The Italian Districts in the Global Value Chains

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Abstract

The aim of this paper is to examine the impact of international production fragmentation on the trade expansion of the Italian Districts (IDs). We suppose that the high heterogeneity in export performances shown by the different IDs in the last years can be explained by their participation and position in the Global Value Chains. To assess this claim at first, we observe how the share of trade in parts and components, on the total districts' trade, is changed in time, and we construct districts profiles according to their import and export composition. Then, we construct our metric of position in the GVCs, considering for every district its PageRank centrality in the global input-output network. We test the relation between PageRank centrality and export performance with a panel data analysis from 1995 to 2011. The results suggest that position in the GVCs had a significant impact on the district's export performance.

1 Introduction

According to Becattini: *"a Marshallian industrial district [. . .]is a geographical entity characterised by the active presence of a group of persons and a population of firms in a given historical and geographical dimension. In the case of the district, in opposition to what is observed in other forms of environment as for instance manufacture cities, a perfect osmosis tends to occur between the local community and the firms"* (Becattini, 1990, pp.36-37).

The main characteristics of the Italian industrial districts (IDs hereafter) are small size of firms, spatial concentration, specialization in one sector, presence of backward linked industries, a social and cultural background who ensure embeddedness of the firms, and a favorable institutional context. In the 90s these characteristics ensured to IDs a remarkable economic dynamism, especially in terms of exports and sales. This successful story has been deeply analyzed in the international literature as an alternative to large scale production, underlining the importance of flexible specialization (Priore and Sabel 1984, Pyke et al. 1990, Porter 1996).

However, more recent, the performances of districts in terms of growth and export worsened and IDs have been criticized because of the "dwarfism" of their firms and the persistence of the specialization in traditional manufacturing sector (Onida 2004, Nardozzi 2004).

IDs have now experienced substantial structural changes. They moved from export-oriented but locally self-contained production systems to globally interdependent production systems rooted in a local context, changing some of the characteristics considered the reasons of the bad performance of IDs. According to Rabellotti et al. (2008) "districts are on the move" reacting to the increase of competition in the global markets.

In this work, we analyze how the districts changed focusing, in particular, on their participation and position in Global Value Chains (GVCs hereafter), trying to assess if the different performance of the industrial districts could be explained by the deepness of their involvement in the fragmentation of production. Participation in GVCs, in fact, gives to IDs the opportunity to achieve economies of scale, expand market share and increase productivity (UNCTAD 2010). If a district specialized in one task is able to link it in GVCs with countries, themselves highly connected in GVCs, it could enjoy a positive network externality.

In order to analyze the internationalization of IDs, first of all, we need to correctly identify them. Moreover, we need to find a proper GVC participation indicator. Empirical analysis of industrial districts has always been plagued by data shortage and the increasing complexity of IDs' international activities has amplified the problem. There are essentially three reasons for this. Firstly, the so-called "globalisation statistics" are still at an early stage of development in most countries. Secondly, the measurement of internationalisation with respect to a very detailed sub-national scale raises additional problems in terms of data quality and availability. Thirdly and more interestingly, the shift from the enterprise or the industry to the ID, as the reference unit of analysis, calls for some substantial complications.

To overcome these problems, we choose to evaluate product fragmentation considering the shifting in the composition of district trade towards intermediate goods. We try to assess if, during out time span, districts changed their specialization in different activities of the production process, given their traditional specialisation in products and industries, evaluating if they moved to upstream or downstream activities. We found evidences of increasing participation of the districts in the GVCs, however, we couldn't completely relay on this results because, if we consider as our metric of production's fragmentation the amount of trade in parts and components, our results are biased by a problem of low accuracy since it is not always easy to determinate if a good is an intermediate or a final one.

We construct a novel indicator of GVCs participation based on input-output tables to handle this data gap. Using WIOD database, we built for every year the overall global value network and we consider every district accordingly to its trade structure. We then calculate for every district and every year the PageRank centrality index, in order to assess the position of a district in the GVC network. After having computed the centrality index, we run econometric estimation to detect whether there is an effect of network externality on the trade performances of the districts and, if so, is direction and weight. We handle the likely presence of endogeneity between export and the network indicator of participation in GVC using panel data model with fixed effect and fist differencing.

The rest of the paper is organized as follows. Section 2 briefly analyzes the literature. Section 3 describes the characteristic of the chosen districts and evaluates recently changes in districts trade in parts and components. Section 4 discuss the new GVCs position indicator. Section 5 presents the data and the methodology used in the empirical analysis. Section 6 summarizes the main results and, finally section 7 concludes our work.

2 Literature Review

Our analysis builds upon different strands of economic literature. More specifically the literature on industrial districts, on GVCs and on economic network jointly provide the theoretical background. In this section, we review briefly the main contribution of the different strands for the problem we address.

Early contribution on the concept of Industrial District can be found in Marshall's seminal work (1890, 1919), however the concept was reconsidered only in the 80s thanks to the contribution of Becattini, (1979, 1990) and, Piore and Sabel, (1984). The first quantitative analysis on the export performance of districts were, on our knowledge, Beccattini and Menghinello (1998), Becchetti and Rossi (2000) Istat (2002) and Menghinello (2003). All found a robust positive relation between IDs and export performance. Recently, a growing number of works has underlined how districts are highly heterogeneous with substantial differences in governance and market structure and, to make the picture more complex, many districts are in the middle of a deep transformation of their sectoral and product specialization influencing their export behaviour (Mariotti et al. 2008, Rabellotti et al. 2008).

Case studies on specific district or sector (Rabellotti 2004, Corò and Volpe 2003, Tattara et al.2006 Amighini and Rabellotti 2006) have investigated how the local value chain of Italian IDs interacts with the global level, based on international trade flows. Amighini and Rabellotti (2006) show, for the footwear sector, how the strategy of internationalization of the districts varies according to their market and geography position, using outward processing trade as an indicator for the fragmentation of production. Corò et al.

(2006) demonstrate that the textile and apparel chain is more open than the footwear and the furniture ones, and that the three chains are mainly related to Eastern European countries, using an index of internationalization based on bilateral flows of intermediate goods.

