the two major value added components of gross exports, i.e. domestic value added (DVA) and foreign value added (FVA), together with the indirect value added component (DVA_INTrex). As extensively illustrated in the second essay of this dissertation, at bilateral level, the DVA is the value added generated in the exporting country and destined for direct importing partners or third countries. The FVA is foreign value added of intermediate inputs embodied in the country's gross exports. Although the fragmentation of production leads to an increase in the share of FVA, the DVA remains the highest share of the gross exports. Within the DVA, it is possible to distinguish the domestic value added in intermediate goods re-exported by the direct importer to other foreign countries (DVA_INTrex). Since it can be considered a proxy for joint participation of the bilateral trade partners in a global production network, it could be interesting to assess the euro's trade effect on this specific value added flow[125].

Moreover, the analysis considers two aggregate and two sectoral bilateral export flows. The former are total exports (the sum of bilateral exports in all 35 WIOD sectors) and manufacturing exports (the sum of bilateral exports in 14 manufacturing sectors listed in WIOD). In the second essay, exports in *Machinery* and *Leather, leather product and footwear* sectors are also considered. These are two important industries with different technological characteristics, different countries involved in their international production networks and different weights in the pattern of trade of Eurozone countries. Thus, sixteen dependent variables are analysed, combining the four export flows (one in gross term and three in value added terms) with two aggregate and two sectoral flows.

2000-2014. Since it does not include data for the pre-euro period, this essay relies on the 2013 release. Unfortunately, due to different construction criteria, the 2016 release is not directly comparable with the previous one. Therefore, the two releases cannot be merged to create a new dataset for the years 1995-2014.

[124] Luxembourg is generally considered an outlier in trade analysis. As a precaution, I exclude this country from the empirical analysis.

[125] The methodology by Wang et al. (2013) allows the pure double-counted items to be separated from the main value added components. Thus, the components used in this analysis are net of double counting items which are registered separately. See the second essay in this dissertation for a review of this accounting framework.

Data on countries' GDP are taken from the World Development Indicators database of the World Bank. Distance and other economic geography and cultural tie variables are taken from the CEPII Gravity Dataset.

The EURO dummy variable has been constructed considering that enlargement of the Eurozone is an ongoing process. The euro was launched on 1 January 1999 and from then until December 2000, the Eurozone was a monetary union between 11 out of 15 EU member States (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain). On January 2001, Greece became the 12th member of the Eurozone. Since January 2002, the Eurozone has also become a currency union with the introduction of euro banknotes and coins as legal tender. Slovenia joined in 2007, followed by Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015. Since the WIOD dataset (2013 release) covers the period 1995-2011, this analysis ends in 2011 with a Eurozone of 17 members. Following most of the literature, the EURO dummy variables take the value of 1 since 1999.

Similarly, the EU dummy variable considers the enlargement process. In 1995, the EU gained three more new members (Austria, Finland and Sweden) that joined Germany, France, Italy, the Netherlands, Belgium, Luxembourg, Denmark, Ireland, the United Kingdom, Greece, Spain and Portugal in the EU 15. The 2004 enlargement concerned 10 countries (Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia). Bulgaria and Romania joined in 2007. The latest member is Croatia which joined the EU in 2013 but is not covered by the WIOD database.

3.4 Empirical outcomes and assessment of the euro's effect on trade

This section presents the results of the empirical specifications and estimators described in Section 3.3.

In the first sets of "gravity-like" regressions, the euro's effect on trade has been estimated using standard gravity variables, policy dummy variables and different fixed effect combinations in order to compare the outcomes with the existing literature using gross export data[126].

[126] Estimations have been performed using both traditional robust standard errors and standard errors clustered by country pair since the robust standard errors procedure may not be sufficient to correct for correlation of the error terms within groups and may lead to biased estimated errors. As a consequence, recent surveys on the gravity

In estimations with time fixed effects (Equation 1), the coefficients of GDPs and distance have the expected sign and lie in the usual range, in both aggregate (Table 3.1) and sectoral (Table 3.2) estimates; this result is shared with gross and value added export flows[127]. Therefore, the first outcome is that the use of value added components does not modify the original results of gravity equation in which GDPs and bilateral distance are fundamental determinants of bilateral trade flows.

This result is in line with Altomonte et al. (2015). It is noteworthy that some slight differences between the different export flows emerge. In particular, manufacturing exports are more sensitive to distance compared with total exports which also include commodities and services. This is not surprising, considering that manufacturing is strictly involved in the fragmentation of production and that parts and components cross international borders many times at different stages of production. Sectoral estimates support this preliminary finding.

Second, although these estimates could be biased due to their inability to fully account for the "third-countries" effect in a value added perspective (see Section 3.3.1), it seems that the "gravity-like" approach explains all types of value added trade flows well. Indeed, the R-squared ranges from 0.492 for the *Leather, leather product and footwear* sector[128] with the log of indirect value added as dependent variable to 0.849 for the DVA component of manufacturing exports. These values are very similar to the R-squared registered for the standard gross export measure, suggesting that the bias of my "gravity-like" estimates could be considered not so relevant.

Focusing on the euro's effect, which is the major interest of the analysis, it is negative and highly significant with both gross exports and value added components[129]. On the one hand, the results for total and manufacturing gross exports are in line with other previous studies that have found a negative impact of the euro on bilateral gross trade within the Eurozone, using

literature (De Benedictis and Taglioni, 2011; Head and Mayer, 2014) suggest controlling for such a correlation within the group clustering the errors around the group. Nevertheless, in my gravity and "gravity like" regressions, when standard errors are clustered by country pair, the coefficient of the euro dummy loses statistical significance in most of the estimates and especially in sectoral estimates and the same holds for some traditional gravity variables (common language and common border). This outcome emphasizes once again the difficulty in univocally detecting the trade effect of the euro by using the standard gravity specification both because of the limited time variability of the euro dummy and the inherent difficulties of the parametric linear gravity specification to control for non-parametric unobservables. The results of the gravity estimations with standard errors clustered by country pair are reported in Appendix D.

[127] The same holds for the other time invariant variables, i.e. contiguity and common language. The exception is the sign of the coefficient for the common language in the Leather, leather product and footwear sector that is negative or not significant rather than positive. However, it can be considered negligible.

[128] It is not surprising that the R-squared is lower in the sectoral estimates than the aggregate ones.

[129] Again, the exception is the Leather, leather product and footwear sector where the coefficient of the effect of the euro is positive or not significant.

similar specifications of the gravity equation (see, for example, Baldwin and Taglioni, 2007; Baldwin et al., 2008)[130]. On the other hand, the use of value added components maintains the negative sign of the euro's trade impact. The magnitude would seem to suggest that the DVA is more sensitive to the policy dummy than the other value added components, with a magnitude in line with those of gross exports[131]. A plausible explanation for this outcome is that, although the relevant fragmentation of production and the increasing of the FVA share in exports, the DVA is a component that best approximates gross exports (in our dataset, the DVA is, on average, about 77% of gross exports).

The coefficient of common membership in the European Union is negative as well. This result is in line with previous empirical studies that showed that for some years, EU membership reduced trade (Frankel, 2010). Moreover, it can be interpreted considering that before joining the EU, a state must fulfil a series of economic conditions and has to achieve "the capacity to cope with competitive pressure and market forces within the Union" (European Council, 1993). The accession process, from application for membership to membership, includes a series of steps towards progressive economic integration. Therefore, it is plausible that the main trade benefits are earlier than the accession date. Finally, this preliminary explanation could be linked to the general remark by Baldwin et al. (2008) regarding the difficulty in detecting through a simple EU dummy variable the complex set of integration initiatives that shape the EU policy. It may be also related to the objective limitations of the "gravity-like" approach which is not able to detect the complex network of trade in parts and components as acknowledged in Section 3.3.1.

Similar results also emerge in the exporter-time and importer-time fixed effect estimation (Equation 2), in both aggregate (Table 3.3) and sectoral (Table 3.4) estimates, as regards standard gravity variables, EU and EURO dummy variables. As expected, the R-squared is higher than using Equation 1 which controls only for time trends. When compared with existing literature in gross value, the outcome for total gross exports is also consistent with

[130] This outcome deviates from the most common wisdom that the euro has significantly promoted trade. Following Rose (2016), this deviance could be explained considering that the limited span of the WIOD dataset - especially in terms of the countries covered - could bias downward the estimates of the effect of the euro.

[131] As suggested by one of the referees, I also test if the difference in the coefficients between the estimates with value added components and those using gross exports value is statistically significant. The results for the estimates using Equation (1) and (2) are reported in Appendix E and show a differential impact of the euro on gross and value added exports flows; indeed, the difference between the coefficients is significant in most of the estimates. These results provide some support for the hypothesis that the analysis with value added data can offer information partially different compared with traditional analysis with gross exports values.

<u>Table 3.1</u> Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 1: time effects

	Total				**Manufacturing**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
Exporter GDP	0.9768***	1.0188***	0.8353***	1.0347***	1.059***	1.1187***	0.9079***	1.1521***
	0.004	*0.004*	*0.004*	*0.005*	*0.005*	*0.005*	*0.005*	*0.006*
Importer GDP	0.8818***	0.8729***	0.9335***	0.7864***	0.9311***	0.9246***	0.9680***	0.8650***
	0.004	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.004*	*0.005*
EURO dummy	-0.1075***	-0.1277***	-0.0556***	-0.0881***	-0.1178***	-0.1490***	-0.0631**	-0.1241***
	0.021	*0.020*	*0.025*	*0.023*	*0.023*	*0.022*	*0.027*	*0.025*
EU dummy	-0.0965***	-0.0889***	-0.0559***	-0.0721***	-0.1241***	-0.1169***	-0.0748***	-0.1738***
	0.017	*0.017*	*0.019*	*0.020*	*0.019*	*0.018*	*0.021*	*0.022*
DIST	-1.0053***	-0.9688***	-1.0931***	-1.0736***	-1.1393***	-1.112***	-1.1806***	-1.2555***
	0.009	*0.009*	*0.010*	*0.011*	*0.010*	*0.010*	*0.011*	*0.012*
contig	0.5763***	0.5870***	0.4747***	0.5177***	0.5459***	0.5610***	0.4469***	0.5055***
	0.028	*0.028*	*0.028*	*0.031*	*0.030*	*0.030*	*0.032*	*0.032*
comlang_off	0.4503***	0.4248***	0.4449***	0.3458***	0.2999***	0.2490***	0.3684***	0.1393***
	0.038	*0.039*	*0.040*	*0.046*	*0.040*	*0.040*	*0.043*	*0.046*
Number of obs	25188	25188	25187	25188	25188	25188	25187	25188
R-squared	0.8426	0.8488	0.8035	0.7904	0.8303	0.843	0.785	0.7936
Root MSE	0.9668	0.9563	1.0718	1.1495	1.0772	1.0503	1.1946	1.2475

Notes: Exporter and importer GDP in log; EURO = common use of euro; EU=common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant and year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

<u>Table 3.2</u> Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 1: time effects

