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The Development of Productive Structures of EU Member Countries and Their International Competitiveness

Andreas Reinstaller, Werner Hölzl, Johannes Kutsam, Christian Schmid

Research assistance: Kathrin Hranyai, Irene Langer

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AUSTRIAN INSTITUTE OF ECONOMIC RESEARCH

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Abstract

This study examines the development of the productive structures of the EU using international trade data and methods from complexity theory referred to as the "product space" approach. The results show that the set of products for which a country has already a comparative advantage in international trade is a strong predictor for the type of products in which it will develop a comparative advantage and obtain significant world market shares. This implies that the development of the productive structures of a country is a highly cumulative process and any upgrading is necessarily deeply rooted in current capabilities and industrial specialisation. Complementary factors and competencies have to be built up. This makes it more difficult for countries to change their productive structures. In the light of the results of this study the smart specialisation strategy which the European Commission pursues in its cohesion policy for the years 2014-2020 seems to be well placed to foster the competitiveness of the European Union in general and the European regions in particular. Some caveats however apply.

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The development of productive structures of EU Member States and their international competitiveness

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Executive Summary

This study has examined the development of the productive structures of the EU and its Member States by drawing on recent developments in the analysis of economic complexity and international trade patterns. The "product space" literature conceives of globally traded products either i) as a network linking successful exporters to products or ii) as a network of products that are related through a common knowledge base (see Hidalgo - Hausmann, 2009, Hidalgo et al., 2007). The analysis of these networks reveals unobserved information on the capabilities of countries, the characteristics of products and the structure of the economies. From this information it is possible to construct outcome based indicators on structural change, competitiveness and the growth potential of countries that do not rely on aggregate economic data and indicators that are often strongly correlated with their GDP and therefore are difficult to disentangle from it. Hence, these indicators are a useful addition to other performance monitoring tools. Product space measures are also very useful for policy making as they are strong predictors for potential success in international trade.

One summary indicator that comes out of the analysis of the network linking products to successful exporters is the complexity score. It captures the depth and the breadth of the knowledge base of an economy. The assessment of Europe's economies shows that there is a considerable dispersion in this indicator across Member States. While some countries figure among the most complex economies worldwide (e.g. Germany, Sweden or Finland), others have upgraded their productive structures and are in the process of catching up to the most advanced economies inside the EU (several of the eastern European Member States). For other countries again (e.g. Greece, Portugal or Romania) a stasis in the development of their productive structures is evident for the observed period.

Sector level results show that the average complexity of product categories in which European firms are significant exporters are high in international comparison. Also in product categories with low complexity scores European producers are often active in the top quality segments. Over the period 1995-2010 the BRIC countries and especially China have upgraded the complexity of their business sector output. In some sectors China has even caught up to average EU levels. Generally however the output of China and other BRIC countries remains biased towards products with lower complexity. Nevertheless, given the dynamics of change it is likely that the competitive pressure on European producers will increase further. To escape this pressure it is necessary to increase the diversification and exclusivity of products and to upgrade to even higher quality levels inside existing product categories. The quality upgrading potential differs by sector however, so that some diversification and structural change will likely have to be part of the picture.

Opportunities and potentials for upgrading can be assessed through another product space indicator that exploits the fact that products are related to one another through common knowledge bases and similar factors of production. For this reason the set of products for which a country has already a comparative advantage in international trade is a strong predictor for the type of products in which it will develop a comparative advantage. Our

results show however, that some critical threshold has to be passed before this mechanism becomes effective. This implies that the development of the productive structures of a country is a highly cumulative process and any upgrading is necessarily deeply rooted in current capabilities and industrial specialisation. It is not possible to develop internationally competitive products out of the blue. Complementary factors and competencies have to be built up. This makes it more difficult for countries to change their productive structures. One way of making the task easier is through joining international supply chains where countries only need the know-how for a specific task rather than for a product in total.

In the light of the results of this study the smart specialisation strategy which the European Commission pursues in its cohesion policy for the years 2014 till 2020 seems to be well placed to foster the competitiveness of the European Union in general and the European regions in particular. However, the development of regional strategies should comprise an assessment on how the competence and factor base of one region is related to that of neighbouring or even far distant regions and implement measures that support the exchange of knowledge and production factors between these regions.

It should also be considered that diversification is a process in which areas of weakness develop into areas of strength by drawing on the knowledge and factor base of current areas of strength. Regional strategies of smart specialisation should therefore consider how the current regional competence base can be used to develop related areas in which the region has not yet a competitive advantage.

The results of this study show that the opportunities for upgrading productive structures are distributed very unevenly across countries and sectors. These disparities typically increase as one gets to the regional level. It may be necessary that in regions with little opportunity for upgrading smart specialisation is complemented by other structural policies to avoid that they do get trapped in inferior productive structures.

The investment focus on specific technologies such as key enabling technologies pledged by different Communications by the European Commission can strengthen the competitiveness of the EU as these types of products tend to be complex, i.e. they draw on a large knowledge base and are produced only by a few competitors. However investments should only be pursued in regions where there is a competence base to which these technologies can link up. If this is not the case it is very likely that the policy will remain ineffective with regard to the region developing an international competitive strength in that area.

In order to reap the benefits of diversification it is important that the factor substitution mechanisms operate properly in the economy. It is therefore very important for the upgrading of productive structures inside the EU that the functioning of the Single Market and of the European Research Area is improved.

1 Introduction

It has long been claimed that the majority of the EU economies have failed to foster their competitiveness in terms of their positioning in relation to goods with strong market prospects. On the one hand, a frequent claim of research papers and policy documents released over the past decade was that most European economies have not managed to keep up with the fast pace of technical change and innovation that has taken place in the past decade in countries such as the United States or Korea. On the other hand, the European economies are increasingly put under pressure by the fast rise of emerging economies such as China, India, or Brazil. It is claimed that these countries with their combination of low factor costs and increasing quality of their human resources and infrastructure are attracting an increasing share of world industrial production and are therefore undermining the industrial base of the European economies.

This view is of course too rough to capture the true complexity of the issues related to the competitiveness of the European economies. Unlike the United States the EU27 have been able to keep their world market share in complex industrial goods relatively stable over the past decade. However, there is strong empirical evidence that in the past decade the European Union has undergone a process of transformation in which several groups of countries inside the Union have experienced different and in part diverging patterns of economic performance and competitiveness. This development puts considerable strain on the inner coherence of the Union. Some countries run considerable trade deficits while others run consistently trade surpluses. At the same time the EU as a whole currently runs a trade deficit. These economic disparities are likely to increase as other countries join the EU, and as others strive to overcome the sovereign debt crisis that has ensued after the banking crisis of 2008. The inward and outward economic stability of the EU hinges critically on the capability of the EU and its Member States to manage these divergent development patterns inside the Union.

In its Strategy Europe 2020 the European Commission has pledged to address these challenges by strengthening the competitiveness of the European Union through various initiatives. Among them the Smart Specialisation strategy (see European Commission, 2010b) formulated in the Flagship Initiative Innovation Union (European Commission, 2010a) and specified in follow-up documents aims at identifying areas in which the national and especially regional economies are already strong or show promise and to support them through a targeted support to research and innovation. Another very recent initiative is the "Partnership for a stronger European industry" (European Commission, 2012) that aims at reversing the decline of the role of industry in Europe and to strengthen the industrial base in Europe through the development, promotion and deployment of specific infrastructures, e.g. smart grids, or specific technologies or products such as the so-called key enabling technologies or bio-based products.

This study will shed light on the potentials for (smart) specialisation and the strengthening of the industrial base in Europe through an analysis of the productive structures of the European

Union and its member states and support decision making especially in relation to the two policy initiatives outlined above. It draws on recent developments in the analysis of economic complexity and international trade patterns often referred to as "product space" literature (see Hidalgo - Hausmann, 2009, Hidalgo et al., 2007). This analytical approach conceives of globally traded products as a network linking products or products and countries. Products are related to each other if countries are likely to develop a comparative advantage in the export of both. Similarly countries and products are linked if a country develops a comparative advantage in trade in those products. From these relationships it is possible to recover hidden information on the capabilities in which the productive structures of countries are rooted. Indicators derived from this approach have been used to assess the competitiveness of the EU and its Member States.

The study is structured as follows: Chapter one provides a brief literature review of the principal contributions underlying this study. Chapter two describes briefly the principal data sources. Chapter three analyses the competitiveness of the European economies and important competitors on the basis of so-called complexity scores that are derived from the analysis of the network linking countries to exported products. The implications of these results are then also reviewed for two-digit economic sectors. Chapter four uses indicators derived from the network of products to assess the potential for economic upgrading and industrial restructuring in across the EU Member States. Chapter five explores the linkages between the product space indicators and other well established indicators of national capacity such as R&D, educational attainment and so forth. Chapter six finally provides a brief summary and draws policy conclusions. As the report uses concepts that are rather unfamiliar in the context of economic analyses we provide a glossary of key concepts at the end of this report.

2 The link between economic performance and the mix of goods a country produces and exports: a review of the literature

There is a substantial body of evidence that the characteristics of the basket of goods countries produce and export are related to their level of economic development and economic performance. Saviotti - Frenken (2008), for instance, argue that changes in the production structures of countries are closely linked to the creation of greater wealth across countries and that these changes in turn are intimately related to a continuous increase in product variety. Their results show that changes of product variety within sectors are an important determinant of changes in income per capita and labour productivity growth in the short run, whereas changes of variety between sectors affect economic growth in the long run. They interpret this evidence that changes in product variety within industries reflect small incremental improvements of the production structures of economies. These changes however are prone to run into decreasing returns after some time. Changes in cross sector product variety reflect instead the creation of completely new products and industries. These are more fundamental changes in production structures that affect economic performance only over a longer time horizon.

Lall - Weiss - Zhang (2005) shed more light on the relationship between the composition of the export basket and economic performance looking at differences between developed and developing countries. They classify products according to their level of sophistication where sophistication is calculated as a score based on the unit values of the exports of a country in a particular product category relative to the unit value ranges of that product across countries.[1] Higher scores therefore imply higher unit values of exports. The authors find that in the aggregate sophistication does not seem to be strongly related to the economic growth of the country. They argue that this is due to the fragmentation of global value chains that results from the relocation of activities across countries. This leads to a reduction of the sophistication in terms of a narrowing of the ranges of the unit values across countries. This process takes place largely among middle income countries on a catching up trajectory and high income countries. Hence, product upgrading in catching up countries leads to changes in the international division of labour and as a consequence to changes in the composition of the production structure across countries.

Hausmann - Hwang - Rodrik (2007) have advanced a forceful study on the relationship between the mix of goods a country produces and exports and economic growth. They assume that products traded in the world economy can be ranked by their implicit productivity level in terms of the units of output generated by an investment of a given size (see Box 1 for details). As a consequence the growth performance of a country will be determined by its specialisation in specific products or product categories. However, for their production in these areas to be viable firms need to meet minimum productivity thresholds. The authors assume that the capability of firms to meet these thresholds depends in turn on economic and social

[1] Unit values are given by the monetary value of export or imports in specific product classes divided by their quantities. Unit values therefore are a price index of the products included in a specific product class.

framework conditions that push economies towards higher productivity levels. If these are not favourable an economy will face difficulties in changing the specialisation of its productive structures. The authors explore this relationship empirically through the construction of a quantitative index that ranks goods depending on their implied productivity levels and establish empirically that the type of goods an economy specialises in and its rate of economic growth are linked.

A recent study by Sutton - Trefler (2011) examines these results in depth. They argue that Hausmann - Hwang - Rodrik (2007) do not properly take into account quality differences inside specific product categories or industries (vertical differentiation). Countries with different quality capabilities may export the goods in the same categories at different price levels. Multiple quality levels can coexist. The existence of such price ranges implies however that many products are uninformative in terms of their implied productivity. They provide little information on the income and growth prospects of a country. Their analysis shows that poor countries can increase their economic performance by improving the quality of the uninformative products produced both by rich and poor countries. Hence, changes in the product mix are not necessary to improve income per capita and economic performance at first. The upgrading of existing structures may prove a better strategy. Once a country has reached higher quality levels in uninformative products it can then diversify into products produced by rich countries by entering into these product classes on the low-quality low-price end of the quality ladder. Wealthy countries instead must strive to diversify their product portfolio by generating new high value products as low income countries enter into these markets.