Starting from the seminal papers of Gereffi and Korzeniewicz (1994) and Gereffi (1999), the GVCs framework properly emerged in the early 2000s to combine aspects of several different industrial organization backgrounds including commodity chains, networks, industrial districts and clusters (CGGC, 2005; Gereffi, Humphrey, Kaplinsky, and Sturgeon, 2001; Gereffi, Humphrey, and Sturgeon, 2005). From an operational point of view, two alternative approaches have been used to evaluate the magnitude of the fragmentation of production. The first consider national trade data to quantify the importance of trade of parts and components in trade flows (Ng and Yeats 2003 and Athukorala 2011), the second consider input-output tables to quantify trade value added in production network (Koopman et al.2014, WTO 2011 and IDE-JETRO 2011). Both this approaches, despite the different empirical techniques employed, reach the same conclusions underling how, in the last years, trade increasingly relied on intermediate goods, and, on average, foreign value added in producing goods and services is increasing. We will discuss extensively this metrics while we develop an indicator of participation in GVC.

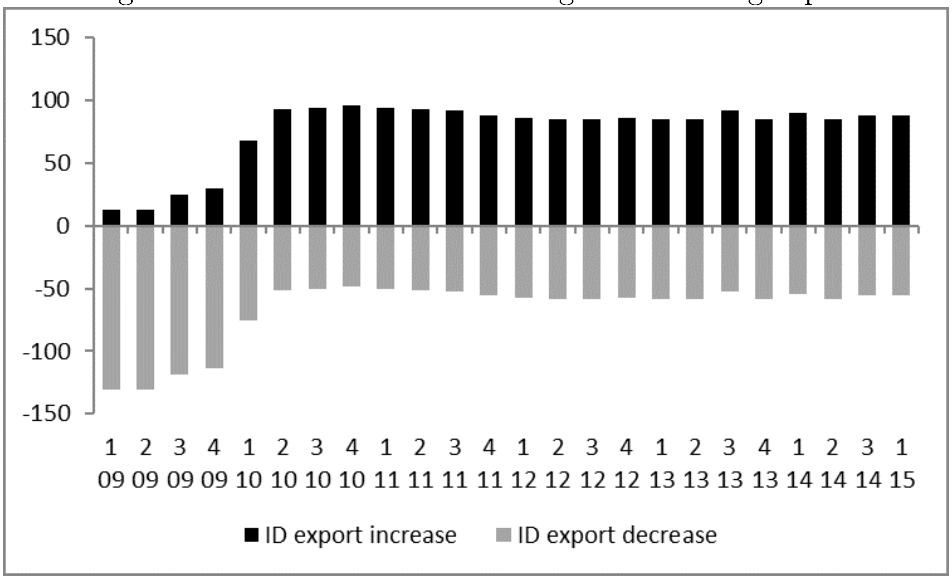
In order to study the interconnections of districts within GVCs we use network analysis. Complex network techniques have been use widely to analyse trade interactions (Serrano and Boguñá (2003), Garlaschelli and Loffredo (2004, 2005), Serrano et al. (2007), Kali and Reyes (2007), Fagiolo et al.

(2010), and Fan et al. (2014). Moreover, international trade economists have also applied network metrics to examine the evolution of total world trade, as in De Benedictis and Tajoli (2011) and De Benedictis et al. (2014), and of trade in specific sectors, as in Akerman and Seim (2014) for arms trade and Amighini and Gorgoni (2014) for auto parts trade. For what specifically concern the construction of input-output network Cerina et al. (2014) Zhu et al (2015) and, Amador and Cabral (2015) study the topological property of the overall network, focusing on the country-product linkages. In a different vein, Ferrarini (2013) uses international trade data on products classified as parts and components to quantify vertical trade among countries in a network framework.

3 Districts in the Global Value Chains

Italian IDs have a very successful story as exporters as mentioned above. (Menghinello 2003). According to Intesa San Paolo, in 2014, the contribution of IDs to Italian exports exceeded 35%, and in the first quarter of 2015 it represents 73% of the Italian manufactured trade surplus. As we can see from figure 1, in the last years the number of Italian districts which increased their export quarter on quarter has raised, showing a significant dynamism. Although the limits of this empirical results, this figure provides a preliminary assessment of the remarkable relevance of IDs for the Italian performance on the international markets.

Figure 1: Number of IDs increasing or decreasing export



Source: Intesa San Paolo

In this section, we analyse the evolution of the import and export flows of Italian districts from 1995 to 2011 focusing on how they move along the value chain, if at all.

The first issue is how to correctly identify Italian IDs. There are several ways. The most used is the exhaustive classification developed by ISTAT (Sforzi 1990, ISTAT 1997). In this approach, IDs are identified as a specific subset of all Local labour market (hereafter LLMs) following a two steps statistical procedure based on location quotients (hereafter LQ). Firstly, manufacturing LLMs are identified as a subset of LLMs presenting a local concentration of employment in manufacturing activities exceeding the national average. Secondly, MIDs are detected from the sub-set of manufacturing LLMs as those presenting a local concentration of activities run by small and medium-size firms[1] that is superior to the national average. For the year 2011, the last year for which data are available, this simple statistical procedure led to the identification of 141 local manufacturing systems characterised by a dominant presence of small and medium size enterprises, out of a total of 784 LLMs.

The two steps statistical procedure adopted by ISTAT (1997) to identify local manufacturing systems characterised by a dominant presence of small and medium size enterprises has proved to be successful in correctly identifying the majority of known IDs in Italy. Two advantages of this approach are the following: 1) this approach adopts a functional classification rather than an administrative one to define the basic territorial unit, 2), the adoption of a quantitative approach represents a significant step forward in the development of a theoretically and empirically sound classification of IDs with respect to alternative classification frameworks, which are exclusively based on qualitative and highly subjective information.

The dataset includes bilateral data of import and export at the three digit of Statistical Classification of Products by Activity (CPA Ateco 3) at provincial level (NUTS 3). While at the LLM level, IDs are identified directly by using ISTAT classification (1997), relevant problems arise for our data, which include the province as reference territorial detail. Provincial units usually do not properly reflect the effective spatial distribution of economic activity. As a result, the geographical boundaries of them often either very loosely include or cut across a geographical agglomeration of economic activity. Our identification of IDs at the provincial level is based on the work

[1]Small and medium size firms are defined as having less than 250 employees.

by Becattini and Menghinello (1998). They develop a methodology based on municipality data that quantitatively assesses to what extent a cell made by the combination of an industry and of a province is representative of the potentially underlying IDs. Starting from the ISTAT classification of IDs made at the LLM level, they identify 40 combinations of industries and provinces characterised by the dominant presence of IDs. In our work, following their methodology, we use this industry-province level of analysis.

Using this provincial-sector focus, we further refine our unit of analysis. Since our main interest is the export performance of the districts, we select a subset of IDs considering only those relevant for the trade composition of the reference province. To proxy this, we consider only districts with a high ratio between the provincial export of industry characterizing the district and the total provincial export of manufactured goods.