	Leather, leather product and footwear				**Machinery**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
Exporter GDP	1.2702***	1.3210***	1.1202***	1.3535***	1.3671***	1.4268***	1.2130***	1.4333***
	0.012	*0.012*	*0.012*	*0.013*	*0.007*	*0.007*	*0.008*	*0.008*
Importer GDP	1.0354***	1.0310***	1.0653***	0.9618***	0.9923***	0.9914***	1.00394***	0.9601***
	0.009	*0.009*	*0.010*	*0.011*	*0.006*	*0.006*	*0.007*	*0.006*
EURO dummy	0.0986*	0.0882	0.1642***	-0.0797	-0.3365***	-0.3453***	-0.3002***	-0.4250***
	0.060	*0.059*	*0.063*	*0.068*	*0.034*	*0.034*	*0.036*	*0.036*
EU dummy	-0.3005***	-0.2804***	-0.3039***	-0.4343***	-0.1904***	-0.2068***	-0.1470***	-0.1295***
	0.048	*0.047*	*0.051*	*0.053*	*0.028*	*0.028*	*0.030*	*0.031*
DIST	-1.3502***	-1.3177***	-1.4415***	-1.4393***	-1.4161***	-1.4108***	-1.4177***	-1.5283***
	0.022	*0.021*	*0.022*	*0.025*	*0.014*	*0.014*	*0.015*	*0.015*
contig	0.8690***	0.8790***	0.8213***	0.8490***	0.3750***	0.3834***	0.3336***	0.3159***
	0.059	*0.059*	*0.061*	*0.067*	*0.042*	*0.043*	*0.043*	*0.046*
comlang_off	-0.1828***	-0.1874***	-0.1275***	-0.3522***	0.0252	-0.0035	0.0506	0.0169***
	0.070	*0.071*	*0.066*	*0.086*	*0.051*	*0.051*	*0.052*	*0.056*
Number of obs	24681	24681	24681	24151	25142	25142	25142	25128
R-squared	0.5436	0.5550	0.5068	0.4927	0.7628	0.7743	0.7177	0.7514
Root MSE	2.4539	2.4448	2.5292	2.7259	1.5784	1.5642	1.6760	1.6794

Notes: Exporter and importer GDP in log; EURO = common use of euro; EU=common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant and year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Table 3.3 **Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects**

	Total				**Manufacturing**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	-0.2480***	-0.2613***	-0.2254***	-0.2801***	-0.1793***	-0.1847***	-0.1717***	-0.1896***
	0.024	*0.024*	*0.024*	*0.026*	*0.025*	*0.025*	*0.026*	*0.027*
EU dummy	-0.1954***	-0.1888***	-0.1679***	-0.2181***	-0.1569***	-0.1479***	-0.1764***	-0.1705***
	0.024	*0.024*	*0.023*	*0.026*	*0.025*	*0.025*	*0.026*	*0.027*
DIST	-1.2465***	-1.2216***	-1.2837***	-1.2925***	-1.3614***	-1.3493***	-1.3617***	-1.4303***
	0.013	*0.013*	*0.013*	*0.013*	*0.014*	*0.014*	*0.014*	*0.015*
contig	0.4346***	0.4272***	0.4296***	0.3759***	0.4128***	0.3972***	0.4196***	0.3395***
	0.030	*0.030*	*0.030*	*0.031*	*0.032*	*0.032*	*0.033*	*0.033*
comlang_off	0.1735***	0.1578***	0.1552***	0.1025***	0.1723***	0.1635***	0.1554***	0.1408***
	0.042	*0.043*	*0.042*	*0.045*	*0.044*	*0.044*	*0.044*	*0.049*
Number of obs	25188	25188	25187	25188	25188	25188	25187	25188
R-squared	0.9002	0.9002	0.9003	0.8888	0.9011	0.9052	0.8958	0.8948
Root MSE	0.7902	0.7978	0.7837	0.8597	0.8440	0.8378	0.8540	0.9144

Notes: EURO = common use of euro; EU = common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language. Constant, exporter-year and importer-year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

<u>Table 3.4</u> Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects

	Leather, leather product and footwear				**Machinery**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	-0.3424***	-0.3407***	-0.3210***	-0.5222***	-0.2189***	-0.2186***	-0.2142***	-0.2425***
	0.055	*0.055*	*0.055*	*0.061*	*0.034*	*0.034*	*0.034*	*0.035*
EU dummy	-0.3244***	-0.3230***	-0.3248***	-0.3309***	-0.4462***	-0.4469***	-0.4507***	-0.3975***
	0.049	*0.049*	*0.049*	*0.057*	*0.034*	*0.034*	*0.034*	*0.035*
DIST	-1.6596***	-1.6556***	-1.6528***	-1.724***	-1.4062***	-1.4022***	-1.4072***	-1.3975***
	0.024	*0.024*	*0.024*	*0.026*	*0.018*	*0.018*	*0.018*	*0.018*
contig	0.5366***	0.5357***	0.5591***	0.4483***	0.3176***	0.3108***	0.3109***	0.3196***
	0.055	*0.055*	*0.055*	*0.057*	*0.045*	*0.045*	*0.045*	*0.045*
comlang_off	0.1463**	0.1468**	0.1617**	-0.0745	0.2490***	0.2455***	0.2479***	0.2028***
	0.067	*0.067*	*0.067*	*0.072*	*0.054*	*0.054*	*0.054*	*0.055*
Number of obs	24681	24681	24681	24151	25142	25142	25142	25128
R-squared	0.8142	0.8177	0.8096	0.7888	0.8810	0.8846	0.872	0.8833
Root MSE	1.6083	1.6075	1.6142	1.8077	1.1478	1.1482	1.1585	1.1811

Notes: EURO = common use of euro; EU = common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant, exporter-year and importer-year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

the most up-to-date analysis by Glick and Rose (2016, p. 85) who find a negative trade effect of the euro.

The second set of estimates is reported in Table 3.5 (aggregate estimates) and Table 3.6 (sectoral estimates) which show the results for the most updated and preferred specification of the gravity equation with policy dummies, country-time and country-pair fixed effects (Equation 3).

Overall, in the majority of estimates, the coefficients of the EU dummy variable are insignificant[132]. In addition to the explanations suggested above for the first set of regressions, this result could also depend on the limited ability of this specification to identify membership effects as pointed out by Hornok (2011). Indeed, she argues that the theory-consistent fixed effects gravity equation leaves only the bilateral variation in the data whereas the membership dummies (e.g. EU, euro) have very little variation in this dimension. As a result, in several settings, only one parameter can be identified.

On the EURO dummy variable, the results of the aggregate estimates confirm a negative effect of the euro on both total and manufacturing bilateral exports. It is interesting to note that the coefficient is no longer significant using the indirect value added in manufacturing exports. Considering the benchmark specification of the gravity equation, it seems that the euro has no impact on the domestic value added in intermediate goods re-exported by the direct importer to other foreign countries. A tentative explanation could suggest an inability of the traditional gravity framework to capture the indirect effects due to an increasing complexity of the productive networks. This inability has been one of the reasons that led Noguera (2012) to conclude that bilateral value added trade could not be fully understood within the traditional gravity framework and propose an alternative gravity equation[133]. The sectoral estimates deviate from the aggregate outcomes of the Rose effect. In the traditional gravity equation using gross exports data, the coefficient of the EURO dummy variable is positive and highly significant for *Leather, leather product and footwear* exports. On the contrary, the coefficient is not significant for *Machinery* exports. These results are in line with those obtained by Rotili (2014, p.39) using the same specification on bilateral gross exports for the same countries but

[132] The exception is represented by the *Machinery* sector. If these results are compared with others in Tables 3.5 and 3.6, the difficulty in distinguishing the trade impact of the euro from the effect of the other EU policy measures, stressed by Baldwin et al. (2008), seems to emerge once again.

[133] Noguera (2012)'s fascinating working paper has been the first attempt to derive a gravity equation for value added trade. Johnson and Noguera (2016) and Aichele and Hailand (2016) followed. Although these contributions have not yet been published in academic journals, there is an urgent need for an in-depth academic discussion of this subject.

over a short period (1995-2009). Overall, the use of value added components lead to maintaining the sign of the euro's trade impact.

In order to support and validate these sectoral results which diverge from aggregate estimates, I use the Poisson maximum-likelihood (PML) estimator as a robustness check, as suggested by Head and Mayer (2014) (see Section 3.2.2). These estimates are obtained using dependent variables in levels instead of logarithms[134] and including the log of the GDPs of the exporting and importing countries, country-pair fixed effects to control for the potential problem of endogeneity (self-selection) bias and year dummies to account for cyclical trends shared by all countries[135]. The results are reported in Table 3.7. As already stated, the PML estimator is normally used to address the presence of zeros in bilateral trade flows that could affect more sectoral rather than aggregate estimates, especially in datasets involving mainly large nations as the one used in this empirical analysis[136]. However, comparing the number of observations in Table 3.7 and Table 3.6, it is evident that the zero trade flows in the dataset remain very small in both *Leather, leather product and footwear* (about 2.0%) and *Machinery* (about 0.2%).

The results of the PML estimator lead to a heterogeneous overall picture of the Rose effect. These results confirm that the euro has a positive effect on bilateral export flows of the *Leather, leather product and footwear* sector in gross terms (0.10) and in its domestic value added component (0.11). However, the coefficients become not significant using foreign and indirect value added components. Similarly, in the *Machinery* sector, the coefficients of the EURO dummy variable are positive for gross export (0.04) and domestic value added component (0.5), whereas they switch to negative for the other value added flows. These results could be first pieces of evidence that when changing the functional form, the results may not be univocal between the use of the conventional gross exports values and the adoption of different value added components.

[134] The functional form is no longer log-linear as in the gravity approaches.

[135] In implementing this estimator, I follow Gil Pareja et al. (2016).

[136] Another way of dealing with the problem of zero trade flows is to use the Heckman sample selection estimator. However, the PML has additional desirable properties for empirical analysis using a gravity model. First, this estimator is consistent with the presence of fixed effects, as required by the most updated and preferred specification of the gravity equation. Second, the PML estimator also controls for heteroscedasticity bias (Shepherd, 2013).