Box 1: Income level ranked export basket and economic performance

Hausmann - Hwang - Rodrik (2007) construct a quantitative index that ranks the goods traded by a country according to their implied productivity. This measure characterises the production space of each economy in terms of the average productivity level implied in the products it exports and therefore implicitly captures the technological sophistication of an economy. These indicators are calculated as follows: If countries are indexed by *c* variable $x_{c,p}$ represents the value of exports of country *c* in product *p*, and X_c is the total value of exports of country c. If Y_c is now the GDP per capita of country *c*, then the implied productivity of a product *p*, $PRODY_p$, is defined as

$$PRODY_p = \sum_c w_{c,p} \, Y_c,$$

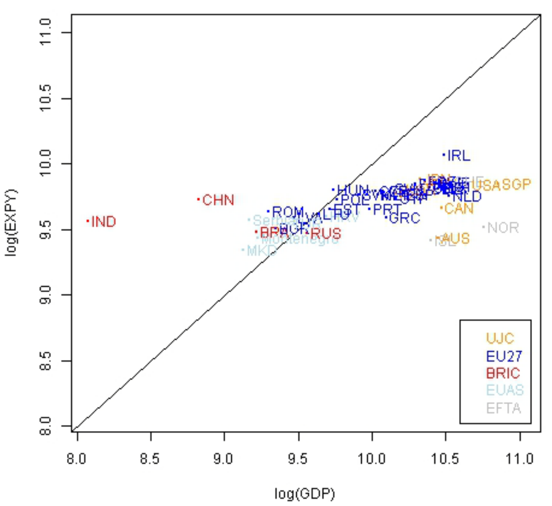
where $w_{c,p}$ is a weight defined as $w_{c,p} = \frac{x_{c,p}}{X_c} / \sum_c \frac{x_{c,p}}{X_c}$. From this product specific index the authors calculate then the implied productivity of the export basket of country c by summing up the PRODY values for the exported products as follows:

$$EXPY_c = \sum_p \frac{x_{c,p}}{X_c} PRODY_p.$$

The implied productivity of the export basket of a country *c* is therefore given by the implied productivity of each product weighted by the share this product has in the total trade volume of country *c*.

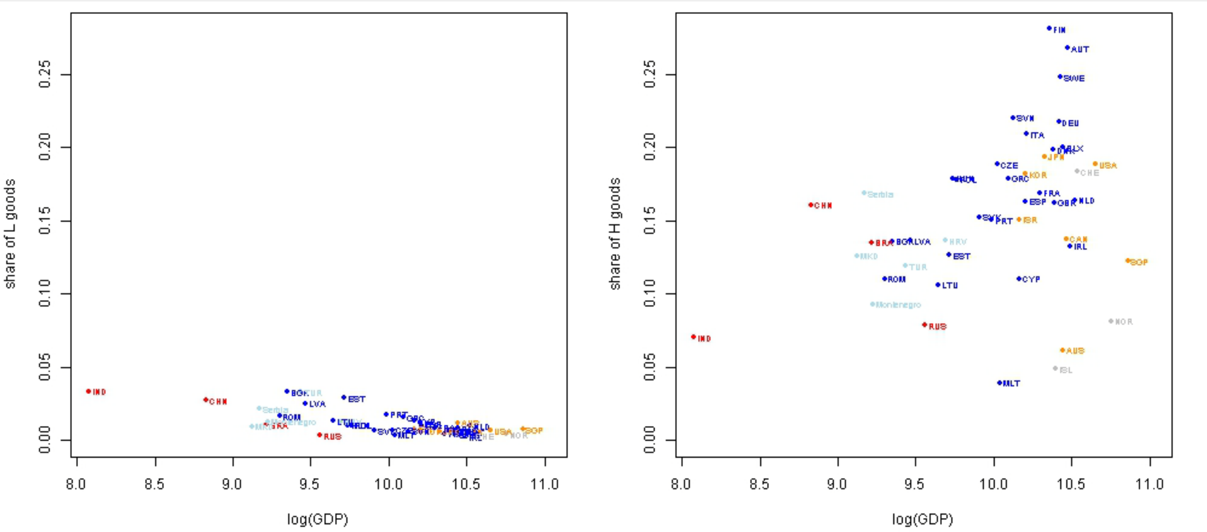
The results presented by Hausmann - Hwang - Rodrik (2007) show that products with low PRODY values tend to be primary commodities exported by low income countries. Commodities with high PRODY values are typically industrial goods that are important exports of several advanced industrialised countries. They also show that EXPY, the implied productivity of the export basket of countries, is strongly correlated with their GDP per capita. *Figure 1* shows the relationship between EXPY and GDP per capita in the EU and important industrialised or industrialising countries. They conclude that countries that countries that are able to position themselves in the type of goods rich countries export will grow faster than countries that specialise in other goods. It therefore matters for long run economic growth what products a country exports.

Figure 1: Implied productivity of countries' export baskets (EXPY) and national income, all countries 2010



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010); World Bank Database (GDP at constant 2005 values and purchasing power parities)

Figure 2: The share of high and low productivity goods (Sutton - Trefler, 2011), European countries and important industrialised countries 1995 and 2010



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010); World Bank Database (GDP at constant 2005 values and purchasing power parities)

The approach by Hausmann - Hwang - Rodrik (2007) needs to be interpreted carefully. Sutton - Trefler (2011) argue that for about four fifths of all products in the data sample they use their presence in a country's export basked does not reveal much about its income level. The reason for this is that for each product wide price ranges can be observed (see also Schott, 2004) and the dispersion of income levels of the countries producing these goods is also very large. This is the case when product markets are vertically differentiated and when the traded commodities differ in terms of the level of technological sophistication required for their production. It is therefore more informative to look only at products produced by low income (L products) and products produced by high income countries (H products). Figure 2 above shows that high income countries such as the EU Member States have a considerably higher export share of H products.

Hidalgo et al. (2007) and Hidalgo - Hausmann (2009) analyse the relationship between the composition of the export basket and economic performance from a different point of view. They conceive of the productive structure of an economy as a network linking specific capabilities to specific products. From this they construct measures that capture this relationship. They characterise economies that are more diversified (in terms of the number of products they export) and that are able to produce more exclusive products as being more complex. Hence, their measures for the complexity of an economy reflect different types of capabilities a country has to produce a specific product mix. Using trade data they show that higher levels of complexity are related to higher economic performance. They show also – echoing the results by Leamer (1984) – that the most advanced economies have more complex production structures and as a consequence have also a comparative advantage in the production and export of more complex products, whereas the production structures of less developed countries are also less complex. They also show that it is very difficult for countries to change their production structures. This reflects the results by Saviotti - Frenken (2008) who have argued that it is more difficult to increase the product variety across industries rather than within industries. For these reasons Jankowska - Nagengast - Perea (2012) argue using the same approach that middle income countries face a potential middle-income trap which requires well designed policies of economic development and diversification.

This report will explore the implications of the contributions reviewed in this section for the competitiveness of the EU and its member states.

3 Data

The analysis presented in this report relies on trade data. The principal data source is the Base pour l'Analyse du Commerce International (BACI) dataset from the Centre d'Études Prospectives et d'Informations Internationales (CEPII). It contains data for 232 countries and 5,109 product categories classified using the Harmonized System at the 6-digit level. It covers the years 1995 till 2010. A detailed description of the data is given by Gaulier - Zignago (2010); we will just highlight some important aspects of this database.

The BACI database builds on the COMTRADE database provided by the United Nations. It contains detailed import and export data reported by statistical authorities of close to 200 countries starting from 1962 to the most recent year.[2] In total the database contains more than 1.75 billion trade data records. A typical record contains the exports of a specific commodity between two countries in a specific year in terms of value (US dollars), weight and supplementary quantity (number of the supplied commodities). The database is continuously updated.

COMTRADE provides two sets of series for any given trade flow if both commercial partners report the transaction to the UN. Exports are generally reported on a Free on Board (FOB) basis, while the related imports from the trading partner are reported including Costs for Insurance and Freight (CIF). While the two series should be identical for any given product and year except for the CIF positions, in practice these data prove to be often inconsistent. As reasons for these inconsistencies Gaulier - Zignago (2010) list among other causes:

- There may be difficulties in identifying the actual trading partners, as customs official are likely to pay more attention to the actual origin of an imported product given that this determines the tariff levels to be applied, while the actual destination of exports is less relevant to their work.
- Reported values detailed by commodities may not sum up to the total trade value for a given country as due to confidentiality countries may not report some of its detailed trade while these will be included at the higher commodity level and in the total trade value.

BACI reconciles bilateral trade flows reported by the exporting and the importing country. It uses mirror flows to complete missing reportings. It also estimates approximations for the correct CIF costs which are then used to make import and export series between trade partners consistent.

BACI provides also comparable quantities such that unit values that are comparable across countries can be calculated. Values in COMTRADE are reported in thousands of US dollars. Quantities however can be registered in different units of measure (meters, square meters, etc.). Since most of exchanged quantities are reported in tons, Gaulier - Zignago (2010) convert the remaining quantities by estimating implicit rates of conversion of other units into ton units using mirror flows reported in tons by a country and in another unit by the other

[2] http://comtrade.un.org/

trading partner. This implies that unit values can be examined for a larger number of commodities.

With regard to the other data sources on trade such as the Eurostat COMEXT database, BACI and the underlying COMTRADE database have the advantage that almost all countries report the country of origin of a product as partner country for imports according to the rules of origin effective in each country. Hence, the term 'partner country' in the case of imports does not necessarily imply a direct trading relationship. For the purpose of this study this is an important aspect as we are interested in developing indicators of local capabilities. Looking at direct trading relationship would distort this picture.

The time window provided by this database ranging from 1995 to 2010 is long enough to capture substantial changes in productive structures and ensure that all major economies are covered consistently. As the most severe changes in political geography (e.g. falling apart of USSR, German unification) have taken place before 1995 the starting date of the series ensures that there are no important breaks in the data due to these events.

For the calculations presented in the following chapters the data have been filtered in order to reduce the noise in the data. We have dropped observations where only a single unit is shipped in a year when

- the Country-product-year observations must have quantity greater than 50 and CPI-deflated annual export value (in 1989 dollars) less than $50,000;
- country-product observations do appear in fewer than two years in the sample.

In addition a number of country-like entities like "Areas not elsewhere specified" that are included in COMTRADE and BACI to have consistent accounts for data with insufficient information on the trading partners have been dropped.

All analyses reported in this study have been carried out using both, the filtered and the unfiltered dataset in order to assess the sensitivity of the results to the filters described above. They have also been repeated with four-digit COMTRADE data to assess the accuracy of our results. However, no significant discrepancies could be detected and as a consequence the reported results are based on filtered data for the six-digit data set based on the BACI data.

For a number of calculations we present also figures for sector aggregates according to the NACE 1.1 classification. These data have been aggregated up from the product level using trade value weights. Products have been assigned to NACE sectors through HS – CPA conversion tables available from Eurostat.

All other country specific data used in these report were drawn from the World Bank. Analyses on the sector level have made us of the EUKLEMS database.

4 The economic complexity of the EU Member States

4.1 Introduction and background

The review of relevant prior research has shown that advances in national income levels per capita involve both changes in the composition of the product mix exported by a country, as well as improvements in product quality and productivity. By exploring which countries export certain products and how common certain products are across countries it is possible to extract information on the capabilities and other resources available in a country to produce them. This is of particular importance to analyse the competitiveness of countries and sectors.[3]

An analytical approach that exploits this type of information has been pioneered by Hausmann and Hidalgo in a number of papers (see Hidalgo - Hausmann, 2009; Hausmann - Hidalgo, 2011). The key assumption underlying their analytical framework is that countries need a large set of complementary and non-tradable inputs they refer to as capabilities.[4] If *countries* differ in these capabilities and products differ in the type of capabilities that are needed to produce and successfully trade them, countries with more capabilities will be more diversified. Trade patterns therefore capture the breadth of the knowledge base of a country. On the other hand, *products* that require more capabilities will be successfully exported only by those countries that have these capabilities and as a consequence they will be more exclusive (or less ubiquitous). Hence, the more diversified a country is in terms of the products it produces and the more exclusive (or less ubiquitous) these products are in terms of the number of countries producing and exporting them the more competitive and better performing an economy should be as its product mix represents a unique source of competitive advantage. Trade patterns therefore capture also the depth of the knowledge base (in terms of its specialisation and uniqueness).