Table 1: Selected province, industry and relevance index

ID (Italian province)	**Specialization**	**Relevance rank**
Belluno	Eyewear	78.2
Udine	Mechanical equipment	36.4
Biella	Textiles & clothing	30.7
Prato	Textiles & clothing	30.5
Arezzo	Gold and Jewellery	28.8
Pisa	Leather & footwear	27.1
Rimini	Textiles & clothing	26.9
Lecco	Mechanical equipment	25.2
Alessandria	Gold and Jewellery	25.2

Table 1: Selected province, industry and relevance index

ID (Italian province)	Specialization	Relevance rank
Macerata	Leather & footwear	24.2
Ascoli Piceno[2]	Leather & footwear	23.8
Viterbo	Ceramics and tile	22.5
Bologna	Mechanical equipment	20.7
Firenze	Leather & footwear	20.6
Novara	Mechanical equipment	20.2
Ancona	Mechanical equipment	18.6
Pordenone	Wood and furniture	18.2
Modena	Ceramics and tile	17
Lucca	Paper products	14.1
Pesaro	Wood and furniture	13.9
Treviso	Wood and furniture	13.9
Vicenza	Leather & footwear	13.3
Avellino	Leather & footwear	13
Como	Textiles & clothing	11.9
Como	Wood and furniture	11.5
Forlì	Leather & footwear	10.7
Perugia	Textiles & clothing	10.6
Venezia	Leather & footwear	10.6
Pistoia	Leather & footwear	10.5

[2] From 2004 the province of Ascoli Piceno was divided in Fermo and Ascoli Piceno in our analysis we consider them jointly.

Table 1: Selected province, industry and relevance index

ID (Italian province)	Specialization	Relevance rank
Pordenone	Mechanical equipment	10.1
Verona	Mechanical equipment	9.7
Verbania	Mechanical equipment	9.5
Mantova	Textiles & clothing	9.4
Treviso	Mechanical equipment	8.9
Udine	Wood and furniture	8.9
Bari	Wood and furniture	8.7
Pavia	Leather & footwear	8.6
Caserta	Leather & footwear	8.4

Source: Authors elaboration on ISTAT data

To further improve the quality of our data, we calculate which part of the import at provincial level could be consider as an input for the district. To do so, for every province considered, we find another province with a similar value of GDP per capita and we clean our import data, weighting them for the correspondent value of the province with no district. In this way we disentangle the "district effect" on import.

To analyze the participation of districts in Global Value Chains we need to examine patterns of final and intermediate goods trade. The increasing trade in intermediate goods is a good proxy for GVC formation because, if the production is fragmented, parts and components will cross national borders more than once, before final goods are produced (Sturgeon and Gereffi 2010).

To properly assess this, we need to carefully single out final and intermediates goods.

The BEC classification developed by the United Nation Statistic Division has become popular to classify categories of intermediate goods to examine issues related to GVCs, but even if it presents some pro such as its clarity, the comprehensive and consistent approach and the easiness of reproduction, it has some problematic aspects. As underlined by Sturgeon and Memedovic (2010), it is too highly aggregated and it is old so that it may no longer reflect the actual use of goods in new industries. These problems are even more severe if we consider, as in our case, traditional sectors as leather and footwear and, textiles and clothing.

To deal with this problem, we choose to classify the product inside the *filière* reference sector according to Main Industrial Group (hereafter MIG) classification developed by Eurostat at three digit classification. The MIG classification divides goods at the NACE three-digit level according to their use. The classification distinguishes between consumer durable, consumer not durable, intermediates, energy and capital goods. For our purpose the main advantage of MIG with respect to BEC is the higher level of decomposition which allows us to have intermediate and final goods in every sector. Moreover, in our analysis, to focus deeply on the change inside the *filière*, we further divide MIG intermediate goods in intermediate goods and raw materials.

Table 2: Share of intermediate goods per worker

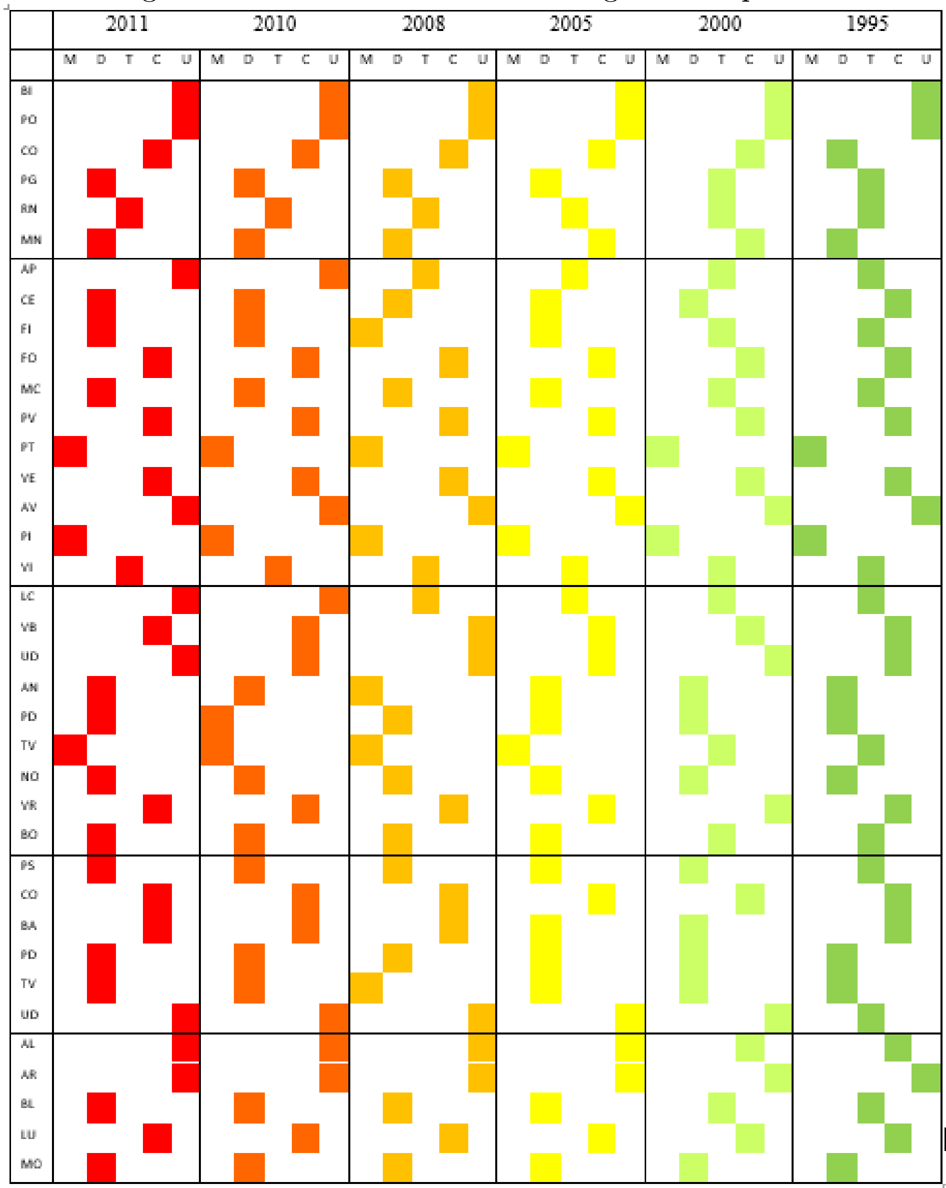
	Import			Export		
ID	**1995**	**2011**	**Var**	**1995**	**2011**	**Var**
Alessandria	5.7	9.2	3.5	16.3	29.1	12.8
Ancona	4.4	44.3	39.9	3.9	7.3	3.4
Arezzo	0.14	0.27	0.1	0.8	1.5	0.7
Ascoli Piceno	35.1	50.5	15.4	4.9	27.6	22.7
Avellino	10.9	13.9	3.0	3.5	17.2	13.7
Bari	74.1	75.1	1.0	36.2	35.3	-0.9
Belluno	1.2	1.1	-0.1	2.2	2.9	0.7
Biella	15.3	30.2	14.9	59.1	60.2	1.1
Bologna	20.9	50.9	30.0	11.4	17.2	5.8
Caserta	76.8	78.4	1.6	22.4	19.9	-2.5
Como (T&C)	76	76.2	0.2	42.1	74.7	32.6
Como (W&F)	88.2	87.5	-0.7	35	37.5	2.5
Firenze	15.7	24.1	8.4	26.1	26	-0.1
Forlì	24.6	13.4	-11.2	53.4	52.4	-1
Lecco	2.3	4.9	2.6	8.9	16.4	7.5
Lucca	2.5	3.13	0.6	22.8	35.7	12.9
Macerata	4.1	9.2	5.1	4.5	18.6	14.1
Mantova	70.1	71.3	1.2	44.2	46.4	2.2
Modena	44.6	61.5	16.9	3.73	12.4	8.67
Novara	2	4.5	2.5	2.8	2.9	0.1
Pavia	89.3	96	6.7	74	82.1	8.1