Table 3.5 **Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects**

	Total				**Manufacturing**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	-0.0891***	-0.1055***	-0.0737***	-0.1212***	-0.0465*	-0.0584***	-0.0431*	-0.009
	0.021	*0.021*	*0.021*	*0.023*	*0.023*	*0.023*	*0.024*	*0.027*
EU dummy	0.031	0.0354*	0.024	-0.003	-0.023	-0.018	-0.022	-0.059
	0.020	*0.020*	*0.021*	*0.022*	*0.025*	*0.024*	*0.025*	*0.027*
Number of obs	25188	25188	25187	25188	25188	25188	25187	25188
R-squared	0.9761	0.9768	0.9745	0.9726	0.9688	0.9706	0.9661	0.9656
Root MSE	0.3985	0.3967	0.4083	0.4400	0.48899	0.4806	0.5023	0.53897

Notes: EURO = common use of euro; EU = common membership in EU. Constant, exporter-year, importer-year and country pair controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Table 3.6 **Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects**

	Leather, leather product and footwear				**Machinery**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	0.1792***	0.1812***	0.1945***	-0.1259*	0.026	0.026	0.023	-0.014
	0.0644719	*0.064*	*0.065*	*0.071*	*0.036*	*0.036*	*0.037*	*0.038*
EU dummy	-0.058	-0.057	-0.052	-0.2252***	-0.1346***	-0.1352***	-0.1315***	-0.1287***
	0.055	*0.055*	*0.055*	*0.063*	*0.036*	*0.036*	*0.037*	*0.038*
Number of obs	24681	24681	24681	24151	25142	25142	25142	25128
R-squared	0.9171	0.9186	0.9143	0.9026	0.9534	0.9549	0.9493	0.954
Root MSE	1.1081	1.1079	1.1171	1.2667	0.7402	0.7403	0.7518	0.7648

Notes: EURO = common use of euro; EU = common membership in EU. Constant, exporter-year, importer-year and country pair controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Table 3.7 **Sectoral estimates (period 1995-2011) - Poisson maximum-likelihood (PML) estimator**

	Leather, leather product and footwear				**Machinery**			
Regressand:	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
Exporter GDP	0.8713***	0.9168***	0.6317***	0.7842***	1.0532***	1.0826***	0.8171***	0.9136***
	0.042	*0.041*	*0.047*	*0.051*	*0.031*	*0.030*	*0.038*	*0.042*
Importer GDP	1.0291***	1.0405***	1.0850***	0.5468***	0.7722***	0.7791***	0.8013***	0.5525***
	0.055	*0.056*	*0.055*	*0.067*	*0.028*	*0.028*	*0.028*	*0.054*
EURO dummy	0.1026**	0.1103***	0.061	0.0208	0.0407**	0.04845*	-0.0468*	-0.0667**
	0.036	*0.037*	*0.039*	*0.048*	*0.021*	*0.020*	*0.024*	*0.029*
EU dummy	0.022	-0.002	0.059	0.3818***	0.1531***	0.1142***	0.1449***	0.2586***
	0.028	*0.029*	*0.032*	*0.046*	*0.023*	*0.023*	*0.024*	*0.030*
Number of obs	25194	25194	25194	25074	25194	25194	25194	25194
R-squared	0.9718	0.9730	0.9600	0.9174	0.9714	0.9714	0.9955	0.9719

Notes: Exporter and importer GDP in log; EURO = common use of euro; EU = common membership in EU.
Constant, time dummies and country pair fixed effects included but not reported**.**
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Finally, the matching estimator proposed by Abadie and Imbens (2006) for the three nearest neighbours is applied to address both the self-selection bias linked to the euro treatment and the non-linearity in the equation functional form between the euro variable and other covariates (Persson, 2001; Baier and Berstrand, 2009)[137]. As suggested by one of the referees, I also estimate the ex-post euro's trade effect using two common alternative non-parametric techniques: the method of propensity score matching (PSM) developed by Rosenbaum and Rubin (1983) and the approach that combines the difference-in-differences estimator by Heckman et al. (1997) with propensity score matching (PSM-DiD). Results are reported in Appendix G.

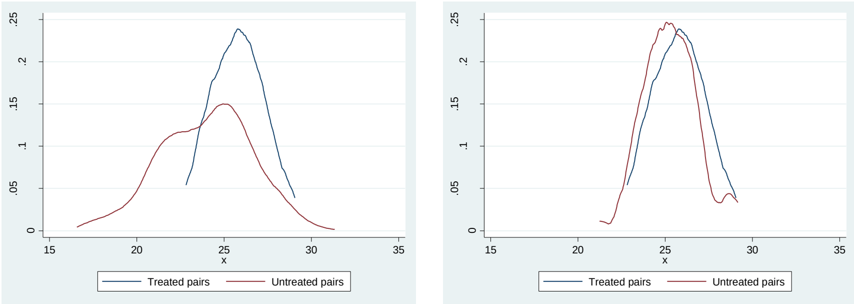
In order to carry out the matching estimations, I consider as treatment year both 1999, when the conversion rates between the euro and the currencies of the participating members states were irrevocably fixed (the Eurozone was a monetary union between 11 out of 15 EU Member States) and 2002, when euro banknotes and coins were introduced as legal tender and the "transition period" ended (the Eurozone became a currency union between 12 out of 15 EU members)[138].

The outcome is the average value of bilateral gross exports or value added components in the period 2004-2006 when 1999 is the treatment year and in the period 2005-2007 when 2002 is considered as treatment year. Thus, the impact of the treatment is assessed after some years since the adoption of the euro[139] and I use the average of three years of exports to avoid bias due to time trends[140]. As anticipated in Section 3.3.2, the covariates are the same reported in Equation (1), except for the EU_{ijt} dummy variable and the year of reference for all covariates is 1995. I apply the matching estimator both to the complete dataset and, in order to adopt the cleanest definition of the control group according to Baldwin et al. (2008), to a smaller dataset restricted to the country pairs with common EU membership in 1995.

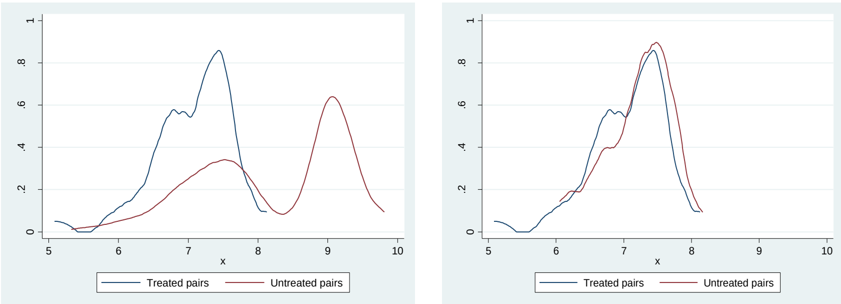
The A-I matching exercise is satisfying on the entire dataset. In fact, Figures 3.1 and 3.2 compare the Kernel density function of the main gravity equation covariates, i.e. GDPs and distance, respectively, for the treated and untreated country pairs pre and post matching procedure[141]. These

[137] Baier and Berstrand (2009) argue that matching techniques can provide an alternative approach when the precise functional relationship is unknown.
[138] Greece became the 12th member of the Eurozone on January 2001.
[139] Generally, a lag of about 5 years in the outcome is considered adequate in the policy evaluation literature. When 2002 is considered as a treatment year, I choose the period 2005-2007 to obtain the value of the outcome in order to avoid bias due to the effect of the economic crisis started in 2008.
[140] I also perform the analysis using the value of the exports in a single year (2004, 2006) and the complete dataset. The results, tabulated in Appendix F, do not show significant differences compared with those obtained using the average of the period 2004-2006 (see Tables 3.8 and 3.9).
[141] The year of treatment is 1999. The same pattern holds for other covariates, as well. For brevity's sake, I do not report all graphs, but these are available on request.

figures show that the post-matching distributions are more similar than the corresponding pre-matching distributions.



<u>Figure 3.1</u> Sum of logs of GDPs for bilateral pairs, pre and post A-I matching - complete dataset



<u>Figure 3.2</u> Logs of distance for bilateral pairs, pre and post AI matching - complete dataset

Tables 3.8 and 3.9 present the results of the A-I matching estimator on the complete dataset for each one of the 16 dependent variables, considering 1999 as the year of treatment. Several interesting results are worth noting. First, controlling for non-linearity-with-self selection, using gross export data, the euro's trade effect within the Eurozone (ATT) is positive and significant. This finding appears to support the common wisdom of the euro's positive effect on gross bilateral trade between Eurozone member states. Second, the impact is even bigger for the entire sample (ATE) and it seems excessively "large". It should mean that after formation of the Eurozone, e.g. total gross bilateral exports among countries in the sample jumped up by about 200% ($e^{1.0979}$-1)[142]. Third, the use of value added components does not modify the sign of the impact.

[142] Probably, as Baldwin et al. (2008) claim with regard to the results of other authors who report a jump of 60% or 70% for trade among the euro-using countries above that of other non-euro members, "we would not need careful econometrics to detect it; a simple data plot would have made it obvious".

<u>Table 3.8</u> A-I Matching - complete dataset, aggregate estimates - Year of treatment: 1999

	Total				**Manufacturing**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE EURO	1.0979***	1.0950***	1.1672***	1.3177***	1.1319***	1.1161***	1.2299***	1.2875***
	0.085	*0.079*	*0.119*	*0.096*	*0.104*	*0.101*	*0.123*	*0.113*
ATT EURO	0.2810***	0.2700***	0.3159***	0.4116***	0.2940***	0.2668***	0.3426***	0.4481***
	0.109	*0.106*	*0.116*	*0.118*	*0.118*	*0.115*	*0.124*	*0.126*
Number of obs	1482	1482	1482	1482	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

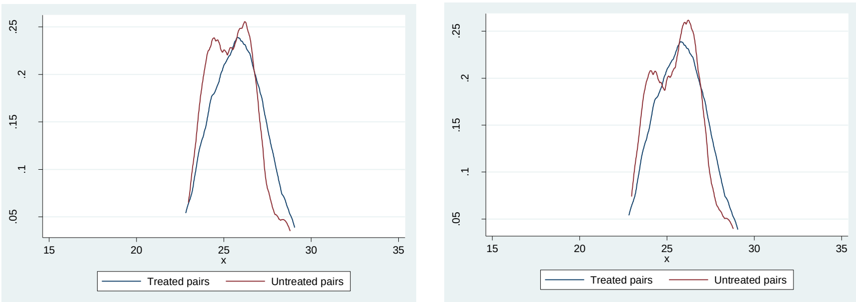
Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

<u>Table 3.9</u> A-I Matching - complete dataset, sectoral estimates - Year of treatment: 1999

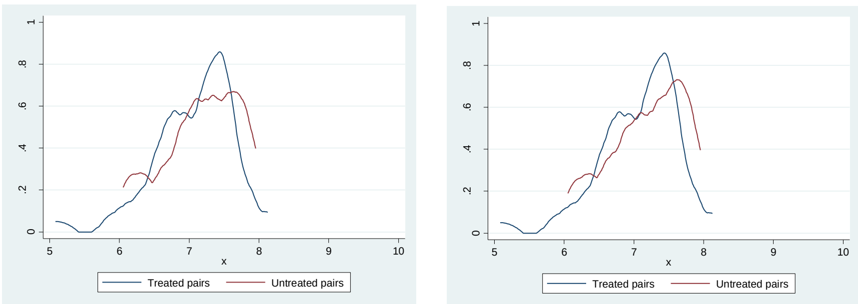
	Leather, leather product and footwear				**Machinery**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE EURO	1.2843***	1.2750***	1.4019***	1.7708***	1.0713***	1.0706***	1.0693***	1.3682***
	0.419	*0.419*	*0.424*	*0.424*	*0.180*	*0.185*	*0.184*	*0.172*
ATT EURO	0.4613**	0.4328**	0.5690***	0.8986***	0.1376	0.1265	0.1269	0.4430***
	0.216	*0.217*	*0.218*	*0.237*	*0.135*	*0.137*	*0.135*	*0.146*
Number of obs	1472	1472	1472	1460	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

The A-I matching exercise is much less satisfying if repeated using the control group that according to Baldwin et al. (2008) is most appropriate to account for the unobservable related to the institutional characteristics of the EU integration which is composed of the EU member countries that did not join the Eurozone in 1999, i.e. the restricted dataset. Indeed, Figures 3.3 and 3.4 show that with this database, the A-I procedure is much less balanced since the post-matching distributions for treated and control groups are not more similar than the pre-matching distributions. Moreover, in addition to the Eurozone member countries, the restricted dataset includes a small number of non-member countries and thus the number of untreated observation is very low, compromising the sustainability of the "overlap" assumption that risks being violated. Thus, in order to satisfy the prerequisites for the application of the matching technique, the EU member countries that did not join the Eurozone in 1999 seems a less appropriate control group and the entire dataset provides more trustworthy estimates.