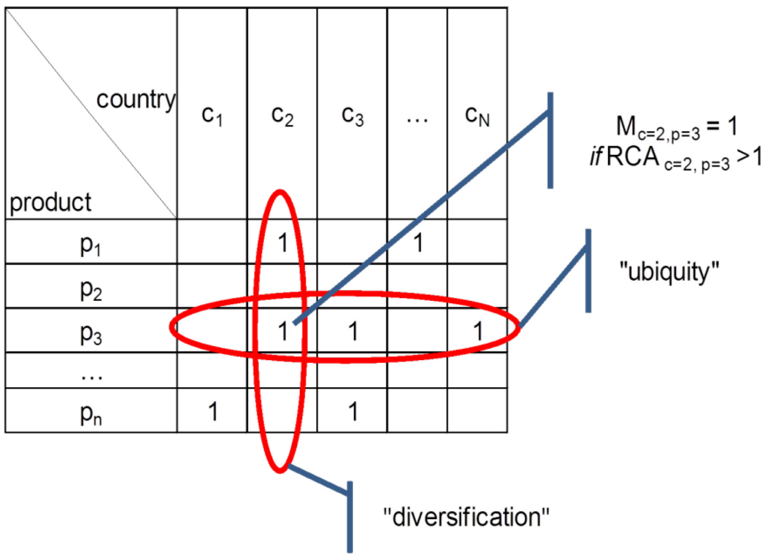
Hidalgo - Hausmann (2009) use trade data to construct measures that capture this relationship which they conceive as a network linking products to countries (and by implication their capabilities). The nodes in this network are therefore all country-product combinations that can be observed in the data. The properties of each node can then be expressed as a combination of the properties of all its neighbours. This approach therefore exploits information from the global trade network to construct indicators that capture important aspects of the level of economic development and the competitiveness of economies by exploiting the fact that the economic fortunes of countries are intertwined via trade, foreign direct investment, and financial capital flows. As the supply of products in one country is highly depen-

[3] Throughout this study competitiveness is conceived as the positioning of an economy in relation with goods strong market prospects. This definition follows Lall - Weiss - Zhang (2005). The market prospects are proxied by the product complexity and the positioning will be assessed on the basis of the world market shares countries or sectors are able to obtain in complex products. The notion of product complexity will be developed in this chapter.

[4] Hidalgo - Hausmann (2009), p.10570, define capabilities as property rights, regulation, infrastructure, specific labour skills and so forth.

dent on economic activities in multiple foreign countries production networks spread across countries and continents. When countries and regions transform as a result of economic, technological, political, or institutional change, the nature of foreign trade changes as well, and trade data therefore capture such changes. The analysis of the goods countries trade successful reveals much of this information and it is not necessary to rely on additional data such as the income of countries to characterise the linkage between the product mix of a country and its economic performance as is done for instance by Hausmann - Hwang - Rodrik (2007).

Figure 3: Diversification and ubiquity of countries and products



Source: Own representation.

Figure 3 gives a first idea on how the country and product indicators proposed by Hidalgo - Hausmann (2009) are constructed. It should be noted that the analysis relies only on exports in which any country is a significant exporter. Hence, countries are linked to a product if the country has a revealed comparative advantage (RCA) in this product (see *Box 1* for an explanation of the measure). The implicit assumption is therefore that a country disposes of capabilities or factor endowments that convey this advantage. In a first step it is now possible to calculate the characteristic of a country by summing up the number of products row wise in which the country (in the figure it is country c_2) is a significant exporter to get a first measure of its diversification.[5] The larger this sum the more diversified a country will be. In the same way the characteristics of each product can be calculated by summing up the entries column wise to get a measure for the "ubiquity" or exclusivity of a product (in the figure it is product p_3). The fewer countries export a product the more exclusive (or less ubiquitous) it is.

[5] Diversification in this context does not imply a comparative advantage in products across many industries or higher product class aggregates but is conceived simply as the number of products in which the country is a significant exporter.

In this way we get a direct characterisation of each country and each product. However, as countries and products are embedded in a network it is possible also to exploit information on countries exporting similar products to characterise each country using a method which Hidalgo - Hausmann (2009) call the method of reflections (see *Box 2* for details).

To get the idea how the method of reflections work we may think of an example from the corporate world namely the criteria underlying the selection of board members. Galaskiewicz et al., (1985) have shown that this selection is closely determined -- next to considerations about the professional capability -- by considerations of social status of the candidate. To establish the social status of a person, one may look at the membership of the candidate in some social organisations and structures, such as the local country club, an executive board of a company, the board of a football club, the parochial council and so forth. If the candidate is a member of all these organisations we may say that a neighbourhood relationship between them exists. By the number of memberships of the candidate in different social organisations it is possible to draw a first conclusion about his social connectedness. By looking at the other members in any of these social organisations we may also get a first idea on the type of social connections they offer to each member.

However, as we are interested in establishing the social status of the candidate, we may ask how valuable the social connections say in the country club actually are. Better connected people with access to more exclusive social organisations may be a good indicator of the social status of the candidate. But to assess this, we have to look at the neighbourhood relatioships of the other club members. So if another member of the country club is also a member of the local chapter of the Rotary Club a neighbourhood relationship between the country club and the Rotary Club exists. However, from the point of view of the candidate the relationship is already one step away, as he will be able to establish a link only through the member who is also a member in the Rotary Club. However, the existence of this link has some value and therefore a positive impact on the candidate's status. If this exercise is repeated for all club members we are able to evaluate all neighbourhood relationships that are one step away and this will sharpens our understanding of the social value of the country club membership to any club member. But we may go further and ask what the link to the Rotary Chapter is worth in terms of the people who are members of that chapter for the social status of the candidate and all other members of the country club. This process can be repeated until all neighbourhood relationships are taken into account (e.g. by Rotary Club members who are board members of other companies, and other members on these boards who are members of other country clubs in the country etc).

If we think now of the persons in our example as products, of the social organisations as countries, and of the social status as the competitiveness of a product then the example carries directly over to the context of this study. More exclusive (or less ubiquitous) products have a strong influence on the competitiveness of countries in the global market. Their exclusivity reflects the presence or absence of very specific capabilities in a country: having exclusive products in the portfolio that are related in terms of the underlying capabilities to other exclusive products is more important than having many of poor value. In the country product network the direct neighbours of countries are other countries exporting the same product. For products the direct neighbours are products exported by the same countries. By moving through the network of connections that are two, three or four steps away we obtain increasingly precise indicators for the capabilities of the economies and products in the sample. *The resulting indicators therefore capture the breadth and the depth of the knowledge-base of a country.* Table 1 provides an interpretation of the indicators that include the information that is up to two steps away from a country or product.

Table 1: Interpretation of the indicators calculated using the Method of Reflections, first three pairs.

n	country	product
0	$k_{c,0}$: number of products exported by country *c*, ***diversification*** → *"How many products are exported by country c?"*	$k_{p,0}$: number of countries exporting product *p*, ***ubiquity*** → *"How many countries export product p?"*
1	$k_{c,1}$: average ubiquity of products exported by country c → *"How common are the products exported by country c?"*	$k_{p,1}$: Average diversification of the countries exporting product *p* → *"How diversified are the countries exporting product p?"*
2	$k_{c,2}$: Average diversification of countries with a similar export basket as country c → *"How diversified are countries exporting similar products as those exported by country c?"*	$k_{p,2}$: Average ubiquity of the products exported by countries exporting product p → *"How ubiquitous are the products exported by product p's exporters?"*

Source: Abdon et al. (2010), p. 8, following Hidalgo - Hausmann (2009), Supplementary material p.8

Box 2: The method of reflections to calculate the complexity of productive systems

If the matrix shown in Figure 3 is summed up row wise over products *p* one obtains a measure for the diversification of a country *c*.

$$k_{c,0} = \sum_p M_{c,p} \cdots \text{diversification} \quad (1)$$

If on the other hand the matrix is summed up column wise one obtains a measure for the ubiquity of comparative advantage in the trade of a specific product *p*, i.e. this measure tells us how many countries *c* have a comparative advantage in trading this product.

$$k_{p,0} = \sum_c M_{c,p} \cdots \text{ubiquity} \quad (2)$$

By combining these two indicators it is possible to calculate through recursive substitution how *common products are that are exported by a specific country*,

$$\rightarrow k_{c,n} = \frac{1}{k_{c,0}} \sum_p M_{c,p}\, k_{p,n-1} \ldots \text{for } n \geq 1, \quad (3)$$

and how *diversified the countries are that produce a specific product*

$$\rightarrow k_{p,n} = \frac{1}{k_{p,0}} \sum_{c} M_{c,p}\, k_{c,n-1} \ldots \text{for } n \geq 1. \quad (4)$$

If formula (3) goes through an additional iteration the indicator now tells us how diversified countries are that export similar products as those exported by country *c*. An additional iteration for formula (4) tells us then how ubiquitous products are that are exported by product *p*'s exporters. Each additional iteration *n* adds information on the neighbour of a country or product, that is *n* steps away from country *c* or product *p*. Table 1 gives an overview on how the indicators calculated using the Method of Reflection can be interpreted. Higher iterations than those presented in the table are increasingly difficult to interpret. The technical appendix of Hidalgo - Hausmann (2009) provides a simple numerical example.

A difficulty in this method is to establish the upper bound of the count variable *n*. In other words, how many steps far away from a country or product need to be calculated in order to establish a stable ranking of countries and products? Caldarelli et al. (2012) show that the solution proposed by Hidalgo - Hausmann (2009) who stop the iterations after eighteen or nineteen steps cannot lead to accurate rankings. As a matter of fact the method should lead to a unique stable indicator value for all countries (a fixed point). They also show that by appropriately weighting the likelihoods that a particular product is produced by a specific country and that a particular country produces a specific product an adequate ranking can be obtained. However, the numerical values they estimate while being mathematically more solid do not lead to considerable deviations from Hidalgo and Hausmann's original results. An important other implication of the work by Caldarelli et al. (2012) is that the number of iterations to achieve convergence depends on the network characteristics at any moment in time, and that the maximum number of iterations will vary from year to year. In the current study the upper bound of *n* has been established for each year in the sample by means of an algorithm that examines the number of rank changes of products and countries after each iteration. As long as the number of rank changes decreases, iterations are repeated. When stability in ranks is achieved the algorithm stops. We index the related iteration with "*max*". This implies that the values calculated for $k_{c,max}$ and $k_{p,max}$ are not directly comparable over time. To establish comparability the variables have been standardised and the related indicators $\hat{k}_{c,max}$ and $\hat{k}_{p,max}$ therefore represent scores capturing the positioning of a country or product in the distribution of all indicators at a specific moment in time. These scores are then comparable over time.