Table 2: Share of intermediate goods per worker

	Import			Export		
ID	**1995**	**2011**	**Var**	**1995**	**2011**	**Var**
Perugia	52.8	51.4	-1.4	21.5	35.8	14.3
Pesaro	60.1	63.4	3.3	2.89	14.2	11.31
Pisa	28.9	23.4	-5.5	17.5	38.6	21.1
Pistoia	2.3	1.7	-0.6	16.6	23.4	6.8
Pordenone (mec)	29	37.8	8.8	15.3	17.8	2.5
Pordenone (W&F)	63.3	71.5	8.2	4.3	9.8	5.5
Prato	41.9	49.6	7.7	53.6	57.9	4.3
Rimini	14.3	13.3	-1.0	12.2	4.3	-7.9
Treviso (mec)	18.6	8.2	-10.4	8.4	15.1	6.7
Treviso (W&F)	51.4	73.4	22.0	12.9	13.8	0.9
Udine (mec)	31	32.3	1.3	1.8	4.5	2.7
Udine (W&F)	12.7	21.7	9.0	11.5	36.5	25
Venezia	68.5	65.3	-3.2	46.2	48.3	2.1
Verbania	17.7	34.6	16.9	4	8.9	4.9
Verona	12.3	19.1	6.8	32.8	33.7	0.9
Vicenza	18.1	24.6	6.5	3.6	17.5	13.9
Viterbo	2.55	3.99	1.4	1.5	12	10.5

Source: Authors elaboration on ISTAT data

Figure 2: IDs classification according to their profiles



Source: Author's elaboration

In table 2, we report the share of import or export of intermediates goods per worker for every district in our sample. We divide trade flows for the number of employees of the district to proxy for the dimension of the sector. Traditionally, since Italy is poor of raw materials, the IDs are importer of raw materials and exporter of final goods, however in the last ten years this traditional scenario has changed and the IDs are connected to international markets also in the intermediates phases of production. We notice that almost every district (30 out of 38 for import and 33 out of 38 for export) has increased trade in intermediate goods and, only 2, namely Forlì and Rimini, have not increased its trade in parts neither for import nor for export. If we consider the districts which have not increased trade in parts, we notice that especially for export, these are districts less involved in international trade. This simple empirical results give us some hints about how the participation of districts in the GVCs has changed in the last years.

To further evaluate the extent of the change in the position of the IDs, we jointly consider the evolution of import and export composition. We construct 5 different profiles for the districts according to the composition of their trade flows: Merchandising, Downstream, Traditional, Central and Upstream. We consider a district merchandising if it imports and exports mainly final goods, downstream if it exports final goods and imports intermediate ones, traditional if it imports raw materials and exports final goods, central if it imports and exports intermediate goods and finally upstream if it imports raw materials and export intermediate goods. We determine the profile of every district simply calculating for every year:

$$\begin{aligned} DP &= \frac{imp_c + exp_c}{imp_{tot} + exp_{tot}} \; with \\ c &= \{raw\ materials\, intermediate, final\} \end{aligned} \tag{1}$$

according to the profile considered. We divide all the results for the average of the year of the considered sector and finally, we consider the highest value as the profile of the district for the year.

In figure 2, shows, divided by sector, all the districts in the sample as well as their position in the production chain for every year.

First of all, we notice that even in the same sector the districts show high heterogeneity in trade composition. A traditional characteristic of Italian districts is to be specialized in a very specific range of products and different districts in the same sector are specialized in different parts of the production chain so they trade goods according to this specialization. However, even with this strong specialization, districts are moving over time since 26 IDs have changed their profile. The sectors with a higher dynamism are mechanical equipment and, secondly wood and furniture in which almost every district from 1995 to 2011 has changed its profiles while, as expected, the lowest dynamism could be found in a traditional sector such as leather and footwear, which still present a strong local focus.