<u>Figure 3.3</u> Sum of logs of GDPs for bilateral pairs, pre and post A-I matching - restricted dataset



<u>Figure 3.4</u> Logs of distance for bilateral pairs, pre and post AI matching - restricted dataset

All these caveats considered, the results of the A-I matching estimates on the restricted dataset are reported in Tables 3.10 and 3.11. These results confirms that the use of value added components do not change the sign of the euro's effect and show that the estimates lost significance especially at sectoral level.

Table 3.10 **A-I Matching - restricted dataset, aggregate estimates - Year of treatment: 1999**

	Total				Manufacturing			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	0.2043*	0.1556	1.2727**	0.3395***	0.3254***	0.2716**	0.3504***	0.6019***
	0.102	*0.099*	*0.119*	*0.111*	*0.110*	*0.107*	*0.126*	*0.112*
ATT AI EURO	0.3637***	0.3119***	0.4279***	0.4965***	0.4672***	0.4066***	0.4992***	0.7299***
	0.108	*0.106*	*0.125*	*0.119*	*0.114*	*0.111*	*0.132*	*0.117*
Number of obs	182	182	182	182	182	182	182	182
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Table 3.11 **A-I Matching - restricted dataset, sectoral estimates - Year of treatment: 1999**

	Leather, leather product and footwear				Machinery			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	0.7110***	0.6651***	0.8196***	1.3284***	0.2520*	0.2287	0.2723*	0.5073***
	0.240	*0.240*	*0.248*	*0.251*	*0.138*	*0.139*	*0.143*	*0.151*
ATT AI EURO	0.8058***	0.7564***	0.9214***	1.4685***	0.3155**	0.2922**	0.3036**	0.5757***
	0.236	*0.236*	*0.246*	*0.253*	*0.138*	*0.140*	*0.141*	*0.160*
Number of obs	182	182	182	182	182	182	182	182
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Moreover, alternative non-parametric techniques, such as PSM and PSM-DiD (see Appendix G), confirm how different estimation techniques led to different results (Glick and Rose, 2016) and that the PSM technique - which also underlies the PSM-DiD - is a less precise procedure than A-I estimates (see Appendix G.1). In addition, since the A-I three neighbours matching estimator has acquired a distinctive theoretical foundation thanks to the work by Baier and Bergstrand (2009) (see Section 3.3.2), I choose the A-I matching estimator as the preferred non-parametric technique.

Overall, it would seem that the A-I matching estimates overturn the results obtained using the "gravity-like" approach. This could be a largely expected result at least for two reasons: (i) matching techniques let us match only similar pairs - according to a set of observed characteristics - thus reducing the traditional bias in panel estimates when treated pairs are compared with all the other units in the sample; (ii) relaxing the assumption of linearity lets us better approximate the true relationship between the euro and trade flows and detect its causal impact by avoiding the constraints of the use of parametric "gravity-like" estimates which prove to be - at the current state of the empirical literature - unable to include all the relevant multilateral effects of trade in parts and components.

Nevertheless, when 2002 becomes the treatment year and the average outcome values are calculated for the period 2005-2007 (Tables 3.12 and 3.13), the coefficients of both ATE and ATT are lower in the magnitude compared with Tables 3.8 and 3.9 and for the ATT are not more significant for all dependent variables, except for the estimates with *Machinery* exports data which are significant but show a negative trade effect of the euro. A preliminary explanation could be in line with some recent analyses (De Sousa, 2012; Rotili, 2014) that observe how the positive trade effect of the euro was concentrated in the first years after its introduction. This means that the euro could have been a driver for the growth of bilateral exports among Eurozone members, but its boost to trade seems to have been gradually reduced.

<u>Table 3.12</u> A-I Matching - complete dataset, aggregate estimates - Year of treatment: 2002

	Total				Manufacturing			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	0.9037***	0.9012***	0.9861***	1.0453***	0.8942***	0.8684***	1.0315***	0.9082***
	0.122	*0.079*	*0.152*	*0.143*	*0.149*	*0.146*	*0.169*	*0.167*
ATT AI EURO	0.0241	0.0222	0.0473	0.0780	-0.0343	-0.0615	0.024	-0.0561
	0.109	*0.098*	*0.107*	*0.111*	*0.109*	*0.108*	*0.117*	*0.121*
Number of obs	1473	1473	1482	1482	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

<u>Table 3.13</u> A-I Matching - complete dataset, sectoral estimates - Year of treatment: 2002

	Leather, leather product and footwear				Machinery			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	1.0848***	1.0857***	1.1929***	1.2843***	0.8177***	0.8194***	0.8438***	0.8878***
	0.321	*0.318*	*0.332*	*0.472*	*0.209*	*0.208*	*0.215*	*0.280*
ATT AI EURO	0.1642	0.1537	0.2421	-0.0087	-0.2537*	-0.2644*	-0.2374*	-0.2547*
	0.207	*0.207*	*0.211*	*0.246*	*0.137*	*0.137*	*0.141*	*0.150*
Number of obs	1472	1472	1454	1454	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

3.5 Conclusions

This essay joins the debate on the euro's effect on trade by providing two original contributions. First, it investigates the impact of the euro on bilateral trade between Eurozone member states from a value added perspective using a "gravity-like" approach on a panel dataset of 39 countries for the period 1995 to 2011. Second, it uses the A-I matching estimator beside standard gravity estimates to control for non-linearity-with-self selection.

Overall, these two methodologies lead to opposite results in terms of the sign of the euro's effect. Indeed, in the gravity framework, I find a negative impact of the euro on bilateral trade whereas the reported results for the A-I matching estimates show a positive effect of the euro on both treated pairs and the entire sample, although it would seem concentrated in the first years of the Eurozone's life. This first overall outcome seems to suggest that the gravity approach is not the proper technique for assessing the impact of a common currency on trade in presence of an increasing fragmentation of production.

In the value added perspective, the noteworthy results are that in both methods the use of value added components do not modify the sign of the euro's effect obtained using gross export data. Moreover, the high consistency of the two estimates seems to suggest that the bias of my "gravity-like" estimates should be considered largely not relevant. Despite this evidence, it has to be stressed that the use of the traditional gravity equation to explain bilateral value added trade requires in-depth theoretical discussion. Therefore, the interpretations proposed regarding some light divergences between results using gross export rather than value added data should be considered tentative and require further research.

In addition, when alternative non-parametric techniques such as PSM and PSM-DiD (Appendix G) are used, the results partially differ from both the gravity and A-I matching technique, confirming that different estimation techniques led to different results (Glick and Rose, 2016).

To conclude, in line with the existing rich literature, the analysis of the trade impact of the euro has not led to clear-cut conclusions. It would seem to confirm that the euro's effect on trade is difficult to detect unequivocally due to methodological constraints, especially linked to the interference between euro and other EU policy measures (Baldwin et al. 2008; Hornok, 2011), and differences in the results offered by different estimation techniques or dataset (Glick and Rose, 2016; Rose, 2016). Nevertheless, it is useful to bear in mind that the establishment of the Eurozone was mainly a political and symbolic step towards an integrated Europe

(Baldwin et al. 2008; Sadeh and Verdun, 2009). In this more comprehensive framework, an assessment of the euro's effect on trade is an important part of a larger economic and political debate regarding the costs and benefits of the common currency and further advances in our understanding of the euro's impact on trade should be made. The debate is more than ever still open and this relevant field of study will certainly continue to be part of my research agenda.

Appendix D - Gravity estimates with standard errors clustered by country pair

<u>Table D.1</u> Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 1: time effects

	Total				Manufacturing			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
Exporter GDP	0.9768***	1.0188***	0.8353***	1.0347***	1.059***	1.1187***	0.9079***	1.1521***
	0.015	*0.015*	*0.016*	*0.018*	*0.016*	*0.015*	*0.017*	*0.019*
Importer GDP	0.8818***	0.8729***	0.9335***	0.7864***	0.9311***	0.9246***	0.9680***	0.8650***
	0.014	*0.014*	*0.015*	*0.016*	*0.015*	*0.014*	*0.016*	*0.017*
EURO dummy	-0.1075**	-0.1277***	-0.0556	-0.0881	-0.1178**	-0.1490**	-0.0631	-0.1241*
	0.050	*0.048*	*0.061*	*0.05*	*0.057*	*0.056*	*0.066*	*0.063*
EU dummy	-0.0965**	-0.0889**	-0.0559	-0.0721	-0.1241***	-0.1169**	-0.0748	-0.1738**
	0.044	*0.043*	*0.050*	*0.055*	*0.048*	*0.046*	*0.055*	*0.058*
DIST	-1.0053***	-0.9688***	-1.0931***	-1.0736***	-1.1393***	-1.112***	-1.1806***	-1.2555***
	0.032	*0.032*	*0.035*	*0.038*	*0.035*	*0.033*	*0.038*	*0.039*
contig	0.5763***	0.5870***	0.4747***	0.5177***	0.5459***	0.5610***	0.4469***	0.5055***
	0.106	*0.108*	*0.107*	*0.121*	*0.113*	*0.114*	*0.121*	*0.120*
comlang_off	0.4504***	0.4248***	0.4449***	0.3458***	0.2999***	0.2490***	0.3684***	0.1393***
	0.145	*0.147*	*0.149*	*0.177*	*0.145*	*0.144*	*0.155*	*0.166*
Number of obs	25188	25188	25187	25188	25188	25188	25187	25188
R-squared	0.8426	0.8488	0.8035	0.7904	0.8303	0.843	0.785	0.7936
Root MSE	0.9668	0.9563	1.0718	1.1495	1.0772	1.0503	1.1946	1.2475

Notes: Exporter and importer GDP in log; EURO = common use of euro; EU=common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant and year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

Table D.2 **Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 1: time effects**

	Leather, leather product and footwear				Machinery			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
Exporter GDP	1.2702***	1.3210***	1.1202***	1.3535***	1.3671***	1.4268***	1.2130***	1.4333***
	0.039	*0.039*	*0.041*	*0.043*	*0.023*	*0.023*	*0.025*	*0.025*
Importer GDP	1.0354***	1.0310***	0.034	0.9618***	0.9923***	0.9914***	1.0039***	0.9601***
	0.033	*0.033*	*0.010*	*0.037*	*0.22*	*0.022*	*0.023*	*0.022*
EURO dummy	0.0986	0.0882	0.1642	-0.0797	-0.3365***	-0.3453***	-0.3002***	-0.4250***
	0.138	*0.137*	*0.145*	*0.156*	*0.082*	*0.083*	*0.087*	*0.087*
EU dummy	-0.3005***	-0.2804**	-0.3039**	-0.4343***	-0.1904***	-0.2068***	-0.1470**	-0.1295*
	0.115	*0.114*	*0.123*	*0.128*	*0.069*	*0.068*	*0.075*	*0.079*
DIST	-1.3502***	-1.3177***	-1.4415***	-1.4393***	-1.4161***	-1.4108***	-1.4178***	-1.5283***
	0.072	*0.072*	*0.074*	*0.079*	*0.047*	*0.047*	*0.05*	*0.052*
contig	0.8690***	0.8790***	0.8213***	0.8490***	0.3750**	0.3834**	0.3336**	0.3159*
	0.219	*0.218*	*0.223*	*0.235*	*0.155*	*0.156*	*0.156*	*0.169*
comlang_off	-0.1828	-0.1874	-0.1275	-0.3522	0.0252	-0.0035	0.0506	0.0169
	0.260	*0.266*	*0.241*	*0.309*	*0.186*	*0.186*	*0.052*	*0.211*
Number of obs	24681	24681	24681	24151	25142	25142	25142	25128
R-squared	0.5436	0.5550	0.5068	0.4927	0.7628	0.7743	0.7177	0.7514
Root MSE	2.4539	2.4448	2.5292	2.7259	1.5784	1.5642	1.6760	1.6794