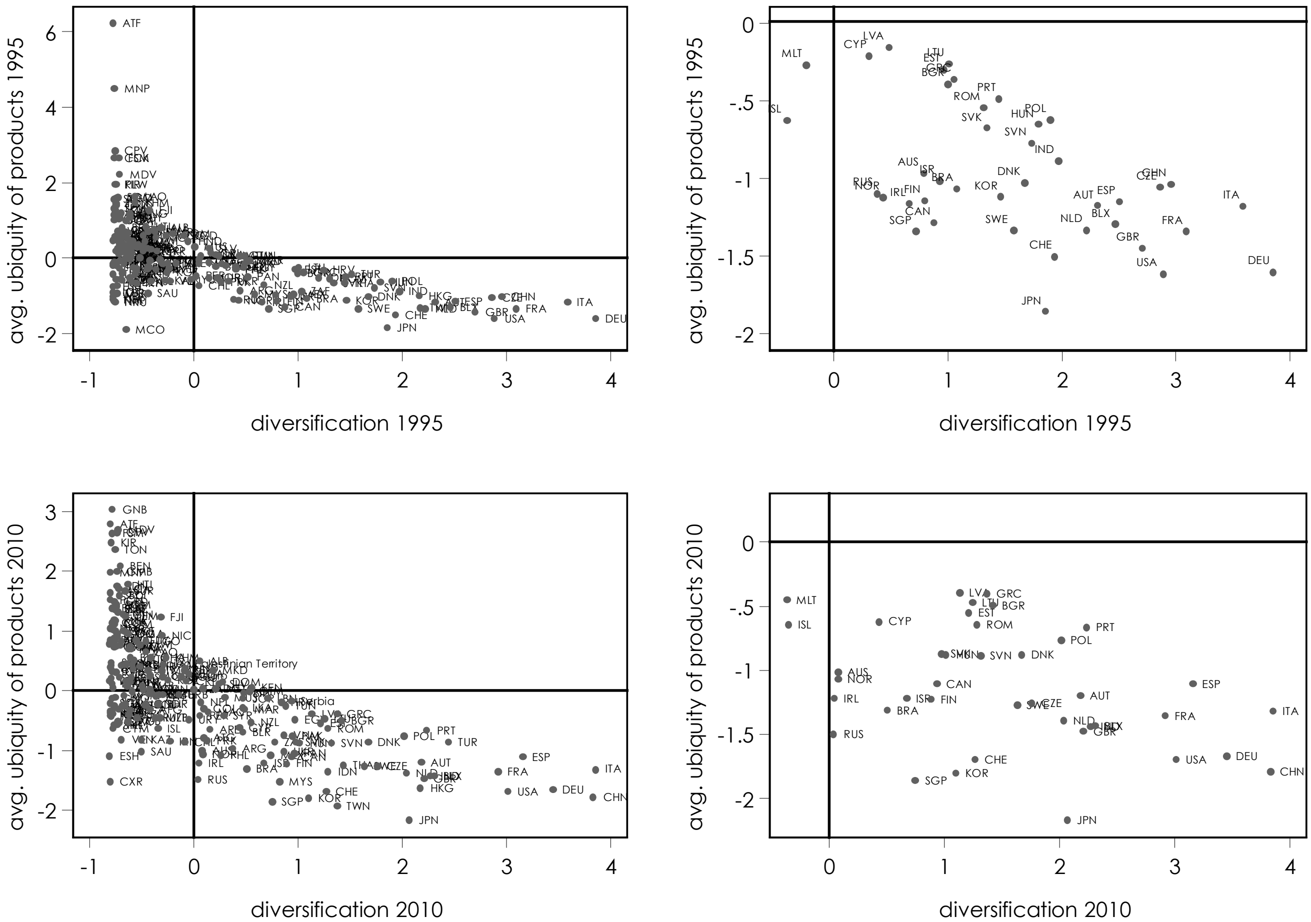
4.2 The complexity of countries' export baskets

Diversification and exclusive products

The method of reflections suggests that countries with higher capabilities are more likely to have also a more diversified production structure and that this diversification enables these countries to produce also more exclusive products. To start the analysis we will first examine the empirical relationship between the diversification of a country and the ubiquity of products especially for the EU Member States and other important economies.

In the previous section we have introduced the key indicators that will be used throughout the remainder of this study describing on the one hand the complexity of the economy of a country and on the other hand the complexity of the products in which a country has a comparative advantage in trade. The *diversification* of a country can be simply calculated from the number of the products in which it has a comparative advantage (see $k_{c,0}$ *Table 1*, page 12). If this indicator takes on a large value the country is highly diversified. The average exclusivity/ubiquity of the products exported by a country is instead the normalised sum over the *ubiquity* of the products in which the countries has a comparative advantage with the diversification of the country (see $k_{c,1}$ *Table 1*). If this indicator takes on a small value the average ubiquity of the products in which the country has a comparative advantage will be small and hence its products will be produced only by few countries. The empirical relationship between these two indicators is presented in Figure 4.

Figure 4: The relationship between the diversification ($k_{c,0}$) of the average ubiquity of the products exported ($k_{c,1}$), all countries and EU Member States & other important industrialised countries, 1995 and 2010 (standardised k-values)



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);

Table 2: Interpretation of the quadrants in Figure 4 (following Hidalgo - Hausmann, 2009)

non-diversified countries producing standard products	diversified countries producing standard products
non-diversified countries producing exclusive products	diversified countries producing exclusive products

The upper panels in Figure 4 plot the diversification of countries against the average ubiquity of their products in the year 1995 whereas the lower panels show the data for the year 2010. The left panels in the figure show the data for the entire sample whereas the right panels zoom in on the EU countries and other important industrialised countries. Each panel in Figure 4 is split in four quadrants according to whether the reported values are above or below average. As the indicators have been standardised relative to the entire sample the boundaries between the quadrants in the upper panels cross at zero. Table 2 provides the interpretation for each quadrant.

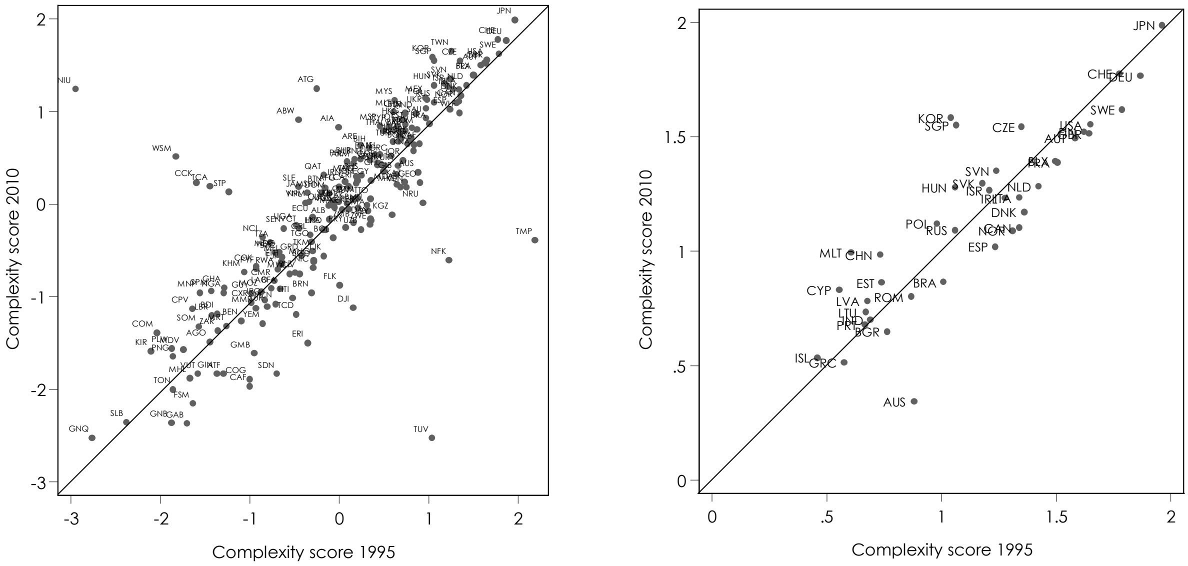
Looking at the entire sample of countries first it is apparent that the plot splits the country sample clearly into less developed countries and developed countries. The lower right quadrants in the panels shows countries that are highly diversified (high $k_{c,0}$) and whose products are also more exclusive (low $k_{c,1}$). This group of countries consists of industrialised countries. All EU Member States fall into this group. Less developed countries are largely non-diversified and produce standard products. The variation in the average ubiquity of the products produced by the countries has diminished over time. However, the disparities across the world economy persist over the period of observation.

The panels in the lower part of the figure show instead an extracted country sample consisting of the EU Member States and important partner countries. The boundaries of the quadrants in these figures have now been calculated relative to the mean of this subsample. Clearly they are shifted relative to the means of the entire sample located at the zero values of both axes. Hence, the quadrants reflect the relative position in the subsample. While all EU countries are diversified countries producing exclusive products in relation to the rest of the world, the two lower panels clearly show differences across the EU. Some of the New Member States are relatively less diversified and produce also less exclusive products. This reflects to some extent the differences in economic performance across EU countries observed already earlier in this report (see *Box 1*). The figure also shows the development of China that has become more diversified and its product portfolio has also become more exclusive over the observation period. This may well be the consequence of China attracting increasing shares of world industrial production which therefore becomes more concentrated internationally. This affects then the ubiquity of the products exported by that country.

Country specific complexity scores and their development over time

While Figure 4 has illustrated the interplay between the diversification of a country and the ubiquity of the products it has in its portfolio, it is important to be aware that these indicators are insofar incomplete as they do not capture the information contained in the entire network of productive relationships as outlined at the beginning of this chapter. We therefore present the indicator that summarises all the information on country capabilities and the ubiquity of products available in the trade data, $k_{c,max}$ in Figure 5. In order to be comparable across years the indicator has been standardised and can be interpreted as a score. As it also captures the complexity of productive structures in terms of the exclusivity and diversification of the underlying capabilities we will refer to it as "complexity score" in the remainder of this report. Countries with a high score are those with productive structures that use many capabilities to produce exclusive products. Countries with a low complexity score have instead productive structures that draw on only few capabilities and are significant exporters of products produced and exported by many other countries.

Figure 5: Changes in the complexity of the world economies between 1995 and 2010



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 5 plots the complexity scores for the years 1995 and 2010 against each other. In this way it is possible to see the score of each country and how it has changed over the observed period. Observations that lie above the 45° line have improved the complexity of their productive structures over the fifteen year period covered by the plot whereas countries that lie below that line have experienced a decline of the complexity of their productive structures relative to the other countries in the sample. The left panel shows all countries in the sample, while the right panel shows only the EU Member States and other important industrialised countries.

All the industrialised countries are situated in the upper right quadrant of the left panel. Most developing countries are instead located in the lower left quadrant. In 2010 Japan (JPN), Germany (DEU), Switzerland (CHE), Sweden (SWE), South Korea (KOR), Singapore (SGP), the US, Great Britain (GBR), Finland (FIN), the Czech Republic (CZE) and Austria (AUT) were the most complex economies. Among these countries South Korea, Singapore, the Czech Republic, and to a lesser extent Switzerland and Japan have experienced a relative increase in the complexity of their productive structures. Taking a closer look at the EU Member States it is apparent that several of the New Member States have increased the complexity of their productive structures. These countries are, from left to right, Cyprus (CYP), Malta (MLT), Estonia (EST), Poland (POL), Hungary (HUN), the Slovak Republic (SVK), Slovenia (SVN) and the Czech Republic (CZE). Some Member States have instead experienced a relative decline in the complexity of their productive structures. These are Greece (GRC), Bulgaria (BGR), Spain (ESP) and to a lesser extent Denmark (DNK) and the Netherlands (NLD). A few other countries such as Sweden or Belgium show also slightly negative deviations. The patterns of change are therefore uneven across the EU countries. For most New Member States we observe a substantial upgrading in the complexity, while for a few other countries such as Greece, Bulgaria or Spain the data show a tendency of divergence. The dispersion of the measured complexity score inside the EU is relatively high. The complexity score of the Greek and the German economies are about one and a half standard deviations apart. It is also interesting to look at the development of the complexity of the Chinese economy. While Figure 4 suggests that China has drastically increased the diversification of its productive structures and the quality of its products in terms of their exclusivity, the results in Figure 5 show that China has strongly upgraded its economy as measured by the complexity score. However the complexity score of the Chinese economy is still well behind the most advanced industrial economies. Among the BRIC countries Russia scores highest.

Figure 5 suggests that while the complexity score of countries changes over time big leaps that lead to a change in the relative position of countries seem however to be rare. Table 3 provides further evidence on the likelihood of a country being able to make a long jump in its overall complexity score. To construct this table the range of complexity scores obtained by countries has been split into deciles, i.e. ten equally sized subsets of the scores, for the years 1995 and 2010. The complexity score is lowest at the first and highest at the tenth interval. From this the probability that a country scoring at some decile makes a transition to a score at another decile has been calculated. The cells of the matrix shaded in grey indicate the probability that a country scoring in some interval continues to score in this interval after 15 years.