Table 3: Matrix of transaction

ID	**2000**	**2005**	**2008**	**2010**	**2011**
Biella	0	0	0	0	0
Prato	0	0	0	0	0
Como T	1	0	0	0	0
Perugia	1	0	0	0	0
Rimini	0	0	0	0	0
Mantova	1	0	1	0	0
Fermo	0	0	1	0	0

Table 3: Matrix of transaction

ID	2000	2005	2008	2010	2011
Caserta	1	0	0	0	0
Firenze	0	0	1	1	0
Forlì	0	0	0	0	0
Macerata	0	1	0	0	0
Pavia	0	0	0	0	0
Pistoia	0	0	0	0	0
Venezia	0	0	0	0	0
Avellino	0	0	0	0	0
Pisa	0	0	0	0	0
Vicenza	0	0	0	0	0
Lecco	0	0	1	0	0
Verbania	0	0	1	1	0
Udine M	1	1	1	1	1
Ancona	0	0	1	1	0
Pordenone M	0	0	0	1	1
Treviso M	1	1	0	0	0
Novara	0	0	0	0	0
Verona	1	1	0	0	0
Bologna	0	1	0	0	0
Pesaro	1	0	0	0	0
Como W&F	0	0	0	0	0
Matera	1	0	1	0	0

Table 3: Matrix of transaction

ID	2000	2005	2008	2010	2011
Pordenone W&F	0	0	0	0	0
Treviso W&F	0	0	1	1	0
Udine W&F	1	0	0	0	0
Alessandria	0	1	0	0	0
Arezzo	0	0	0	0	0
Belluno	0	0	1	0	0
Lucca	0	0	0	0	0
Modena	0	0	0	0	0
Viterbo	0	0	0	0	0

Source: Authors elaboration

To conclude, we can claim that districts are becoming increasingly internationalized and they are getting more involved in the GVCs using different strategies. In the next sections, we analyze the effects of this change on the export performance of IDs.

4 A New Indicator of GVCs

In the literature on GVCs two different approaches emerged to evaluate the participation and the position of different actors: firms, country... in the global production network.

The first one is based on the official trade statistics and, according to the classification of goods, disentangles the trade in parts and components from the one in final goods. Pioneered by Yeats (2001) and used in a number of successive studies (Ng and Yeats, 2003; Athukorala, 2005; Athukorala and Yamashita, 2008) this measure has the merit to be comprehensive and comparable, and to ensure a consistent coverage given the availability of the required data. However, it presents two problematic aspects. First, it suffers from a problem of low accuracy because of difficulties to assessing if a good is intermediate or final (for instance flour could be both depending from the users), and second it considers only pure component production and not all the stages of GVC.

The second approach uses harmonized input-output tables of different countries to evaluate the domestic value-added, the share of domestically produced inputs in production or in total inputs, and foreign value-added, the share of imported inputs in production or in total inputs, for a product exported from a given country. This measure was firstly developed by Feenstra and Hanson (1996) and used by Campa and Goldberg (1997), Egger et al. (2001) and Egger and Egger (2003). A slightly different measures used for the first time by Hummels et al. (1998), called vertical specialization, focuses on the (direct and indirect) import content of exports.

A further development of those ideas is the so call "trade in value added". The idea behind it is that domestic value-added combines with foreign value-added in order to produce exports, which may be used as an intermediate input or consumed as final goods. The domestic value-added in exports can circulate in the global network of production and part of it may return to the domestic economy in this process. Several studies developed this concept the most significant of which, are Johnson and Noguera (2012), Daudin et al. (2011) and Koopman et al. (2014).

Those type of metrics are quite accurate but they require complex data since, along to input-output table and trade data, they need also data on production or value added which are at a provincial level unavailable.

For those reasons, we need to develop a new metric for participation in the GVCs to contrast the lack of data at a provincial-sector level. Global value chains are represented as *"the sequence of all functional activities required in the process of value creation involving more than one country"* (UNCTAD, 2013) showing a clear input-output structure along the process, for this reason we use, as our basic statistical tool, input-output tables. Evaluating the structure of this tables it is natural to interpret them as a network. In fact, each sector-country combination corresponds to a vertex and the trade flows from one sector in a country to another could be seen as a directed edge: the direction goes from the seller to the buyer industries and the flows are monetary. Modelling the trade flows of intermediate goods as a direct network, we can measure the relative position of an actor in the GVCs simply considering an appropriate index of centrality of a vertex within the network.

To construct our network, we use the Word Input-Output Database (WIOD). As a specific network, WIOD has several features: it is directed and weighted, it is denser between the different sectors of the same country since, even if the global economy system is more integrated, the country border still maters and it presents strong self-loops since every sector consumes as an input, a lot of products from the sector itself.

The WIOD tables cover 35 different sectors for each of the 40 countries considered plus a model-constructed rest of the word for the years from 1995 to 2011. For each year they build a harmonized global input-output table with all the input-output flows between any combination of sectors in any country. The values of the transactions are expressed in US millions of dollars (Timmer et al. 2015)

To insert in the global value network our considered IDs, we construct, for every year and for every district, a different network, dropping from the WIOD setup the district-specific sector of Italy and including the district. In order to assess the intermediate flows of the districts, we assume that the content of intermediate goods of the districts with respect to a specific country is proportional to the content of intermediate goods of the Italian sector in which the district is specialized with respect to the same country.

For example, if a district specialized in textile products exports to Germany in a specific year, we assume that the proportion of intermediate goods traded is the same one of the Italian export of textile products to Germany in that year. We apply this correction to obtain the intermediate content of every bilateral flows of the districts. Since we know the bilateral structure of trade of every district but we do not know the sector structure. we assume that the sector repartition of a district is the same of the Italian sector in which the district is specialized with respect to the same country. Given this transformation we obtain for every district the intermediate flows structure for every year and for every country and sector combination.

To simplify the network obtained, we do not consider transactions below 0.5 million dollars, we also consider alternative values for the threshold and the results remained qualitatively unchanged and we do not consider self-loops replacing the diagonal of our adjacent matrix with zeros.

Once we have constructed the network, we need to carefully choose the centrality indicator. There are two properties of the input-output adjacent matrix that make it hard to apply standard centrality measures. First, given the level of aggregation, the networks are dense and they become denser along time so, applying measures based on the idea of shortest path could be misleading since, given the dense structure of the networks, we are more interested in the weights of the edges. Second, the network is direct since we are interested in the direction of trade flows. These problems oblige us to pay even more attention to the choice of the correct indicator. There are a huge number of different measures for centrality, each considering different nodes' characteristics, to assess what is the meaning of importance in a network. Based on the walk structure centrality can be divided into two classes: radial and medial. Radial measures count the number of walks which start or end in a considered vertex (for example degree or eigenvector centrality) while medial consider the number of walks which pass through a given vertex (for example betweenness centrality) Borgatti and Everett 2006.