Notes: Exporter and importer GDP in log; EURO = common use of euro; EU=common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant and year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

<u>Table D.3</u> Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects

	Total				**Manufacturing**			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	-0.2480***	-0.2613***	-0.2254***	-0.2801***	-0.1793***	-0.1847***	-0.1717***	-0.1896***
	0.059	*0.059*	*0.059*	*0.063*	*0.061*	*0.061*	*0.062*	*0.065*
EU dummy	-0.1954***	-0.1888***	-0.1679***	-0.2181***	-0.1569***	-0.1479**	-0.1764***	-0.1705***
	0.059	*0.06*	*0.058*	*0.065*	*0.061*	*0.061*	*0.061*	*0.065*
DIST	-1.2465***	-1.2216***	-1.2837***	-1.2925***	-1.3614***	-1.3493***	-1.3617***	-1.4303***
	0.048	*0.048*	*0.049*	*0.048*	*0.052*	*0.052*	*0.053*	*0.053*
contig	0.4346***	0.4272***	0.4296***	0.3759***	0.4128***	0.3972***	0.4196***	0.3395***
	0.116	*0.117*	*0.117*	*0.121*	*0.124*	*0.125*	*0.126*	*0.127*
comlang_off	0.1735	0.1578	0.1552	0.1025	0.1723***	0.1635***	0.1554	0.1408
	0.16	*0.164*	*0.156*	*0.102*	*0.162*	*0.163*	*0.161*	*0.178*
Number of obs	25188	25188	25187	25188	25188	25188	25187	25188
R-squared	0.9002	0.9002	0.9003	0.8888	0.9011	0.9052	0.8958	0.8948
Root MSE	0.7902	0.7978	0.7837	0.8597	0.8440	0.8378	0.8540	0.9144

Notes: EURO = common use of euro; EU = common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant, exporter-year and importer-year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

Table D.4 **Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects**

	Leather, leather product and footwear				Machinery			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	-0.3424***	-0.3407***	-0.3210***	-0.5222***	-0.2189***	-0.2186***	-0.2142***	-0.2424***
	0.121	*0.121*	*0.121*	*0.135*	*0.078*	*0.078*	*0.078*	*0.081*
EU dummy	-0.3244***	-0.32297***	-0.3248***	-0.3309***	-0.4462***	-0.4469***	-0.4507398***	-0.3976***
	0.109	*0.109*	*0.109*	*0.126*	*0.076*	*0.076*	*0.076*	*0.078*
DIST	-1.6596***	-1.6556***	-1.6528***	-1.724***	-1.4062***	-1.4022***	-1.407179***	-1.3975***
	0.084	*0.083*	*0.084*	*0.085*	*0.064*	*0.064*	*0.064*	*0.063*
contig	0.5366***	0.5357***	0.5591***	0.4483**	0.3176*	0.3108*	0.3108*	0.3196*
	0.202	*0.202*	*0.205*	*0.199*	*0.172*	*0.171*	*0.172*	*0.171*
comlang_off	0.1463	0.1468	0.1617	-0.0745	0.249	0.2455	0.2479	0.2028
	0.238	*0.238*	*0.240*	*0.235*	*0.200*	*0.200*	*0.200*	*0.204*
Number of obs	24681	24681	24681	24151	25142	25142	25142	25128
R-squared	0.8142	0.8177	0.8096	0.7888	0.8810	0.8846	0.872	0.8833
Root MSE	1.6083	1.6075	1.6142	1.8077	1.1478	1.1482	1.1585	1.1811

Notes: EURO = common use of euro; EU = common membership in EU; DIST indicates the log of weighted distance between exporter and importer; contig indicates the nations are geographically contiguous; comlang_off indicates the pair shares an official language.
Constant, exporter-year and importer-year controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

Table D.5 Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects

	Total				Manufacturing			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	-0.0891**	-0.1055***	-0.0737**	-0.1212***	-0.0465	-0.0584	-0.0431	-0.0090
	0.036	*0.037*	*0.036*	*0.042*	*0.039*	*0.039*	*0.04*	*0.040*
EU dummy	0.0310	0.0354	0.0240	-0.0030	-0.0230	-0.0180	-0.0220	-0.0590
	0.045	*0.044*	*0.046*	*0.049*	*0.054*	*0.053*	*0.055*	*0.058*
Number of obs	25188	25188	25187	25188	25188	25188	25187	25188
R-squared	0.9761	0.9768	0.9745	0.9726	0.9688	0.9706	0.9661	0.9656
Root MSE	0.3985	0.3967	0.4083	0.4400	0.48899	0.4806	0.5023	0.53897

Notes: EURO = common use of euro; EU = common membership in EU. Constant, exporter-year, importer-year and country pair controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

Table D.6 Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects

	Leather, leather product and footwear				Machinery			
Regressand: log of	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
EURO dummy	0.1792	0.1812*	0.1945*	-0.1259	0.026	0.026	0.023	-0.014
	0.109	*0.109*	*0.111*	*0.071*	*0.058*	*0.058*	*0.059*	*0.060*
EU dummy	-0.0580	-0.0570	-0.0520	-0.2252*	-0.1346*	-0.1352*	-0.1315*	-0.1287*
	0.118	*0.118*	*0.119*	*0.133*	*0.073*	*0.073*	*0.074*	*0.077*
Number of obs	24681	24681	24681	24151	25142	25142	25142	25128
R-squared	0.9171	0.9186	0.9143	0.9026	0.9534	0.9549	0.9493	0.954
Root MSE	1.1081	1.1079	1.1171	1.2667	0.7402	0.7403	0.7518	0.7648

Notes: EURO = common use of euro; EU = common membership in EU. Constant, exporter-year, importer-year and country pair controls included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

Table D.7 **Sectoral estimates (period 1995-2011) - Poisson maximum-likelihood (PML) estimator**

	Leather, leather product and footwear				**Machinery**			
Regressand:	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
Exporter GDP	0.8713***	0.9168***	0.6317***	0.7842***	1.0532***	1.0826***	0.8171***	0.9136***
	0.106	*0.107*	*0.102*	*0.102*	*0.069*	*0.07*	*0.084*	*0.119*
Importer GDP	1.0291***	1.0405***	1.0850***	0.5468***	0.7722***	0.7791***	0.8013***	0.5525***
	0.167	*0.172*	*0.156*	*0.159*	*0.069*	*0.068*	*0.077*	*0.102*
EURO dummy	0.1026	0.1103	0.061	0.02083	0.0407	0.04845	-0.0468*	-0.0667
	0.078	*0.080*	*0.081*	*0.102*	*0.043*	*0.041*	*0.051*	*0.057*
EU dummy	0.022	-0.002	0.059	0.3818***	0.1531***	0.1142	0.1449***	0.2586***
	0.073	*0.077*	*0.073*	*0.118*	*0.046*	*0.045*	*0.052*	*0.067*
Number of obs	25194	25194	25194	25074	25194	25194	25194	25194
R-squared	0.9718	0.9730	0.9600	0.9174	0.9714	0.9714	0.9955	0.9719

Notes: Exporter and importer GDP in log; EURO = common use of euro; EU = common membership in EU.
Constant, time dummies and country pair fixed effects included but not reported.
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; SEs clustered by country pair in *italics*.

Appendix E - Difference in the EURO coefficient between estimates with value added components and gross exports value

Table E.1 Difference with the EURO coefficient obtained with gross exports value - Equation 1

	DVA	FVA	DVA_INTrex
Total exports	-0.0201***	0.0520***	0.0195
Manufacturing exports	-0.0312***	0.0548***	-0.0063
Leather, leather product and footwear exports	-0.0104***	0.0656***	-0.1591***
Machinery exports	-0.0088***	0.0363***	-0.0899***

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table E.2 Difference with the EURO coefficient obtained with gross exports value - Equation 2

	DVA	FVA	DVA_INTrex
Total exports	-0.0133***	0.0226***	-0.0321***
Manufacturing exports	-0.0054**	0.0076*	-0.0103
Leather, leather product and footwear exports	0.0017***	0.0214***	-0.1798***
Machinery exports	0.0003	0.0047*	-0.0236*

Note: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Appendix F - Matching estimates using the value of the exports in a single year

Table F.1 **A-I Matching - complete dataset, aggregate estimates - Year of treatment: 1999 - Outcome: exports flows in 2004**

	Total				**Manufacturing**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	1.1819***	1.1814***	1.2316***	1.3982***	1.2633***	1.2598***	1.3142***	1.4816***
	0.280	*0.282*	*0.281*	*0.294*	*0.290*	*0.292*	*0.294*	*0.306*
ATT AI EURO	0.3374***	0.3293***	0.3537***	0.4798***	0.3469***	0.3221***	0.3823***	0.5227***
	0.113	*0.111*	*0.119*	*0.125*	*0.125*	*0.123*	*0.130*	*0.138*
Number of obs	1482	1482	1482	1482	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Table F.2 **A-I Matching - complete dataset, sectoral estimates - Year of treatment: 1999 - Outcome: exports flows in 2004**

	Leather, leather product and footwear				**Machinery**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	1.4446***	1.4309***	1.5488***	2.0102***	1.2319***	1.2444***	1.2233***	1.5023***
	0.508	*0.507*	*0.518*	*0.523*	*0.359*	*0.363*	*0.356*	*0.383*
ATT AI EURO	0.5171**	0.4782**	0.6299***	1.0347***	0.1753	0.1651	0.1627	0.4664***
	0.232	*0.232*	*0.236*	*0.298*	*0.135*	*0.136*	*0.137*	*0.158*
Number of obs	1467	1467	1467	1467	1481	1481	1481	1481
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

<u>Table F.3</u> A-I Matching - complete dataset, aggregate estimates - Year of treatment: 1999 - Outcome: exports flows in 2006

	Total				Manufacturing			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	1.0415***	1.0404***	1.1180***	1.2625***	1.0403***	1.0250***	1.0146***	1.1739***
	0.280	*0.274*	*0.273*	*0.287*	*0.281*	*0.292*	*0.283*	*0.287*
ATT AI EURO	0.2347**	0.2243**	0.2744**	0.3537***	0.2438**	0.3940***	0.2165*	0.2968**
	0.113	*0.111*	*0.116*	*0.128*	*0.124*	*0.123*	*0.123*	*0.125*
Number of obs	1482	1482	1482	1482	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

<u>Table F.4</u> A-I Matching - complete dataset, sectoral estimates - Year of treatment: 1999 - Outcome: exports flows in 2006

	Leather, leather product and footwear				Machinery			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE AI EURO	1.3231**	1.3215**	1.4616***	1.6663***	1.0582***	1.0685***	1.0695***	1.2999***
	0.525	*0.525*	*0.530*	*0.056*	*0.346*	*0.349*	*0.346*	*0.358*
ATT AI EURO	0.3926	0.3735	0.4984**	0.8070***	0.1275	0.1229	0.1131	0.3953**
	0.240	*0.238*	*0.246*	*0.292*	*0.143*	*0.143*	*0.146*	*0.165*
Number of obs	1468	1468	1468	1468	1482	1482	1482	1482
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in *italics*.