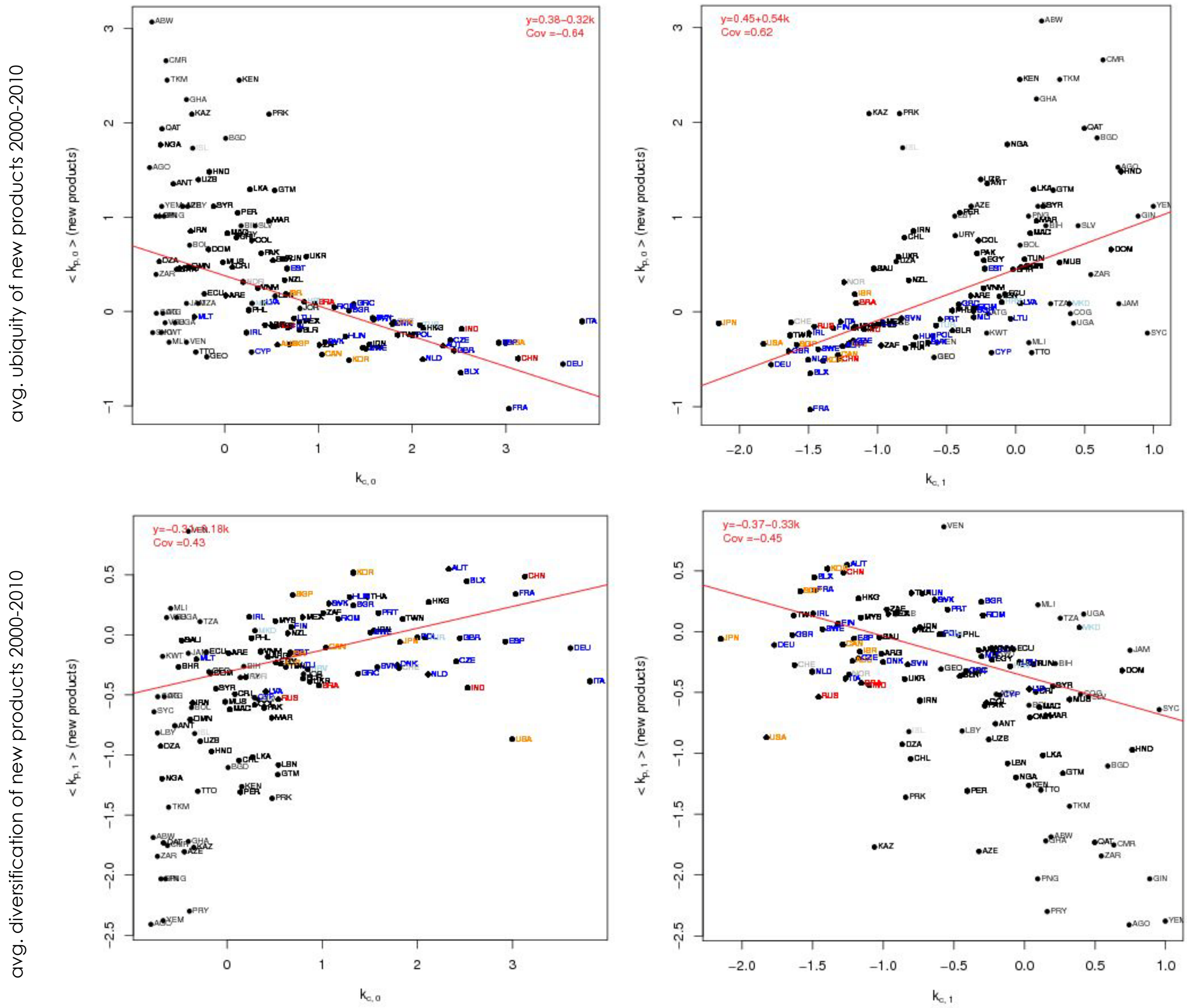
Table 3: Transition probabilities between 10% quantiles in the complexity score, 1995-2010

	1995 (row) -2010 (column)									
Decile	1	2	3	4	5	6	7	8	9	10
1	0.67	0.19	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.05
2	0.25	0.50	0.20	0.00	0.00	0.05	0.00	0.00	0.00	0.00
3	0.05	0.29	0.48	0.19	0.00	0.00	0.00	0.00	0.00	0.00
4	0.05	0.05	0.23	0.27	0.14	0.18	0.00	0.00	0.05	0.05
5	0.00	0.00	0.10	0.19	0.38	0.19	0.05	0.05	0.00	0.05
6	0.00	0.05	0.00	0.14	0.33	0.24	0.19	0.05	0.00	0.00
7	0.00	0.00	0.00	0.09	0.09	0.09	0.45	0.18	0.09	0.00
8	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.52	0.19	0.00
9	0.00	0.00	0.05	0.00	0.05	0.05	0.05	0.11	0.42	0.26
10	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.24	0.71

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010).

One can see from the table that the likelihood of staying in a specific interval of scores is highest at the lower and the upper end of the scale. This indicates that long jumps in the complexity score occur at low frequency. As the last two columns in Table 4, p. 20, show the EU Member States and its closest competitors score at the upper four deciles. In the middle part of the distribution (between the fourth and sixth decile) jumps between the deciles are observed with higher frequency. However, countries don't move gradually to scores at ever higher deciles. Countries have also a high likelihood to score at lower deciles.

Figure 6: Path dependence in the development of the diversification and ubiquity: Newly added products 2000-2010



diversification of countries in year 2000 avg. ubiquity of exported products in year 2000

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010).

Hidalgo - Hausmann (2009) suggest that the process of climbing the quality ladder in terms of the level of diversification and the ubiquity/exclusivity of the products exported by a country depends on prior levels of these indicators. Hence, there is some degree of dependence of future outcomes on countries' prior levels of diversification and product sophistication. Figure 6 shows that the level of diversification ($k_{c,0}$) of a country and the exclusivity of its exports ($k_{c,1}$) predicts the average ubiquity ($<k_{p,0}>$) and the average level of diversification of the products ($<k_{p,1}>$) in which the country turns into a significant exporter (with RCA>1) between 2000 and 2010. This confirms results by Hidalgo - Hausmann (2009) for more aggregate data and a different time period. EU countries are shown in blue labels. There is again a high dispersion (about 1.5 standard deviations difference between the highest and lowest scores) in the exclusivity of the introduced products and this depends on the obtained levels of diversification and the average ubiquity of a country's products in the base year (2000). Countries like Germany, Great Britain, Sweden, Finland or Austria were able to develop a comparative advantage in more exclusive products than countries with lower levels of diversification such as Greece, Portugal, Rumania or Bulgaria. Overall the results indicate that changes in the relative position in the complexity score at the country level are slow and build on capabilities countries have accumulated over time.

Table 4 presents the key summary statistics for the EU countries and other important competing nations. Next to the complexity score for the year 2010 is also shows a quality adjusted complexity score (see below), the data for GDP per capita at constant prices and at purchasing power parities, the implicit productivity of the export basket of each country EXPY (see *Box 1*, p. 4), and the deciles into which the complexity score of each country fell into the years 1995 and 2010 (cf. Table 3). As shown by Hidalgo (2009) there is a close relationship between the complexity score of countries and the implicit productivity of the export basket of a country (EXPY).[6] The EU countries with the highest EXPY in 2010 (IRL, FIN, SWE, DEU, FRA; between 20000 and 25000US$) were all situated in the interval delimited by the tenth decile of the complexity score distribution both in 2010 and also back in 1995. The EU countries with the lowest EXPY levels have also the lowest complexity scores inside the EU at the 7th or 8th decile of the distribution.

There is more variation between the indicators if we compare the income per capita data and the complexity scores. This is due to the fact that the method of reflection and the related complexity scores – as all other indicators examined in this study – are based on trade data, and build on the fact that a country is considered a significant exporter if it has a revealed comparative advantage (RCA>1). On the one hand this implies that the contribution to the creation of value added in a country of services in general and of non-tradeable services and goods in particular is not taken properly into account. In addition, the reliance on the RCA obfuscates also the fact that quite different capabilities are needed to produce and obtain a comparative advantage in the top quality segments of a product than to produce and obtain a comparative advantage in its low quality segments. For this reason, Table 4 presents also a quality adjusted complexity score in which the network matrix shown in Figure 3 on page 10 has been constructed using the more selective criterion that a country need to have both a revealed comparative advantage in terms of the traded quantities, and a revealed comparative advantage in terms of the unit values (i.e. the price index of goods for a specific HS6 product category). [7] This leads to a downward adjustment of the complexity scores of countries that have experienced a fast catching up process such as several New Member States or China. However, as the notion of competitiveness adopted in this study does not exclusively refer to competitiveness in quality and for the comparability of our results with prior

[6] See the appendix to this report for more details.

[7] See the appendix for more details on these calculations.

research, all results presented in this study will refer to the less selective criterion for the network construction used in the original study by Hidalgo - Hausmann (2009).

Table 4: Summary statistics for the EU countries and other important countries

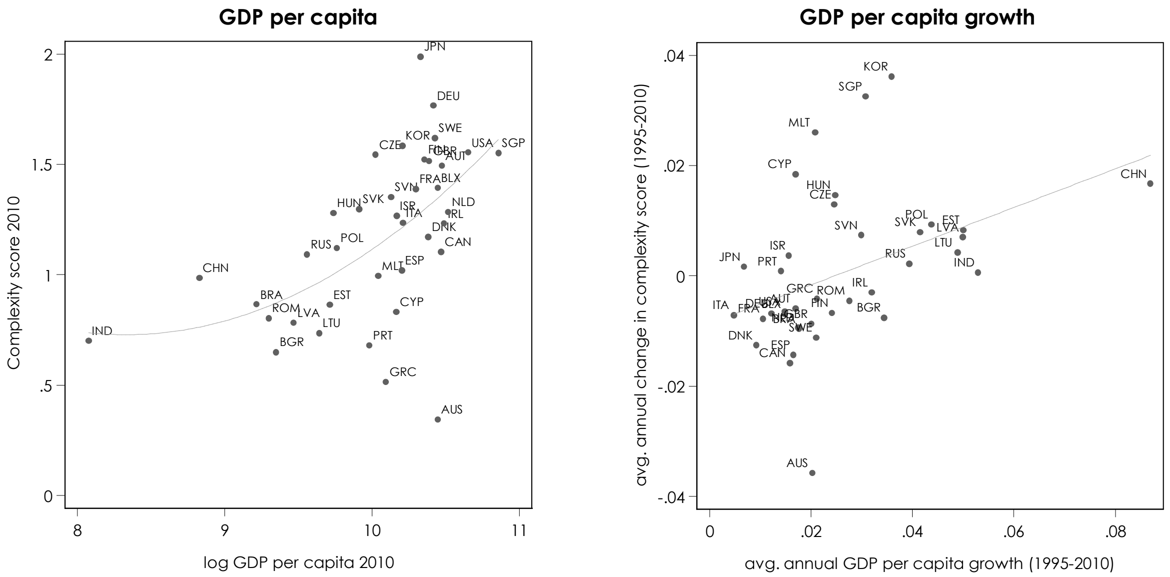
Code	Country	Complexity score 2010	Complexity score 2010 (quality adjusted)	GDP p.c. 2005 USD in PPP	EXPY 2010	Complexity score 2010 (decile)	Complexity score 1995 (decile)
			EU 27				
DEU	Germany	1.76	1.96	33414.41	20518.92	10	10
SWE	Sweden	1.62	1.80	33771.13	20545.04	10	10
CZE	Czech Republic	1.54	1.54	22574.56	18723.02	10	10
FIN	Finland	1.52	1.70	31492.87	20920.42	10	10
GBR	United Kingdom	1.51	1.61	32474.36	19542.34	10	10
AUT	Austria	1.49	1.61	35379.27	19992.51	10	10
BLX	Belgium-Luxembourg	1.39	1.39	34405.69	19111.67	10	10
FRA	France	1.39	1.43	29639.52	20104.39	10	10
SVN	Slovenia	1.35	1.22	25047.76	18914.48	10	10
SVK	Slovak Republic	1.30	1.12	20163.89	18032.51	10	9
NLD	Netherlands	1.28	1.35	36995.96	18447.67	10	10
HUN	Hungary	1.28	1.28	16958.33	18584.14	10	9
ITA	Italy	1.23	1.07	27136.65	18701.91	10	10
IRL	Ireland	1.23	1.51	35987.90	24734.78	9	10
DNK	Denmark	1.17	1.27	32235.47	19762.23	9	10
POL	Poland	1.12	0.98	17351.97	17429.08	9	9
ESP	Spain	1.02	0.81	26940.61	18249.39	9	9
MLT	Malta	0.99	1.08	22950.53	17950.39	9	7
EST	Estonia	0.86	0.66	16561.43	16430.41	9	8
CYP	Cyprus	0.83	0.83	25961.33	17371.78	8	7
ROM	Romania	0.80	0.48	10929.43	15654.90	8	9
LVA	Latvia	0.78	0.58	12938.02	15888.44	8	8
LTU	Lithuania	0.73	0.58	15390.82	15608.11	8	8
PRT	Portugal	0.68	0.41	21660.08	16292.15	8	8
BGR	Bulgaria	0.65	0.28	11486.72	13699.65	8	8
GRC	Greece	0.51	0.18	24206.09	15540.75	7	7
			BRIC				
RUS	Russian Federation	1.09	1.05	14182.56	13331.04	9	9
CHN	China	0.98	0.76	6816.29	17058.99	9	8
BRA	Brazil	0.86	0.89	10055.89	13126.27	9	9
IND	India	0.70	0.41	3213.54	15267.95	8	8
			Other countries				
JPN	Japan	1.99	2.18	30572.94	21313.27	10	10
CHE	Switzerland	1.78	1.91	37582.86	21536.42	10	10
KOR	Korea	1.58	1.44	27026.79	19196.36	10	9
USA	USA	1.55	1.80	42297.07	20030.19	10	10
SGP	Singapore	1.55	1.55	51969.47	20272.52	10	9
ISR	Israel	1.27	1.29	26022.68	19769.87	10	9
CAN	Canada	1.10	1.20	35223.07	17158.73	9	10
NOR	Norway	1.09	1.33	46908.22	15201.27	9	10
AUS	Australia	0.34	0.44	34410.71	12925.54	7	9