To build measure of participation in the GVCs we need to consider not only the number of links every vertex has (namely the degree centrality) but also the importance of the neighbors every vertex is connected with. In fact, not all vertices are equal and we want a measure that assigns more importance if a vertex is connected with other highly connected vertices. Eigenvector centrality solves this problem giving to any vertex a score proportional to the scores of the other vertices it is connected with.

Nonetheless, eigenvector centrality could not be our metric since it performs poorly if applied to direct networks. Generally, eigenvector centrality would be zero for vertex which has no link to a neighbor in a strongly connected component, even if it has a high value of degree. In a direct graph there are only single vertex strongly connected components so we will have some zero centrality vertices.

To solve this problem, we choose to use PageRank centrality. PageRank belongs to the family of eigenvector centrality since it gives importance to a vertex if its neighbors are important and/or if the neighbors of the neighbors are important. Moreover, PageRank centrality fits well with direct network since it assigns to every node by default a small amount of centrality, in this way even zero in-degree vertex will participate to the centrality measures of the nodes they are linked to. It also divides the centrality contribution of a node by its out degree. In this way it solves the situation in which centrality increase only because a vertex is connected with a single high centrality node.

The mathematical formula for PageRank is:

$$x_i = \alpha \sum_{j=1}^{n} A_{ij} \frac{x_j}{k_j^{out}} + \beta \tag{2}$$

Where A_{ij} is the ij value of the adjacent matrix of the network and k_j^{out} is the out-degree weighted value of the vertex j. The first part of the formula represents the classic eigenvector centrality while the second term is the amount of centrality that every node receives regardless its position in the network. The coefficients $\alpha and \beta$ are always positive and since β is just a scaling constant α is the only scaling factor of the contribution of the different vertices, in our calculation we set it equal to 0.85. Moreover, in the case that the out-degree weighted value of a vertex is equal to 0 to solve the problem the value is artificially settled equal to one.

To analyze the relation between eigenvector centrality and PageRank we calculate their Pearson correlation coefficient. We obtain a $r^2 = 0.84$ indicating that, even if highly correlated, the two measures captures something different.

In this analysis we consider especially forward linkages (where the district provides inputs into exports of other countries) but our indicator of participation in the GVCs could be easily changed to consider specifically backward linkages (where the district imports intermediate products to be used in its exports) or the overall position.

5 Data and Econometrics

We finally want to assess how the export performance across the districts depends on their participation in the global value chains. The literature on the determinants of export performance essentially divides them in domestic (supply side) and international (demand side) factors. The international determinants are generally considered using exchange rate and change in the word economic activities. Since in our study we focus on Italian districts we assume that the different districts share the same external environment. Therefore, for the sake of parsimony, we exclude from the analysis all the international factors assuming no cross-sectional variation among them. Our exercise concentrates on supply-side factors, especially inputs factor which are district-specific, rather on international variables, generally more used in the literature. We add to the supply-side factors our indicators or participation in the GVCs to evaluate how much the international fragmentation of production could affect export performance of the districts assessing the impact of the network externality. The increasing fragmentation of production could expand trade volume for the following reasons: first of all, it increases international flows of parts and components increasing export of districts, second, thanks to the increasing specialization, it could realize significant economy of scale since parts and intermediates produced in a more efficient way, could be supplied to a greater number of users in the world market.

The dataset used is a balanced panel stratified by province-sector and time. It covers the 38 selected province- sector combinations for the year 1995, 2000, 2005, 2008, 2010 and 2011 up to a total of 228 observations. The data on export, provincial employee number and value added at the provincial and industry level are official statistics produced by the Italian Statistical Institute (ISTAT). The data on the number of countries every district export to are constructed from the official export data, and the number of patents per million populations is from the European Patent Office. We construct the key variable using the open source network analysis program Gephi: PageRank centrality. All the monetary variables are expressed in real terms (1995 prices) using price index deflators.

The specification of our log-linearized model is:

$$\begin{aligned} lnexp_t^{p,s} &= \alpha_0 + \beta_1 lnL_t^{p,s} + \beta_2 lnvadd_t^p / L_t^{p,s} + \beta_3 lnpat_t^p \\ &+ \beta_4 lnpr_t^{p,s} + \beta_5 lnncexp_t^{p,s} + Dum^s + \varepsilon_t \end{aligned} \tag{3}$$

Where $exp_t^{p,s}$ is the exports of every combination p, s representing a district, $L_t^{p,s}$ represents the number of person employed at time t of every combination p, s expressed in thousands of people, $vadd_t^p / L_t^{p,s}$ is the provincial value added at time t scaled by the district employees, a proxy for the labor productivity, pat_t^p is the number of patents per million population an indicator of the inventive activity of the province and finally $pr_t^{p,s}$ is the PageRank centrality value of every district at time t, our key variable, and $ncexp_t^{p,s}$ represents the number of countries in which every district exports. We also include in our estimation the dummy variable Dum^s to control for sector specific effects.

To this baseline specification. we a specification including annual dummy variables and another dropping the sectorial dummies and including year-sector dummy. We include the year dummies to assess for time specific shocks common to all districts. Since our time span of sixteen years considers pre and post crisis years, we try to disentangle the crisis effects which, on average, depress trade flows. Moreover, the use of year effects avoids the use of controls, such as word income or exchange rate, which not show variation across the districts. We also add year and sectorial dummies to capture the different reaction of the sectors to the trade shocks during out time span. In fact, seems plausible that the sectors are not equally hit by them and the sectors more involved in GVCs show a sharper decline in trade respect to the others.

At first, we estimate our equation with robust estimators. However, our OLS adjusted estimation violates the assumption of strict exogeneity resulting in a biased estimation of the coefficients.

The presence of potential endogeneity, which can seriously bias the final results, is a standard problem if we add centrality measures to an econometric model. Our main concern is about the possibility that export and our centrality measure could be simultaneous in the sense that, in the error terms, are included shocks which may affect both export and centrality so that centrality measure would be correlated with the error term ε_{ij}. Even if we do not obtain our centrality index from the general network of trade, we calculate it from the global input-output network which is, in some sense, a sub-network of the global trade network, therefore the error term may include unobserved variables, such as trade barriers, which may simultaneously affect export performance and centrality measures.

The usual way to deal with endogeneity involves using instruments, however we do not have a proper one. To treat this endogeneity problem, in line with Wooldridge (2002) we will use panel data analysis which allows us to consider the unobserved heterogeneity of our data.

We run our panel estimation using fixed effects rather than random effects since the evaluation of the Hausman test shows a clear evidence for the rejection of the random effects.