Appendix G - PSM and PSM-DID results

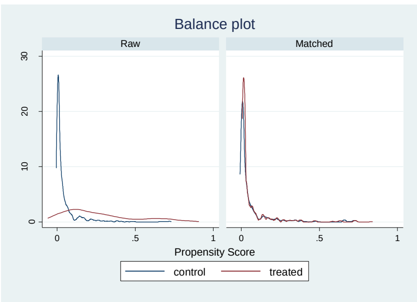
This Appendix presents the results for two common alternative non-parametric techniques: the method of propensity score matching (PSM) developed by Rosenbaum and Rubin (1983) and the approach that combines the difference-in-differences estimator by Heckman et al. (1997) with propensity score matching (PSM-DiD).

The estimates are performed considering 1999 as the treatment year.

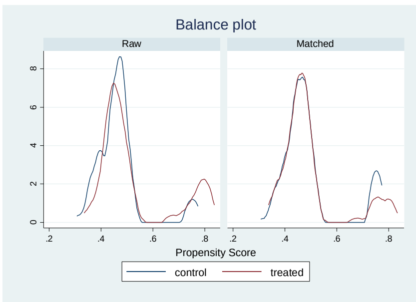
G.1 Propensity Score Matching

Like the three neighbours matching estimator proposed by Abadie and Imbens (2006), PSM allows treated and control country pairs to be compared across a number of relevant observable characteristics. However, when this number is very large, identifying a match for each of the treated country pairs could be an arduous task. To avoid this dimensionality problem, using the PSM approach, matching is performed on only one characteristic that is the probability of the country pair to receive the treatment conditional on several observable characteristics of the pair. This advantage is not costless: PSM is a less precise matching procedure than the A-I matching estimator (Baier and Bergstrand, 2009).

I estimate this probability using a logit function - following previous studies on the euro's effect on trade (Persson, 2001; Chintrakarn, 2008; Sadeh, 2014) - and the same covariates and dataset used to implement the A-I matching estimator in Section 3.4. In a first case, I apply the PSM at the complete dataset and in a second case, in order to adopt the cleanest definition of the control group according to Baldwin et al. (2008), a smaller dataset restricted to the country pairs with common EU membership in 1995 is also used. Both matching exercises are satisfying: the kernel density plots for row and matched data reported in Figures G.1 and G.2 show that the distribution of the covariates in the country pairs used to implement matching estimates is balanced, i.e. it does not vary between treated and control groups.



<u>Figure G.1</u> Kernel density plot - complete dataset



<u>Figure G.2</u> Kernel density plot - restricted dataset

All this considered, Tables G.1, G.2, G.3 and G.4 present the results of the PSM matching estimator. The first two tables are based on the entire dataset, whereas the last two are based on a dataset restricted to 15 EU member states in 1995. The picture that emerges from the PSM estimator is not univocal: on the entire dataset, the ATT coefficient is not significant at all and the coefficient for the ATE is positive and significant only for total exports data; on the restricted dataset, the ATE and ATT coefficients become positive and significant only for all the aggregate estimates.

Comparing PSM results with those of the A-I matching exercise in Section 3.4 confirms that the nearest three neighbours matching estimator proposed by Abadie and Imbens (2006) is a more precise technique than the PSM approach: all A-I estimates have lower standard errors than the corresponding PSM results. This empirical evidence, together with the distinctive theoretical foundations that the A-I matching estimator has acquired thanks to the work by Baier and Bergstrand (2009) (see Section 3.3.2) led me to choose the A-I matching estimates as the preferred non-parametric estimates to present in Section 3.4.

<u>Table G.1</u> Propensity Score Matching - complete dataset, aggregate estimates - Year of treatment: 1999

	Total				Manufacturing			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE EURO	0,2955**	0,288***	0,4375*	0.4180***	0.3911	0.3809	0.527*	0.5077*
	0.116	*0.096*	*0.248*	*0.144*	*0.261*	*0.252*	*0.295*	*0.256*
ATT EURO	-0,0447	-0,0726	0.066	0.0242	-0.0194	-0.0466	0.0811	0.049
	0.145	*0.153*	*0.175*	*0.165*	*0.154*	*0.163*	*0.184*	*0.173*
Number of obs	1482	1482	1482	1482	1482	1482	1482	1482
Control	1392	1392	1392	1392	1392	1392	1392	1392
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

<u>Table G.2</u> Propensity Score Matching - complete dataset, sectoral estimates - Year of treatment: 1999

	Leather, leather product and footwear				Machinery			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE EURO	-0.2446	-0.2449	0.0900	-0.0087	0.4503	0.4483	-0.374***	0.5283
	1.399	*1.386*	*1.427*	*1.501*	*0.6*	*0.617*	*0.064*	*0.377*
ATT EURO	0.083	0.0662	0.2686	0.1141	-0.2233	-0.2250	-0.1421	-0.158
	0.319	*0.311*	*0.393*	*0.353*	*0.205*	*0.217*	*0.193*	*0.181*
Number of obs	1472	1472	1472	1460	1482	1482	1482	1482
Control	1382	1382	1382	1370	1392	1392	1392	1392
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

<u>Table G.3</u> Propensity Score Matching - restricted dataset, aggregate estimates - Year of treatment: 1999

	Total				**Manufacturing**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE EURO	0.4658***	0.4035**	0.5867***	0.5365***	0.5490***	0.4690**	0.6469***	0.7694***
	0.178	*0.171*	*0.218*	*0.1623*	*0.21*	*0.204*	*0.2385*	*0.1865*
ATT EURO	0.5966***	0.5223**	0.7391***	0.6978***	0.7240***	0.6346**	0.8133***	1.0500
	0.231	*0.225*	*0.27*	*0.205*	*0.279*	*0.275*	*0.304*	*0.237*
Number of obs	182	182	182	182	182	182	182	182
Control	92	92	92	92	92	92	92	92
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

<u>Table G.4</u> Propensity Score Matching - restricted dataset, sectoral estimates - Year of treatment: 1999

	Leather, leather product and footwear				**Machinery**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATE EURO	0.3240	0.2760	0.4280	0.948***	0.3481	0.3176	0.4096	0.5408**
	0.334	*0.33*	*0.366*	*0.349*	*0.253*	*0.25*	*0.2717*	*0.228*
ATT EURO	0.5507	0.497	0.6812	1.3258***	0.5500	0.5167	0.6124*	0.8459***
	0.397	*0.391*	*0.448*	*0.374*	*0.348*	*0.3488*	*0.36*	*0.29*
Number of obs	182	182	182	182	182	182	182	182
Control	92	92	92	92	92	92	92	92
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

G.2 PSM-Difference in Differences

Although matching techniques control for the selection on observables, they do not consider other unobservable characteristics that could explain the difference in outcomes between treated and untreated country pairs, in addition to the treatment. A method used to address this issue is to use the Difference-in-Differences (DiD) approach which accounts for unobservable time-invariant characteristics, comparing the difference in outcome before and after the treatment for each country pair. Nevertheless, the DiD method does not eliminate the unobservable differences between the treatment and control groups that change over time. Therefore, in order to provide a valid estimate, the assumption that the outcomes have parallel trends between the treatment and control groups in the absence of treatment has to be proved. In order to control both for selection on observables and on fixed unobserved variables, the DiD estimator can be combined with propensity score matching (PSM-DiD). The PSM-DiD method compares the outcome trends between the treated country pairs and the matched country pairs, pre and post treatment.

I apply this approach in two steps. As a first step for PSM, I estimate the probability of being treated using a logit model and the same covariates and dataset used in Appendix G.1, where the value of the post-treatment outcome is the average of the period 2004-2006[143]. To perform the second step and compare treated pairs and controls after the PSM using DiD, I have to add the value of the pre-treatment outcome to the dataset. As for the post-treatment value, in order to smooth the pre-treatment value, I consider the 1995-1998 average. I repeat the PSM-DiD exercise both on the complete dataset and on a dataset restricted to 15 EU member states in 1995. Figures G.3 and G.4 allow the validity of the underlying assumption of parallel trends to be assessed by comparing the trends of the log of total gross exports[144] for the treatment and control groups before the treatment (1995-1998 period) in complete and restricted datasets, respectively. The assumption can be said to be verified, especially using the restricted dataset.

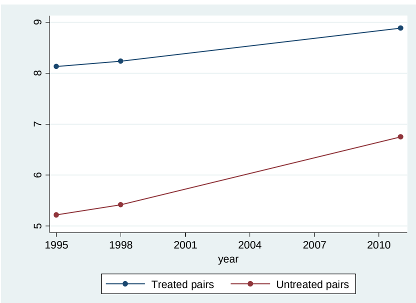


Figure G.3 Outcome trends - complete dataset

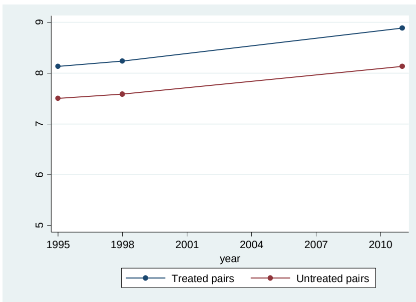


Figure G.4 Outcome trends - restricted dataset

143 Figures G.1 and G.2 in Appendix G.1 show that PSM provides a balanced control sample for estimating the euro's trade effects: the distribution of covariates for the control group produced by PSM is very similar to that for the treated country pairs.
144 The same holds for other dependent variables in value added terms, as well. For the sake of brevity, I do not report all graphs, but these are available on request.

Tables G.5 and G.6 present the results of the PSM-DiD method based on the entire dataset, whereas in Tables G.7 and G.8 the estimates are performed on the dataset restricted to 15 EU member states in 1995. On the entire dataset, the euro membership has a negative and significant effect on bilateral trade between member countries as in the gravity estimates presented in Section 3.4. Nevertheless, the ATT negative coefficient is less significant when the procedure is repeated on the most appropriate control group according to Baldwin et al. (2008) which is the EU member countries that did not join the Eurozone in 1999, i.e. on the restricted dataset.

Overall, these estimates confirm how different estimation techniques lead to different results (Glick and Rose, 2016) and that the span of the datasets, especially by country, seems to affect the estimated effects of the Eurozone on bilateral trade (Glick and Rose, 2016; Rose, 2016). Moreover, since the matching technique underlying the PSM-DiD has been proved to be less precise than A-I estimates (see Appendix G.1), I continue to prefer the A-I matching estimates as non-parametric estimates.