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). World Bank Database (GDP at constant 2005 values and purchasing power parities)

The complexity of productive structures and economic performance

The complexity score of countries is a measure for their trade competitiveness and as such it should be related to the capabilities of countries to generate wealth and economic growth. It captures the depth of the knowledge base of a country insofar as it reflects its capability to produce and successfully export exclusive and highly specialised products. It captures its breadth as it reflects the diversification of its productive structures and by implication its capability to recombine different knowledge bases. It is important for countries to broaden and deepen their knowledge base. This is an important precondition for climbing up the quality ladder in existing products, but also for engaging into recombinant growth as envisaged by Weitzman (1998) or Kauffman - Thurner - Hanel (2008). As several contributions have already proven that the complexity score for the productive structures of an economy is closely related to its income levels as well as economic growth (Abdon et al., 2010; Hausmann - Hidalgo, 2011; Hidalgo - Hausmann, 2009) we limit our discussion here to a brief illustration of this relationship for the EU 27 and its principal competitors in the world markets.

Figure 7: The relationship between the complexity score and economic performance



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). World Bank Database (GDP at constant 2005 values and purchasing power parities)

Their relationship between the income per capita levels and the complexity score of the economy is shown for the EU Member States and other countries in Figure 7. The left panel shows log GDP per capita levels and the complexity score whereas the right panel shows the relationship for growth rates. Less complex economies are also less wealthy. This relationship is stable over time. There is however a considerable dispersion if one looks at the plots. Countries like Australia, Greece, or Portugal deviate from this picture insofar as they have much higher income levels relative the levels their complexity score would predict, whereas other countries like the Czech Republic, Hungary or Germany have lower income levels than the complexity of their economies would predict. The relationship seems also not to be linear. Increases in the GDP per capita levels seem to be associated with more than proportional increases in the complexity score. Such a proportional effect seems to exist for changes of the complexity score and GDP per capita growth rates (right panel).

The right panel of the figure shows the link between changes of economic complexity and the GDP per capita growth for the EU Member States over the fifteen year period spanned by the data base. It indicates that increases in the economic complexity of economies are associated with economic growth. The higher these increases the higher is also the growth performance. A clear outlier in this case is China. The figure reveals also a convergence pattern: Economies with the most complex productive structures in 1995 have experienced smaller increases in their complexity and this was associated with a lower growth in GDP per capita over the period 1995-2010. For economies with a lower complexity score in 1995 instead the reverse is true.

This indicates it becomes increasingly difficult to generate and exploit growth enhancing capabilities as captured by the complexity score. The observations for Korea (KOR), Singapore (SGP), Malta (MLT), Cyprus (CYP), Hungary (HUN) and the Czech Republic (CZE) show that some countries have considerably improved the complexity score of their economies over the observed fifteen year period but that the GDP per capita has not grown in the same proportion. We interpret this as further evidence for some limitations of the complexity score as an indicator for competitiveness. All these countries have experienced a considerably catching up process over the observed period. The GDP per capita growth on the other hand has not progressed at a proportional pace. This hint at the possibility that these countries have improved their export performance in technologically more complex products but in lower quality segments such that incomes did not increase at the same pace. Other factors explaining this development may include differential labour market developments, product market regulation holding back services sector expansion etc.

4.3 The economic complexity of products and the competitiveness of countries and sectors

Complexity of products and competitiveness at the country level

We change now the perspective from the country level to the product level. This implies also a shift from the analysis of complexity scores for countries to complexity scores for product categories at the six-digit level of the Harmonised System. High complexity scores for products imply that the products are more exclusive and produced by more diversified countries. A higher complexity score therefore implies that a broader knowledge base is needed to produce a more exclusive (less ubiquitous) product.[8] The previous sections have shown

[8] Evaluations of the complexity score show that the complexity scores for products in broad categories such as chemical products, machinery and equipment, vehicles, aircraft and other transportation equipment or precision instruments are biased towards higher complexity scores, whereas product categories such as textiles and related articles, footwear or leather and related articles are skewed towards lower complexity scores. The former product classes are typically viewed as high or medium tech product classes, whereas the latter are often viewed as low

that higher degrees of diversification are typically related to more exclusive products. Hence, products with a higher complexity score should be more difficult to imitate and as they are also more exclusive they should generally also command a price premium for their producers. In this section we therefore examine the competitiveness of the EU countries and other important competing nations in terms of the world market shares they are able to obtain for product classes with high complexity scores.

In Figure 8 and 9 the products which a country exports have been sorted according to their complexity score. The figures show the average world market shares the country has obtained in each product category. The world market shares are the fraction of the total value traded across the world in a product class. The averages have been calculated over the period 2005 - 2010. Figure 8 shows these data for the EU countries and Figure 9 for other important industrialised nations. The countries that have a higher density of export shares for products with higher complexity (to the right of the reference line in each plot) can be considered to have a more complex export basket and hence specific capabilities for being successful exporters of complex products.

Figure 8 shows that there are considerable variations across the EU countries in terms of the complexity spectrum of the products in which they obtain their highest world market shares.[9] Among the countries that are successful on the world market in more complex products are Germany (DEU), Sweden (SWE), Finland (FIN), Austria (AUT), Belgium and Luxemburg (BLX), France (FRA), Denmark (DNK), Ireland (IRL), the Netherland (NLD) or the Czech Republic (CZE). This is in line with the evidence for the complexity score at the country level presented in the previous sections. Countries like Romania (ROM), Bulgaria (BGR), Latvia (LVA), Portugal (PRT) or Greece (GRC) on the other hand have not only relatively few products in which they are able to achieve high world market shares. For the products in which these countries are most competitive the product complexity is also skewed towards lower scores. However, these findings should be interpreted in the view of the dynamics of change of the complexity of the productive structures of these countries. Whereas some countries have upgraded their structures (several New Member States) in others they have remained virtually unchanged in terms of the complexity score over the period 1995-2010. Especially this latter group is likely to be exposed to competitive pressure from other countries upgrading to their structures to their levels.

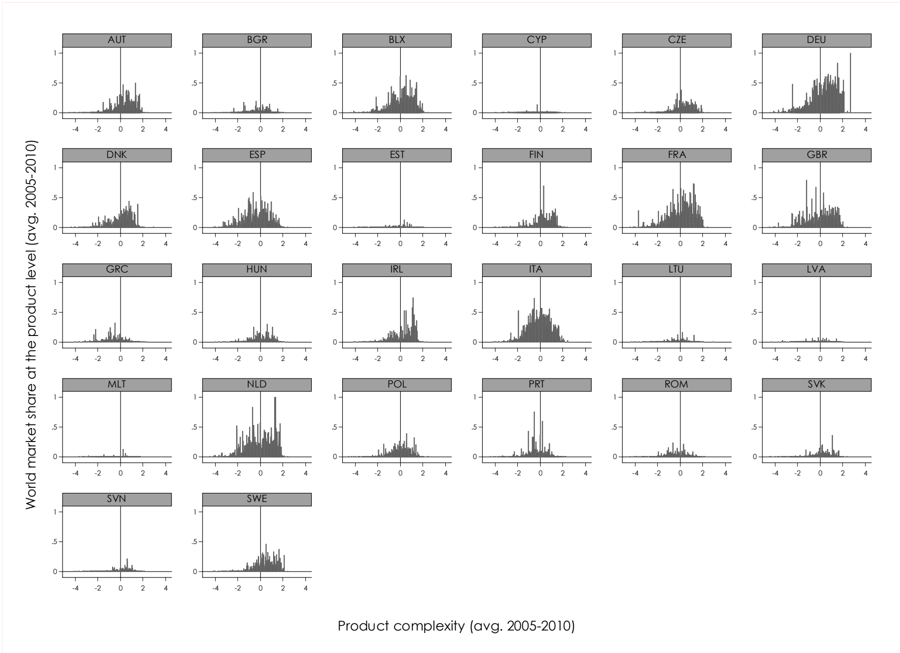
Figure 9 shows that in line with their country specific complexity scores countries like Japan, Switzerland, Singapore or Korea achieve high world market shares in complex products. The mix of exported products in which China is a significant exporter is skewed towards products with lower complexity. However, China has been upgrading its productive structures rapidly

tech product classes. Products that fall under specific classes of key enabling technologies are instead systematically skewed towards higher complexity scores. For details see page 65ff. in the appendix of this report.

[9]Table 16, p. 68, in the appendix provides test statistics for the skewness of the distributions shown in the figures. The figures show all products for each country. However, the representation dominated by the few products in which the countries have significant market shares. The statistical tests show however, that the visual impression these plots convey is accurate.

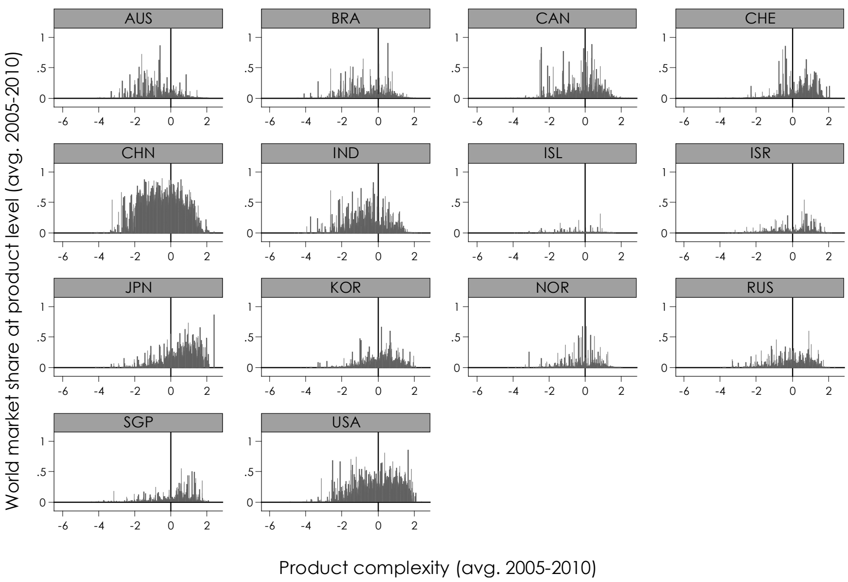
and it obtains also very high world market shares in many product classes. The USA have instead a relatively balanced product mix in terms of the complexity score. US firms achieve high market shares both in products with low and with high complexity scores.