As underlined by Wooldridge (2000), to deal with endogeneity bias using panel data we must focus on the choice between estimation with fixed effects or with first differencing (depending on the nature of the series). If the number of periods is equal to 2, the two techniques give the same results but, when the numbers of periods is higher, the two techniques differ in the relative efficiency of the estimators: fixed effect estimators are more efficient if we assume that the error terms are serially uncorrelated while, first differencing is more efficient when the error term is correlated, for example if it follows a random walk. Since we cannot easily compare the efficiency of the fixed effects and the first differencing we use fixed effect as a benchmark and we will check the robustness of our results using differenced data.

Since our sample is narrow and in our baseline specification we use both the number of employees and a linear combination of them and the value added, we have multicollinearity between two independent variables in our model. Even if multicollinearity does not bias our results, it increases standard errors reducing the power of our tests. To solve this problem without losing information we choose to drop, for the panel estimation our reference one, the number of employees from the independent variables and to use, as our dependent variable the district's export per worker.

To be efficient, both fixed effect and first differencing estimates need the assumption that the errors in the regression are serially uncorrelated. In our estimation we may expect that export in one period can affect export in the next ones. To test this assumption, we use the Wooldridge test (2002) for first order serial correlation AR (1). The test, based on the residual from a regression in first difference, it is robust for heteroskedasticity. In both our regressions, with fixed effects and first differencing, we find strong rejection of the hypothesis of no serial correlation so, to produce consistent estimator of the standard errors we choose to use clustered standard errors.

We also test for strict exogeneity, since it could result in biased estimates. To test for exogeneity, we apply the Wooldridge test (2002). We try to find any possible feedback effect between potentially endogenous and dependent variables. The test is implemented by estimating the base equation including leading values of our centrality measure which we suspect might not satisfy the assumption of strict exogeneity. We test the presence of endogeneity evaluating the significance of the leading value of centrality with a cluster robust test. First of all, we test for strict exogeneity in the OLS and, as expected, we reject the null for the OLS estimation, since the coefficients are positive and significant at 1% in all the specifications. Then, we test the fixed effects and the first differencing estimation. For both fixed effects and first differencing, in all specifications, we can accept the hypothesis of strict exogeneity since the coefficients of the lagged values of PageRank centrality is never significant not even at the 10%.

6 Results

Table 4: OLS estimation

Dependent variable: $lnexp_t^{p,s}$						
OLS with robust standard error						
	1		2		3	
Regressor	Coefficient	P value	Coefficient	P value	Coefficient	P value
$lnL_t^{p,s}$	1.095***	0.000	1.081***	0.000	1.097***	0.000
$lnvadd_t^p/L_t^{p,s}$	0.516***	0.000	0.497***	0.000	0.489***	0.000
$lnpr_t^{p,s}$	0.355***	0.000	0.405***	0.000	0.385***	0.000
$lnpat_t^p$	0.057	0.328	0.091	0.144	0.128**	0.041
$lnncexp_t^{p,s}$	0.213	0.404	0.177	0.478	0.053*	0.086
Textile	0.055	0.691	0.062	0.654		
Footwear	-0.467***	0.000	-0.464***	0.000		
Furniture	-0.474***	0.001	-0.445***	0.000		
Mechanic	0.166	0.156	0.139	0.257		
Year dummy	No		Yes		No	
Year-sector dummy	No		No		Yes	
Const	72.83***	0.000	12.35***	0.000	12.13***	0.000
N obs	228		228		228	
F stat	23.94	0.000	49.22	0.000	26.72	0.000
Test exo	0.633	0.000	0.634	0.000	0.633	0.000
Test ser corr	34.07	0.000	34.06	0.000	34.07	0.000

Table 5: Fixed effect estimation

Dependent variable: $ln\frac{imp_t^{p,s}}{L_t^{p,s}}$						
Fixed effect with,clustered error						
	1		2		3	
Regressor	Coefficient	P value	Coefficient	P value	Coefficient	P value
$ln, vadd_t^p/L_t^{p,s}$	0.731***	0.000	0.693***	0.000	0.694***	0.000
$ln, pr_t^{p,s}$	0.142	0.103	0.255**	0.034	0.245**	0.025
$lnpat_t^p$	0.198***	0.004	-0.111	0.256	-0.005	0.946
$lnncexp_t^{p,s}$	1.187***	0.003	2.567***	0.00	2.446***	0.000
Year dummy	No		Yes		No	
Year-sector dummy	No		No		Yes	
N obs	228		228		228	
F stat	84.7***	0.000	50.2***	0.000	41.46***	0.000
Test serial corr	57.61***	0.000	57.61***	0.000	57.62***	0.000
Test exo	0.075	0.190	0.054	0.389	0.05	0.408

Table 6: First differencing estimation

Dependent variable: $ln\frac{exp^{p,s}_{t-(t-1)}}{L^{p,s}_{t-(t-1)}}$						
Fixed effect with clustered error						
	1		2		3	
Regressor	Coefficient	P value	Coefficient	P value	Coefficient	P value
$ln, vadd^{p}_{t-(t-1)}/L^{p,s}_{t-(t-1)}$	0.735***	0.000	0.769***	0.000	0.74***	0.000
$ln, pr^{p,s}_{t-(t-1)}$	0.148**	0.046	0.164**	0.023	0.169**	0.021
$ln, pat^{p}_{t-(t-1)}$	-0.161	0.752	-0.0254	0.687	-0.013	0.882
$ln, ncexp^{p,s}_{t-(t-1)}$	3.232***	0.000	2.768***	0.000	2.732***	0.000
Year dummy	No		Yes		No	
Year-sector dummy	No		No		Yes	
N obs	190		190		190	
F stat	233***	0.000	120***	0.000	75.7***	0.000
Test serial corr	61.33***	0.000	60.67***	0.000	61.01***	0.000
Test exo	0.078	0.234	0.062	0.389	0.054	0.467

In tables 4, 5 and 6 we report the results of our estimations: the ordinary least square, the fixed effect and the first differencing.

In the first OLS estimation we consider as explanatory variables: the number of workers, the value added per worker, the proxy for technical innovation, the centrality value, the number of importing countries and sectorial dummies, in the second we add year dummies and in the third we drop the sectorial dummies and we add time-sectorial ones.

In all the specifications, as expected, the coefficients for the number of workers and for the value added per worker are positive and significant showing that, other things kept constant, bigger or more productive district exports more.

The coefficient for the number of patents is always positive, even with a small effect, but it is not significant except for the third estimation in which it is significant. Also the elasticity of export with respect to the number of countries in which the district exports is positive, however not significant except for the third estimation. This two results give us some clues about our preferred model specification. In fact, in the third specification adding time and sectorial dummies into the model we probably add significant regressors since, the reduction of the estimate of the error variance increase the t-statistic of the two variables.