Table G.5 **PSM-Difference in Differences - complete dataset, aggregate estimates - Year of treatment: 1999**

	Total				Manufacturing			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATT EURO	-0,2450***	-0,2341***	-0,2596***	-0,3671***	-0,2468***	-0,2337***	-0,2790***	-0,3354***
	0.056	*0.055*	*0.067*	*0.059*	*0.154*	*0.055*	*0.184*	*0.057*
Number of obs	180	180	180	180	180	180	180	180
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

Table G.6 **PSM-Difference in Differences - complete dataset, sectoral estimates - Year of treatment: 1999**

	Leather, leather product and footwear				Machinery			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATT EURO	-0.0325	-0.0170	-0.0900	0.1416	-0.2069**	-0.1403*	-0.3364***	-0.2564***
	0.128	0.125	0.134	0.188	0.08	0.075	0.089	0.086
Number of obs	180	180	180	180	180	180	180	180
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

<u>Table G.7</u> PSM-Difference in Differences- restricted dataset, aggregate estimates - Year of treatment: 1999

	Total				**Manufacturing**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATT EURO	-0.0411	-0.0685	0.0632	-0.2254***	0.1569***	0.1355**	0.1814***	0.076
	0.061	*0.063*	*0.06*	*0.071*	*0.049*	*0.049*	*0.058*	*0.057*
Number of obs	180	180	180	180	180	180	180	180
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics.

<u>Table G.8</u> PSM-Difference in Differences - restricted dataset, sectoral estimates - Year of treatment: 1999

	Leather, leather product and footwear				**Machinery**			
	Gross exports	DVA	FVA	DVA_INTrex	Gross exports	DVA	FVA	DVA_INTrex
ATT EURO	-0.0182	-0.0234	0.0101	0.4978***	0.132	0.1509*	0.0894	0.1978**
	0.114	*0.113*	*0.123*	*0.186*	*0.089*	*0.088*	*0.098*	*0.089*
Number of obs	180	180	180	180	180	180	180	180
Treated	90	90	90	90	90	90	90	90

Notes: ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; (Robust) SEs in italics

References

Abadie A., Drukker D., Herr J. L. and Imbens G.W. (2004), Implementing matching estimators for average treatment effects in Stata, Stata journal, Vol. 4, pp. 290-311.

Abadie A. and Imbens G.W. (2006), Large sample properties of matching estimators of average treatment effects, Econometrica, Vol. 74, pp. 235-67.

Aichele R. and Heiland I. (2016), Where is the Value Added? Trade Liberalization and Production Networks, CESifo Working Paper No. 6026.

Alesina A. and Barro R.J. (2000), Currency unions, NBER Working Paper, No. 7927.

Alesina A., Barro R.J. and Tenreyro S. (2002), Optimal Currency Areas, in: Gertler M. and Rogoff K. (ed.), NBER Macroeconomics Annual 2002, Vol. 17, pp. 301-356.

Altomonte C., Colantone I., Rungi A. and Sonno T. (2015), Global value networks, in: Amador J. and di Mauro F. (ed.), The Age of Global Value Chains, CERP Press, pp. 85-106.

Anderson J.E. (1979), A theoretical foundation for the gravity equation, The American Economic Review, Vol. 69, No. 1, pp. 106-116.

Anderson J.E. (2011), The Gravity Model, Annual Review of Economics, Annual Reviews, Vol. 3, No. 1, pp. 133-160.

Anderson J.E. and van Wincoop E. (2001), Borders, trade and welfare, NBER Working Paper, No. 8515.

Anderson J.E. and van Wincoop E. (2003), Gravity with Gravitas: A Solution to the Border Puzzle, American Economic Review, Vol. 93, No. 1, pp. 170-192.

Baier S.L. and Bergstrand J.H. (2007), Do free trade agreements actually increase members' international trade?, Journal of International Economics, Vol. 71, No. 1, pp. 72-95.

Baier S.L. and Bergstrand J.H. (2009), Estimating the effects of free trade agreements on international trade flows using matching econometrics. Journal of international Economics, Vol. 77, No. 1, pp. 63-76.

Baldwin R. (2006), The Euro's trade effects, European Central Bank, Working Paper No. 594

Baldwin R. and Taglioni D. (2007), Trade effects of the euro: a comparison of estimators, Journal of Economic Integration, Vol. 22, No. 4, pp. 780–818.

Baldwin R. and Taglioni D. (2014), Gravity chains: Estimating bilateral trade flows when parts and components trade is important, Journal of Banking and Financial Economics, Vol. 2, No. 2, pp. 61-82.

Baldwin R., Di Nino V., Fontagné L., De Santis R.A. and Taglioni D. (2008), Study on the impact of the euro on trade and foreign direct investment, European Economic and Monetary Union Working Paper, No. 321.

Berger H. and Nitsch V. (2005), Zooming out: the trade effect of the euro in historical perspective, CESIfo Working Paper, No. 1435.

Bergstrand J. H. (1985), The gravity equation in international trade: some microeconomic foundations and empirical evidence, The Review of Economics and Statistics, pp. 474-481.

Bergstrand J. H. (1989), The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade, The Review of Economics and Statistics, pp. 143-153.

Bergstrand J. H. (1990), The Heckscher-Ohlin-Samuelson model, the Linder hypothesis and the determinants of bilateral intra-industry trade, The Economic Journal, Vol. 100, No. 403, pp. 1216-1229.

Bun M. J. and Klaassen, F. J. (2007), The euro effect on trade is not as large as commonly thought, Oxford Bulletin of Economics and Statistics, Vol. 69, No. 4, pp. 473-496.

De Benedictis L. and Taglioni D. (2011), The gravity model in international trade, in: The trade impact of European Union preferential policies, Springer Berlin Heidelberg, pp. 55-89.

Camarero M., Gómez E. and Tamarit C. (2014), Is the ‘euro effect on trade so small after all? New evidence using gravity equations with panel cointegration techniques, Economics Letters, Vol. 124, No. 1, pp. 140-142.

Chintrakarn P. (2008), Estimating the Euro Effects on Trade with Propensity Score Matching, Review of International Economics, Vol. 16, No. 1, pp. 186–198.

de Nardis S. and Vicarelli C. (2003), Currency Unions and Trade: The Special Case of EMU, World Review of Economics, Vol. 139, No. 4, pp. 625-649.

de Nardis S., De Santis R. and Vicarelli C. (2007), The Euro's Effect on Trade on a Dynamic Setting, ISAE Working Papers, No. 80.

De Sousa L. V. (2002), Trade Effects of Monetary Integration in Large, Mature Economies, A Primer on European Monetary Union, Kiel Working Paper No. 1137.

De Sousa J. (2012), The currency union effect on trade is decreasing over time, Economics Letters, Vol. 117, No. 3, pp. 917-920.

Esposito P. (2017), Trade creation, trade diversion and imbalances in the EMU, Economic Modelling, Vol. 60, pp. 462–472

European Council (1993), Conclusion of the Presidency, Available on line at: http://www.europarl.europa.eu/summits/copenhagen/default_en.htm

Flam H. and Nordstrom H. (2003), Trade volume effects of the euro: Aggregate and sector estimates, Institute for International Economic Studies, Stockholm University.

Flam H. and Nordstrom H. (2006), Euro effects on the intensive and extensive margins of trade, CESIfo Working Paper No. 1881.

Flam H. and Nordstrom H. (2007), Explaining large euro effects on trade: the extensive margin and vertical specialization, Institute for International Economic Studies, Stockholm University.

Frankel J. A. (2010), The Estimated Trade Effects of the Euro: Why Are They Below Those from Historical Monetary Unions among Smaller Countries? in Alesina A. and Giavazzi F. (ed.). Europe and the Euro, National Bureau of Economic Research Conference Report

Figueiredo E., Lima L. R. and Schaur G. (2016), The effect of the Euro on the bilateral trade distribution, Empirical Economics, Vol. 50, No. 1, pp. 17-29.

Gil-Pareja S., Llorca-Vivero R. and Martínez-Serrano J. A. (2008), Trade effects of monetary agreements: evidence for OECD countries, European Economic Review, Vol. 52, No. 4, pp. 733-755.

Gil-Pareja S., Llorca-Vivero R. and Martínez-Serrano J. A. (2016), Reciprocal vs nonreciprocal trade agreements: which have been best to promote exports?, ETSG Conference paper.

Glick R. and Rose A. K. (2002), Does a Currency Union Affect Trade? The Time Series Evidence, European Economic Review, Vol. 46, No. 6, pp. 1125-1151.

Glick R. and Rose A. K. (2016), Currency unions and trade: A post-EMU reassessment, European Economic Review, Vol. 87, pp. 78-91.

Havránek T. (2010), Rose effect and the euro: is the magic gone?. Review of World Economics, Vol. 146, No. 2, pp. 241-261.

Head K. and Mayer T. (2014), Gravity equations: Workhorse, toolkit and cookbook, in: Gopinath G., Helpman E., Rogoff K. (ed.), Handbook in International Economics, Vol. 4 of Handbook of International Economics, Elsevier, pp. 131-195.

Heckman J., Ichimura H., Smith J. and Todd P. (1997), Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme, Review of Economic Studies, Vol. 64, No.4, pp. 605–654.

Helpman E., Melitz M. and Rubinstein Y. (2008), Estimating Trade Flows: Trading Partners and Trading Volumes, Quarterly Journal of Economics, Vol. 123, pp. 441-487.

Hornok C. (2011), Gravity or Dummies? The Limits of Identification in Gravity Estimations, CeFiG Working Papers No. 15.

Johnson R. C. and Noguera G. (2016), A portrait of trade in value added over four decades, Unpublished Manuscript, Dartmouth College.

Kaplan L. C., Kohl T. and Martínez-Zarzoso I. (2016), The Effects of the Ceecs’ Accession on Sectoral Trade: A Value Added Perspective, Center for European Governance and Economic Development Research, Discussion Paper n. 272.

Katayama H. and Melatos M. (2011), The nonlinear impact of currency unions on bilateral trade, Economics Letters, Vol. 112, No. 1, pp. 94-96.

Kenen P.B. (2002), Currency Unions and Trade: Variations on Themes by Rose and Persson, Reserve Bank of New Zealand, Discussion Paper No. 08.

Kowalski P., Lopez Gonzalez J., Ragoussis A. and Ugarte C. (2015), Participation of Developing Countries in Global Value Chains: Implications for Trade and Trade-Related Policies, OECD Trade Policy Papers, No. 179, OECD Publishing, Paris.

McCallum J. (1995). National borders matter: Canada-US regional trade patterns, The American Economic Review, Vol. 85, No. 3, pp. 615-623.

Melitz M. J. (2003), The impact of trade on intra-industry reallocations and aggregate industry productivity, Econometrica, Vol. 71, No. 6, pp. 1695-1725.

Micco A., Stein E. and Ordoñez G. (2003), The currency union effect on trade: Early evidence from EMU, Economic Policy, Vol. 37, pp. 316-356.

Mongelli F. P., Dorrucci E. and Agur I. (2005), What does European institutional integration tell us about trade integration?, European Central Bank, Occasional Paper Series, No. 40

Montalbano P. and Nenci S. (2014), Assessing the trade impact of the European Neighbourhood Policy on the EU-MED Free Trade Area. Applied Economics, Vol. 46, No. 7, pp. 730-740.