Figure 8: World export shares at the product level over product complexity, EU Member States



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 9: World export shares at the product level over product complexity, other industrialised countries

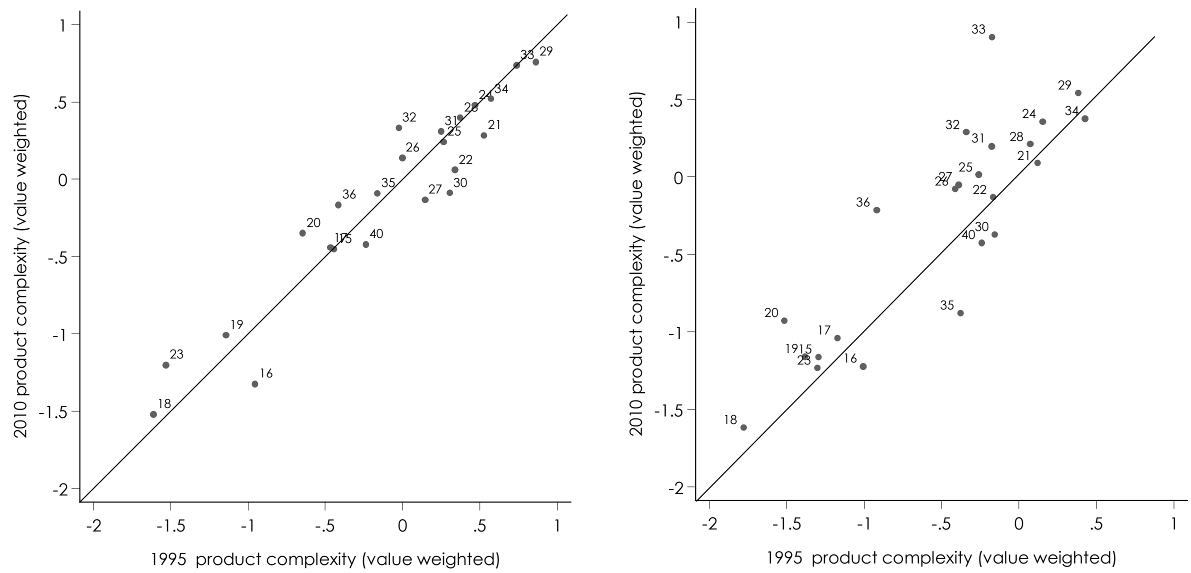


Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Product complexity and competitiveness at the sector level

Countries differ greatly in their sectoral growth and economic performance, as the relative intensity in factor use, the incentives to pursue opportunities, and the specific capabilities required for transforming them into successful business vary between sectors. In this section we will therefore try to establish to what extent the complexity of products varies across sectors. To obtain these figures we have used conversion tables mapping the six digit codes of the Harmonised System into the two digit classes of the NACE sector classification. The aggregate sector indicators were computed by aggregating up the product level indicators using the fraction of the value each product has in the total value of exports of all products classified under a specific NACE class as a weight.

Figure 10: Development of product complexity at the sector level between 1995 and 2010, EU 27 and BRIC countries



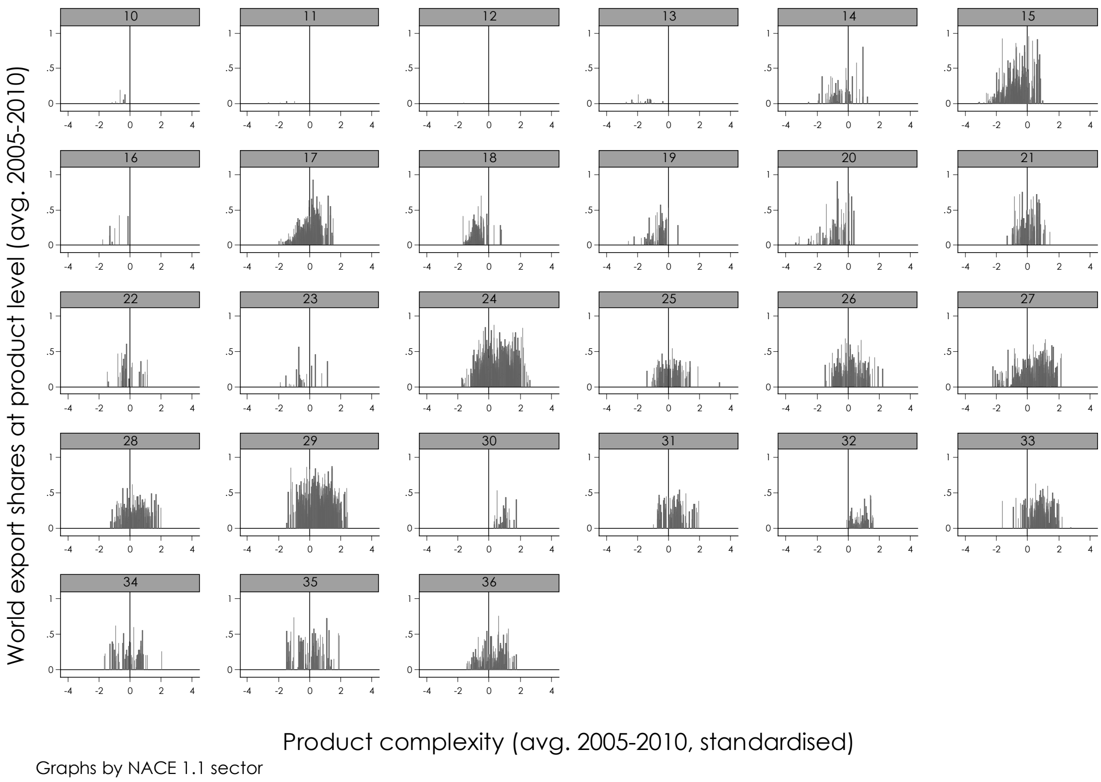
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 10 shows the average product complexity scores at the sector level across all countries for the EU27 (left) and the BRIC countries (right) for the years 1995 and 2010. The horizontal perspective adopted in this figure ignores country specifics. For Europe the picture shows that the sectors producing the most complex products are the machinery and equipment sector (NACE 29), the sector producing medical, precision and optical instruments (NACE 33), the manufacture of motor vehicles (NACE 34), and the chemical sector (NACE 24).[10] These sectors have also maintained their position in terms of the average product complexity scores relative to each other and to other sectors over time. For few sectors, such as the manufacture of pulp and paper (NACE 21) or the manufacture of basic metals (NACE 27) the average complexity score of their products has fallen over time. The reverse is true for the manufacture

[10] See Table 22 on page 85 in the appendix for a complete list of all NACE classes.

of television and communication equipment (NACE 32) where the complexity score has improved over the period of observation. For the EU sectors the figure shows relatively little variation in the average product complexity scores over time. In the BRIC countries in contrast changes have been more dynamic. In these countries some sectors like the manufacture of wood and of wood products (NACE 20), the manufacture of television and communication equipment (NACE 32), the manufacture of medical, precision and optical instruments (NACE 33) and the manufacture of furniture (NACE 36) have considerably improved the average complexity score of their products. However, with the exception of the medical, precision and optical instruments sector basically all sectors in these countries obtain average product complexity scores that lie below those of the same industries in the EU. A comparison of Figure 11 with Figure 13 shows this. The competitive threat from the BRIC countries is therefore particularly relevant for the industries in which the data show a fast improvement of the average product complexity. Overall however, the BRIC countries have produced less exclusive products relying on a less complex knowledge base in the period 1995 to 2010 than the EU countries. The data clearly indicate that these countries are still in a catching up phase.

Figure 11: World export shares at the product level over product complexity by NACE sector, EU 27



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). See Table 22, p. 91 in the appendix for a description of the NACE codes. Intra-EU exports excluded.

Figure 11 through Figure 13 provide evidence for an assessment of the competitiveness at the sector level. As before the products a sector exports have been sorted according to their complexity score. For each product the figures then display the world market shares the firms in the sector are able to obtain. Figure 11 presents the data for the EU 27, Figure 12 for the USA and Japan, and Figure 13 finally shows the details for Korea and China. The data in this case exclude intra-EU trade. Table 17, on page 78 in the appendix, provides the test statistics on the skewness of the distributions shown in these figures.

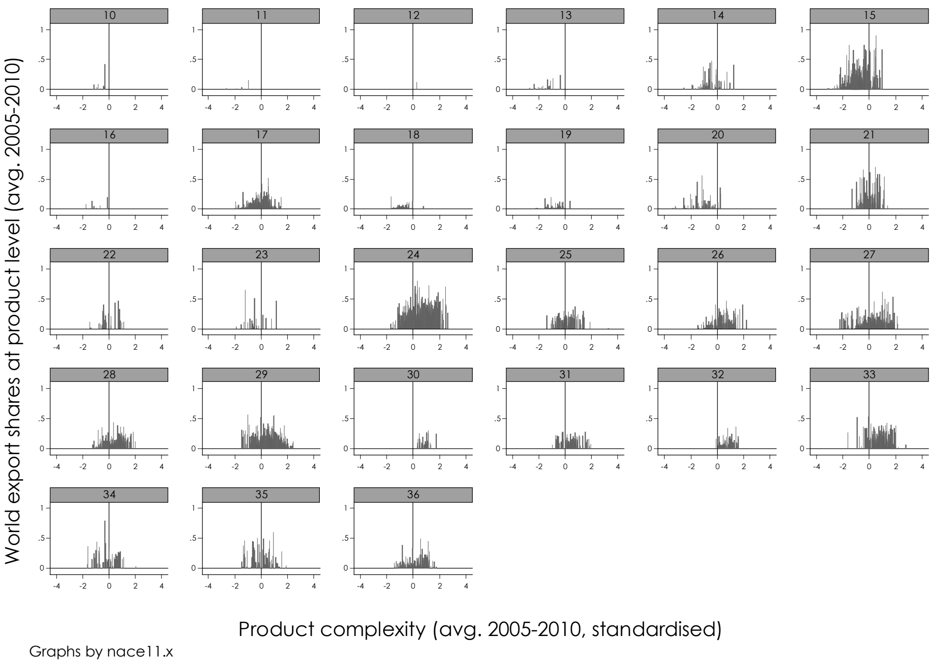
A comparison of the different data across countries and country groups reveals that the EU is a highly diversified economic area in terms of the number of sectors in which European firms are able to obtain significant world market shares. Relative to Korea and Japan more sectors are able to grasp large market shares in a larger number of exported products. This holds to a lesser extent also with regard to the USA. China on the other hand has developed into a highly diversified economy as well. Korea and Japan are more specialised. Country size effects may play a role here however they should be significant only for scale intensive products.

Additional calculations show that the technological specialisation has an impact on the (unweighted) average complexity score of the products in which the EU is a significant exporter. This figure is lower for the EU than for Japan or Korea whose economies are more specialised in sectors with relatively complex products on average, and similar to that of the USA and China. The EU27 as an economic area is however a very strong exporter: for about 67% of the products in which it has a comparative advantage it captures more than 10% of the world market share. For the USA the figure is 43%, China 54%, Japan 24% and Korea 7%. The calculations also show that the complexity score of the products for which European exporters are able to capture more than 10% of the world market share is also higher than the complexity score for all products where the EU has a comparative advantage. The same holds for the US, Japan and Korea, but not for China, where the complexity score does not change. This implies that the EU exporters, but also those in the US, Japan and Korea are able to capture larger shares of the world market by producing more exclusive products relying on a broader knowledge base. China is competitive in product categories with comparatively lower complexity.