Our key variable, the PageRank centrality of the districts in the network of intermediate goods is positive and significant in all the specifications, confirming our theory that more a district is involved in the Global Value Chain with country and sector combination which are central players in the network more its export will increase drag by the increasing demand for imported intermediates goods of the trade partners.

The sectorial dummies are jointly significant and give us some interesting results. They show that mechanical and, to a less extent, textile districts, with respect to other made in Italy, perform better while traditional sectors like Leather and Footwear and Furniture show more modest export performance.

However, we could not rely on the OLS results to support our theory since, as noted earlier, the pooled OLS estimation suffer from endogeneity and the estimates are therefore likely to be biased.

To overcome this problem, we analyze the coefficients of the panel data analysis since they do not suffer from the endogenous problem of the centrality measures. We first consider the fixed effect specification.

The value added for worker coefficient is positive and significant in all the specifications. The elasticity is higher, a 1% increase in value added per workers increases export per workers between 0.69% and 0.73%, with respect to the OLS estimation because we drop the human capital endowment variable to solve the problem of collinearity between the two.

Patent variable, in panel analysis, shows an unexpected behavior switching from positive value to negative ones, being significant only in the first specification in which the sign is positive. The reasons can be two. First of all, the data on patent are only indirect measure for innovation used because of lacking data, therefore, once controlled for unobserved district specific variables, it may lose significance. Second, since the variable becomes not significant if we add some sort of time dummies, it may be possible that patent number follow some sort of time trend.

In the fixed effect estimation, the number of countries a district export to become highly significant and positive. The elasticity of export with respect to this variable is also very high since it varies between 1.19% and 2.57% since, all the district, are highly involved in trade and, on average, export to a massive number of countries, therefore, a 1% increase in the number of countries a district export to signify a notable increase in the number of countries.

The PageRank centrality is slightly non-significant in the first specification probably because, as already mentioned, we need to add some sort of time trend to catch the correct effect of our regressor on export performance. It becomes significant in the others and in particular, it is positive and significant in the third specification confirming significant evidence of the impact of the participation in international fragmentation of production on its export performance

As a robustness check we run our three specification using first differencing. The results do not change substantially confirming our fixed effect estimation.

7 Conclusions

In this paper, we apply the well-known concept of participation in the Global Value Chain to understand how the export performance of Italian districts could be positive affected by their position in the global value network.

More specifically, using different indicators of GVC position, we analyze how selected Italian districts from 1995 to 2011 have changed their participation in internationally fragmented production.

Our analysis starts from the empirical observation of a significant increase in the share of parts and components in the international trade of the Italian districts. In the first part of our work, we try to determine if this increase in trade in parts could be explained by new internationalization strategies adopted by the districts, analyzing the evolution of import and export composition of the selected districts overtime. We highlighter a notable change in the profiles of almost all the districts.

To properly assess how significant is this strategy change, we develop a novel indicator of position in GVCs. We need a new indicator since, if we consider as our metric of fragmentation of production the amount of trade in parts and components, our results are biased by a problem of low accuracy as it is not always easy to determinate if a good is an intermediate or a final one; if we consider traditional measures based on harmonized input-output tables of different countries, we could not study districts performance for the reason that we lack proper data. To overcome those problems, we calculate for every district, every year, the PageRank centrality in the global input-output network, considering it as our measures of position in the GVCs.

In the empirical analysis we evaluate how, being a central player in the global input-output network could boost the export performance of the districts. In every specification considered, our results show the positive network effect on export of being central in the global input-output network, and being involved in trade with sectors and countries which are in turn central.

Therefore, since GVCs trade has grown in the last years and is likely to further increases in the next, our analysis gives evidence about how determinant for districts' export performance is and would be the participation and the relative position in the GVCs.

Policy makers and institutions, especially at local level must carefully consider this change in trade flows and actively operate to increase districts participation in GVCs, in order to increase their competitiveness in the global markets. Policies can have a significant role. In fact, since with fragmentation of production of parts and components will cross national borders more than once, before final goods are produced, modest tariffs reduction can be magnified. Services liberalization, infrastructural investments, and disputes settlement could boost the districts participation in the GVCs increasing their performance and competitiveness.

8 Appendix

Table 7: List of WIOD countries

Eurozone		Non Euro EU		Nafta		East Asia		BRIIAT	
Name	**Code**	**Name**	**Code**	**Name**	**Code**	**Name**	**Code**	**Name**	**Code**
Austria	AUT	Bulgaria	BGR	Canada	CAN	China	CHN	Australia	AUS
Belgium	BEL	Czech R		Mexico	MEX	Japan	JPN	Brazil	BRA
Cyprus	CYP	Denmark	DNK	USA	USA	S. Korea	KOR	India	IND
Estonia	EST	Hungary	HUN			Taiwan	TWN	Indonesia	IDN
Finland	FIN	Latvia	LVA					Russia	RUS
France	FRA	Lithania	LTU					Turkey	TUR
Germany	DEU	Poland	POL						
Greece	GRC	Romania	ROM						
Irland	IRL	Sweden	SWE						
Italy	ITA	UK	GBR						
Luxemb.	LUX								
Malta	MLT								
Netherlands	NLD								
Portugal	PRT								
Slovakia	SVK								
Slovenia	SVN								
Spain	ESP								

Table 8: Selected province, industry and relevance index

Full name	ISIC REV.3	WIOD code
Agriculture, Hunting, Forestry and Fishing	AtB	C1
Mining and Quarrying	C	C2
Food, Beverage and Tobacco	15t16	C3

Table 8: Selected province, industry and relevance index

Full name	**ISIC REV.3**	**WIOD code**
Textile and Textile Products	17t18	C4
Leather and Footwear	19	C5
Wood and Products of Wood and Cork	20	C6
Pulp, Paper, Printing and Publishing	21t22	C7
Coke, Refined Petroleum and Nuclear Fuel	23	C8
Chemicals and Chemical Products	24	C9
Rubber and Plastics	25	C10
Other Non-Metallic Minerals	26	C11
Basic Metals and Fabricated Metal	27t28	C12
Machinery, NEC	29	C13
Electrical and Optical Equipment	30t33	C14
Transport Equipment	34t35	C15
Manufacturing, NEC	36t37	C16
Eletricity, Gas and Water Supply	E	C17
Construction	F	C18
Sale, Maintenance and Repair of Motor Vehicles	50	C19
Wholesale Trade and Commission Trade	51	C20
Retail Trade	52	C21
Hotels and Restaurant	H	C22

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