Mundell R. A. (1961), A theory of optimum currency areas. The American Economic Review, Vol. 51, No. 4, pp. 657-665.

Nitsch V. (2004), Have a Break, Have a ... National Currency: When Do Monetary Unions Fall Apart?, CESifo Working Paper No. 1113.

Nitsch V. (2002), Honey I Shrunk the Currency Union Effect on trade, World Economy, Vol. 25, No. 4, pp. 457-474.

Noguera G. (2012), Trade costs and gravity for gross and value added trade, Job Market Paper, Columbia University.

Osnago A., Rocha N. and Ruta M. (2016), Deep Agreements and Global Value Chains, Global Value Chain Development Report 2016, Background Paper.

Pakko M. R. and Wall H. J. (2001), Reconsidering the Trade-Creating Effects of a Currency Union, Federal Reserve Board of St. Louis Review, Vol. 83, No. 5, pp. 37-45.

Persson T. (2001), Currency unions and trade: how large is the treatment effect?, Economic Policy, Vol. 16, No. 33, pp. 434-448.

Rose A. K. (2000), One money, one market: the effect of common currencies on trade. Economic Policy, Vol. 15, No. 30, pp. 08-45.

Rose A. K. (2016), Why do Estimates of the EMU Effect on Trade Vary so Much?, Open Economies Review, 1-18.

Rose A. K. and Stanley T. D. (2005), A Meta-Analysis of the Effect of Common Currencies on International Trade, Journal of Economic Surveys, Vol. 19, No. 3, pp. 347-365.

Rose A. K. and van Wincoop E. (2001), National money as a barrier to international trade: The real case for currency union, The American Economic Review, Vol. 91, No. 2, pp. 386-390.

Rosenbaum P. and Rubin D. (1983), The Central Role of the Propensity Score in Observational Studies for Causal Effects, Biometrika, Vol. 70, No.1, pp. 41–55.

Rotili L. (2014), The Euro effects on intermediate and final exports, Sapienza University of Rome, Working Papers, No. 7

Santos Silva J.M.C. and Tenreyro S. (2006), The log of gravity, The Review of Economics and Statistics, Vol. 88, No. 4, pp. 641-658.

Santos Silva J.M.C. and Tenreyro S. (2010), Currency Unions in Prospect and Retrospect, Annual Review of Economics, Vol. 2, pp. 51-74

Sadeh T. (2014), The euro’s effect on trade, European Union Politics, Vol. 15, No. 2, pp. 215-234.

Shepherd B. (2013), The gravity model of international trade: A user guide, UNESCAP, ARTNeT Books and Research Reports.

Taglioni D. (2002), Exchange rate volatility as a barrier to trade: new methodologies and recent evidence, Économie internationale, Vol. 1, No. 89-90, pp. 227-259.

Timmer M. (ed.) (2012), The World Input-Output Database (WIOD): Contents, Sources and Methods, WIOD background document available at www.wiod.org

Tinbergen J. (1962), Shaping the World Economy, Twentieth Century Fund, New York

Wang Z., Wei S. and Zhu K. (2013), Quantifying International production sharing at the bilateral and sector levels, NBER Working Paper, No. 19677.

General conclusions

Over the last decades, production has become the outcome of complex linkages established between different sectors and countries over time and the shares of international trade flows increasingly consist of intermediate and unfinished goods shipped from one country to another to combine manufacturing or services activities at home with those performed abroad.

This new production paradigm - often referred to as international fragmentation of production - has brought economic research to question traditional issues such as specialization patterns and the determinants of trade flows. New lines of study have emerged that attempt to properly analyse these issues in a world in which the international fragmentation of production has become increasingly important, with new analytical tools brought to bear on these topics.

In this framework, this dissertation has considered these issues from both a theoretical and an empirical perspectives. The first essay has presented an historical excursion of the issue of trade specialization in international trade theory and provided an overview of the key elements that the current theoretical debate suggests should be taken into account when analysing specialization and trade patterns in a world characterized by international fragmentation of production. In the second essay, some of the most recent and influential methodologies have been used to perform a descriptive analysis of both trade specialization and international supply and production networks of selected countries in manufacturing sectors in order to look at these issues "through the lenses of value added". Finally, using bilateral value added trade data, the third essay has provided an empirical analysis of the euro's effect on bilateral trade between Eurozone member states under an international fragmentation of production framework, using both a "gravity-like" approach and non-parametric matching techniques.

Each of these perspectives has taken advantage of the theoretical and empirical contributions at the current frontiers of research, collecting all the main elements of the current theoretical debate in a unified framework and providing original descriptive and empirical analyses.

Overall, this dissertation has underlined that international trade theory seems to offer several fascinating directions, both theoretical and empirical, in which to improve our knowledge of specialization and the international fragmentation of production.

List of Figures

Figure 2.1 Value added and double counting in bilateral trade flows..................................... 42

Figure 2.2 Accounting of gross exports by Koopman et al. (2014, p. 482)............................ 51

Figure 2.3 Bilateral Gross Exports Accounting adapted from Wang et al. (2013, pp. 23-24) 53

Figure 3.1 Sum of logs of GDPs for bilateral pairs, pre and post A-I matching - complete dataset 134

Figure 3.2 Logs of distance for bilateral pairs, pre and post AI matching - complete dataset .... .134

Figure 3.3 Sum of logs of GDPs for bilateral pairs, pre and post A-I matching - restricted dataset 136

Figure 3.4 Logs of distance for bilateral pairs, pre and post AI matching - restricted dataset 136

Figure A.1 - Schematic outline of national input-output table (IOT), from Timmer et al. (2012) 91

Figure A.2 - Schematic outline of ICIO table (three regions), from Timmer et al. (2012)...... 92

Figure A.3 - Schematic outline of ICIO table with G countries and N sectors........................ 93

Figure G.1 - Kernel density plot - complete dataset 151

Figure G.2 - Kernel density plot - restricted dataset 151

Figure G.3 - Outcome trends - complete dataset.. 155

Figure G.4 - Outcome trends - restricted dataset 155

List of Tables

Table 2.1 RSCA indicators in value added and gross value for the Italian manufacturing sectors 64
Table 2.2 Trade specialization indicators of Italy's main competitors in its comparative advantage sectors: gross versus added value RSCA - Year: 1995 71
Table 2.3 Trade specialization indicators of Italy's main competitors in its comparative advantage sectors: gross versus added value RSCA - Year: 2011 72
Table 2.4 Value added decomposition of gross exports in the Machinery sector - selected countries 75
Table 2.5 Value added decomposition of gross exports in the Leather sector - selected countries 77
Table 2.6 Main source countries of FVA in Italian Machinery exports 79
Table 2.7 Main source countries of FVA in German Machinery exports 80
Table 2.8 Main source countries of FVA in US Machinery exports 80
Table 2.9 Main source countries of FVA in Chinese Machinery exports 82
Table 2.10 Main source countries of FVA in Japanese Machinery exports 82
Table 2.11 Main source countries of FVA in Italian Leather and footwear exports 84
Table 2.12 Main source countries of FVA in German Leather and footwear exports 84
Table 2.13 Main source countries of FVA in US Leather and footwear exports 84
Table 2.14 Main source countries of FVA in Chinese Leather and footwear exports 85
Table 2.15 Main source countries of FVA in Japanese Leather and footwear exports 85
Table 2.16 Value added decomposition of Italian gross exports in Machinery to its main destination markets 86
Table 2.17 Value added decomposition of Italian gross exports in Leather, leather products and footwear to its main destination markets 87

Table B.1 Dataset for research on value added exports 95

Table C.1 Country Coverage of WIOD (Release 2013) 96
Table C.2 Industry Coverage of WIOD (Release 2013) 97

Table 3.1 Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 1: time effects 125
Table 3.2 Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 1: time effects 126
Table 3.3 Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects 127
Table 3.4 Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects 128
Table 3.5 Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects 131
Table 3.6 Gravity and "gravity-like" sectoral estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects 131
Table 3.7 Sectoral estimates (period 1995-2011) - Poisson maximum-likelihood (PML) estimator 132
Table 3.8 A-I Matching - complete dataset, aggregate estimates - Year of treatment: 1999 135
Table 3.9 A-I Matching - complete dataset, sectoral estimates - Year of treatment: 1999 135
Table 3.10 A-I Matching - restricted dataset, aggregate estimates - Year of treatment: 1999 137
Table 3.11 A-I Matching - restricted dataset, sectoral estimates - Year of treatment: 1999 137
Table 3.12 A-I Matching - complete dataset, aggregate estimates - Year of treatment: 2002 139
Table 3.13 A-I Matching - complete dataset, sectoral estimates - Year of treatment: 2002 .. 139

Table D.1 Gravity and "gravity-like" aggregate estimates (period 1995-2011) - Equation 1: time effects 142

Table D.2 Gravity and “gravity-like” sectoral estimates (period 1995-2011) - Equation 1: time effects 143
Table D.3 Gravity and “gravity-like” aggregate estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects 144
Table D.4 Gravity and “gravity-like” sectoral estimates (period 1995-2011) - Equation 2: exporter-time and importer-time fixed effects 145
Table D.5 Gravity and “gravity-like” aggregate estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects 146
Table D.6 Gravity and “gravity-like” sectoral estimates (period 1995-2011) - Equation 3: country-time and country-pair fixed effects 146
Table D.7 Sectoral estimates (period 1995-2011) - Poisson maximum-likelihood (PML) estimator 147

Table E.1 Difference with the EURO coefficient obtained with gross exports value - Equation 1 148
Table E.2 Difference with the EURO coefficient obtained with gross exports value - Equation 2 148

Table F.1 A-I Matching - complete dataset, aggregate estimates - Year of treatment: 1999 - Outcome: exports flows in 2004 149
Table F.2 A-I Matching - complete dataset, sectoral estimates - Year of treatment: 1999 - Outcome: exports flows in 2004 149
Table F.3 A-I Matching - complete dataset, aggregate estimates - Year of treatment: 1999 - Outcome: exports flows in 2006 150
Table F.4 A-I Matching - complete dataset, sectoral estimates - Year of treatment: 1999 - Outcome: exports flows in 2006 150

Table G.1 Propensity Score Matching - complete dataset, aggregate estimates - Year of treatment: 1999 153
Table G.2 Propensity Score Matching - complete dataset, sectoral estimates - Year of treatment: 1999 153
Table G.3 Propensity Score Matching - restricted dataset, aggregate estimates - Year of treatment: 1999 154

Table G.4 Propensity Score Matching - restricted dataset, sectoral estimates - Year of treatment: 1999 154
Table G.5 PSM-Difference in Differences - complete dataset, aggregate estimates - Year of treatment: 1999 157
Table G.6 PSM-Difference in Differences - complete dataset, sectoral estimates - Year of treatment: 1999 157
Table G.7 PSM-Difference in Differences- restricted dataset, aggregate estimates - Year of treatment: 1999 158
Table G.8 PSM-Difference in Differences - restricted dataset, sectoral estimates - Year of treatment: 1999 158

UNIVERSITÀ DEGLI STUDI ROMA TRE