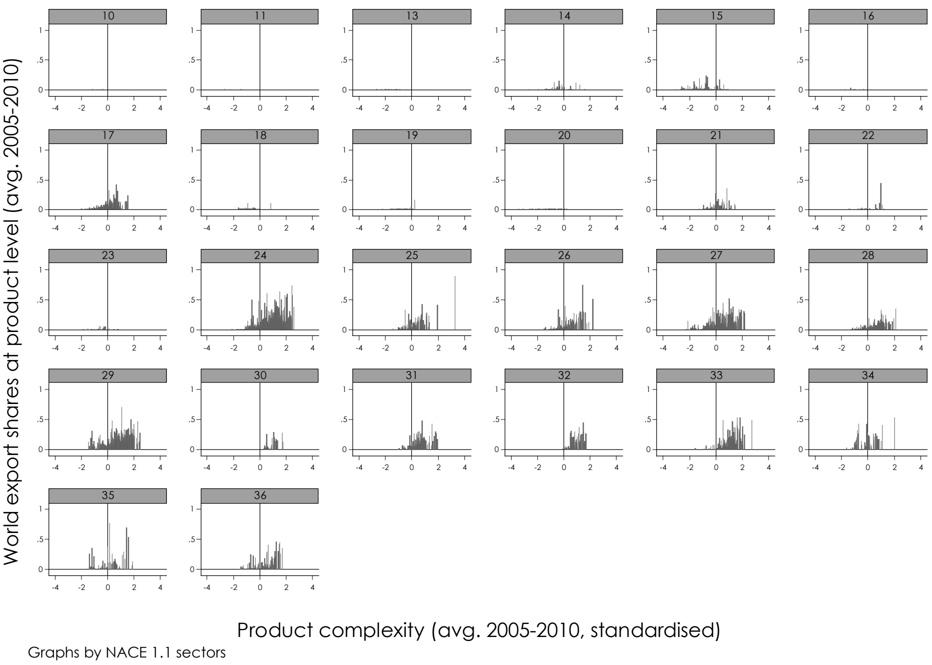
From this cross country comparison we may conclude that the EU as an economic area has been very competitive over the observation period. This competitiveness at the sector level builds upon the generation of more exclusive products relying on a broader knowledge base. However, the results also indicate that the BRIC countries and here especially China are upgrading the complexity of the output of their sectors at a high pace gradually catching up to the levels of the European sectors thereby putting considerable pressure on European producers from below (in terms of the product complexity), which makes the production of less complex products also less viable.

Figure 12: World export shares at the product level over product complexity, USA and JAPAN by NACE sector

USA



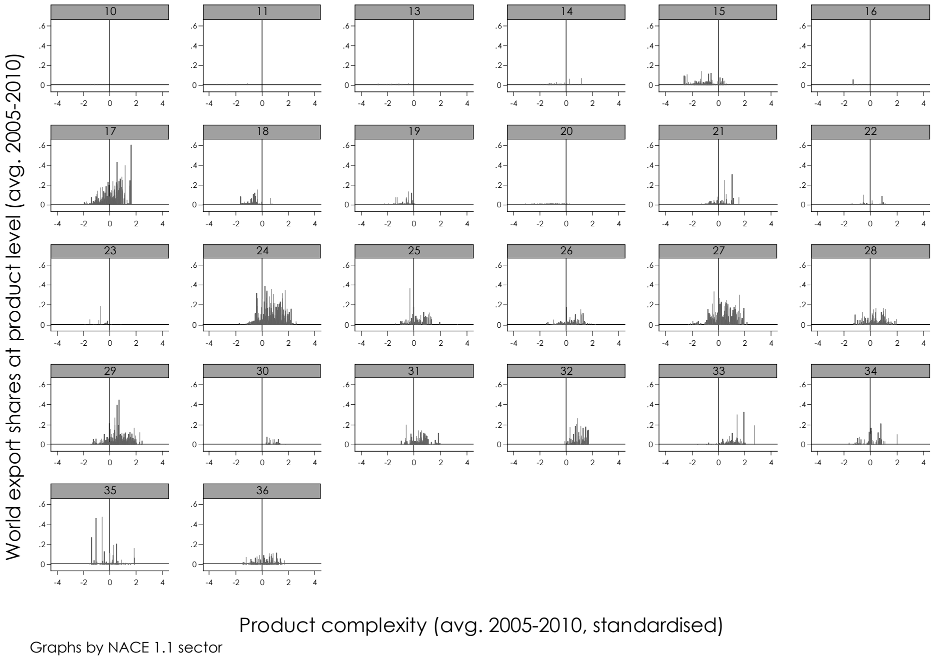
Japan



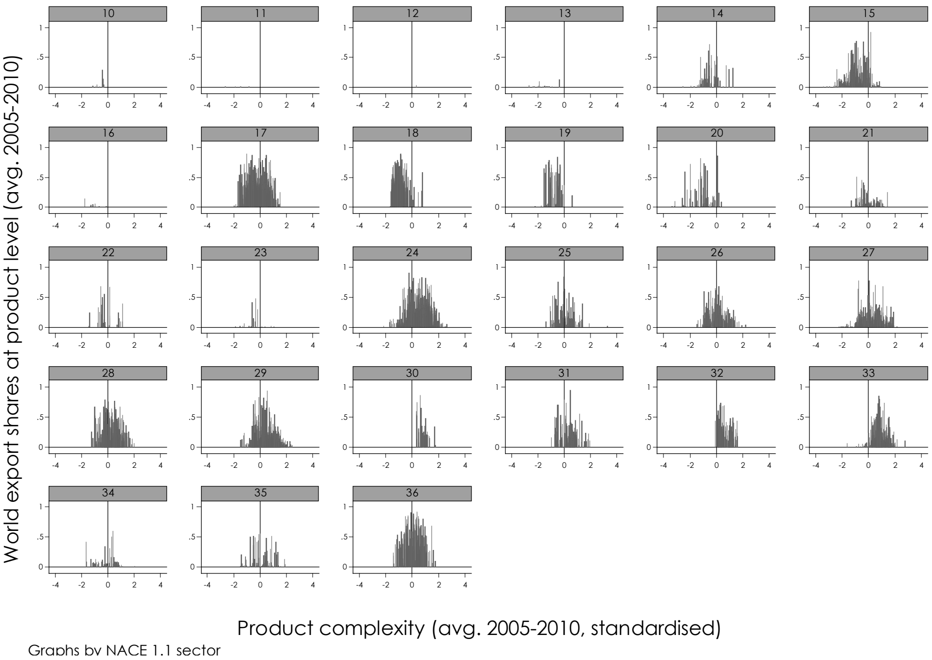
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Intra-EU exports excluded.

Figure 13: World export shares at the product level over product complexity, Korea and China by NACE sector

Korea



China



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Intra-EU exports excluded.

Table 5: Skewness of world market share weighted complexity of products by EU Member State and NACE sector in manufacturing

	NACE sectors																					
country	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
AUT	-7.80	-1.55	-0.67	-3.84	-4.29	-2.50	0.18	0.31	1.07	8.85	1.64	5.23	4.42	3.15	9.39	4.18	3.47	3.13	3.69	3.78	4.48	5.56
BGR	-2.03	-1.13	-2.47	-2.33	-4.31	4.85	-3.70	-0.35	-1.30	14.10	5.07	-2.00	-11.26	11.59	2.01	2.91	-0.52	6.03	10.83	-1.17	0.87	1.05
BLX	0.27	-1.36	1.06	-2.35	-2.62	-2.20	1.06	3.20	3.33	3.48	4.18	0.94	6.25	3.26	3.26	3.84	2.85	1.65	8.28	1.83	3.91	-0.71
CYP	0.64	-1.43	-4.87	-10.49	-2.84	-2.34	2.04	-1.44	-0.42	6.45	3.28	-1.16	-4.28	-0.08	9.89	1.78	-4.71	4.39	5.37	-4.17	-3.28	-0.84
CZE	1.52	-1.38	1.28	-7.56	-0.07	-1.39	7.37	2.86	1.13	8.89	3.44	2.60	4.39	1.89	5.05	4.38	2.71	3.15	9.71	2.32	2.45	7.54
DEU	-5.55	-1.04	4.08	-0.48	-1.82	-0.83	1.13	1.78	0.94	2.00	1.37	1.60	1.88	1.35	1.40	2.84	1.43	2.12	1.52	-0.21	1.71	2.84
DNK	-0.10	-1.11	-3.25	-0.45	-2.66	-2.58	2.06	0.89	0.10	12.42	2.22	-4.61	-0.52	3.46	3.69	1.71	7.21	6.83	3.04	0.24	-3.63	-2.34
ESP	-3.55	-1.09	-0.98	-1.66	-1.64	-4.52	4.21	-3.91	3.22	3.57	2.61	-3.37	1.95	0.11	9.64	1.06	1.41	2.87	3.04	0.37	1.59	-2.31
EST	-9.05	-0.57	-2.26	-3.71	-1.44	-0.13	7.87	-4.13	-1.80	8.36	0.82	-0.28	-0.30	9.35	4.12	1.63	1.96	2.91	2.02	-3.93	-1.39	-7.88
FIN	13.66	-0.59	9.90	-3.10	-5.14	-3.06	3.47	-0.01	-0.08	8.79	9.10	2.81	3.92	3.32	6.72	1.74	5.62	6.23	5.29	3.87	-4.95	-2.52
FRA	-0.88	-1.78	1.83	-4.76	-2.36	-2.87	4.92	-0.50	2.87	4.04	0.58	2.15	4.50	-0.90	10.07	2.37	1.40	4.58	0.94	-0.13	3.96	1.37
GBR	-9.48	-1.00	0.17	-4.71	-0.97	-1.45	4.25	0.88	1.49	3.50	1.65	2.60	1.22	2.37	0.30	2.40	-1.61	3.12	0.72	1.14	-1.18	6.87
GRC	-6.56	-1.30	-6.37	-5.49	-5.67	-2.68	2.58	1.60	2.14	4.04	0.91	-4.76	0.63	4.77	5.71	3.64	-0.56	5.74	8.56	-6.29	-3.26	-1.64
HUN	4.81	-0.68	-3.84	-4.38	0.09	-1.98	6.57	0.78	-2.24	8.82	3.58	3.94	0.03	1.46	3.10	3.64	1.92	5.18	4.28	3.90	7.53	-4.82
IRL	-4.49	-1.15	-2.10	-11.37	1.43	-3.03	-0.30	2.96	-0.42	7.51	2.32	-6.55	4.30	5.73	7.07	1.95	2.58	4.20	6.13	0.52	4.84	7.28
ITA	-7.07	-1.81	0.84	-2.27	-1.47	-2.13	3.50	0.32	0.79	3.74	0.58	-1.97	3.05	0.59	1.49	1.86	0.59	3.40	4.38	1.15	-0.28	-1.02
LTU	-1.25	-1.08	-6.67	-2.49	-2.38	-2.02	2.51	-0.93	-1.87	15.82	-1.16	5.06	-11.57	9.04	6.30	2.83	5.60	0.68	2.82	-2.19	-4.39	2.01
LVA	-8.38	-1.07	-5.61	-3.68	-2.40	-2.55	-2.57	-1.53	-1.76	14.92	3.51	-0.85	-7.19	1.14	7.51	2.93	-4.15	6.03	4.24	0.77	-0.27	-3.41
MLT	-5.48	-1.15	3.94	-4.69	-2.29	-1.40	1.06	-2.78	0.71	3.36	3.48	2.78	2.00	5.39	4.59	2.16	2.68	5.77	3.29	-0.80	-2.58	-0.79
NLD	-4.69	-0.40	11.10	-2.09	-1.32	-1.81	4.23	0.57	0.46	5.27	4.54	7.11	1.61	2.34	9.89	3.11	2.51	6.68	3.93	1.24	1.29	11.14
POL	0.19	-0.73	-4.43	-1.32	-2.99	-1.18	0.46	-0.11	2.60	1.98	0.64	4.71	-12.89	1.53	15.52	2.12	0.84	3.43	4.19	4.04	-2.95	-4.12
PRT	-5.17	-1.90	-4.38	-4.28	-2.15	-3.74	6.99	-1.96	-0.68	5.22	2.92	-2.61	-4.37	-0.77	8.43	3.89	2.42	4.29	5.37	1.50	-3.23	-1.97
ROM	-8.83	-1.73	-8.27	-3.94	-0.78	-5.01	1.33	0.54	-0.87	5.43	3.45	-0.88	-3.18	-0.54	4.77	3.33	-8.74	6.10	3.76	0.17	-0.46	6.36
SVK	-10.21	-0.81	-0.74	-3.50	-1.66	-2.40	1.68	4.21	2.57	9.03	4.01	0.68	2.82	6.51	10.57	2.35	0.63	6.52	5.48	6.91	5.33	0.55
SVN	-3.89	-0.61	-6.00	-2.56	-2.85	-2.27	2.05	-1.80	-0.42	9.46	4.87	2.47	9.39	4.71	7.35	3.51	3.82	4.58	4.87	4.73	-2.05	4.30
SWE	-3.93	-1.39	8.32	-2.58	-1.53	-1.82	1.32	-1.90	3.98	11.71	6.26	4.87	3.59	5.29	5.35	1.67	3.75	8.08	3.78	2.31	3.09	-9.30

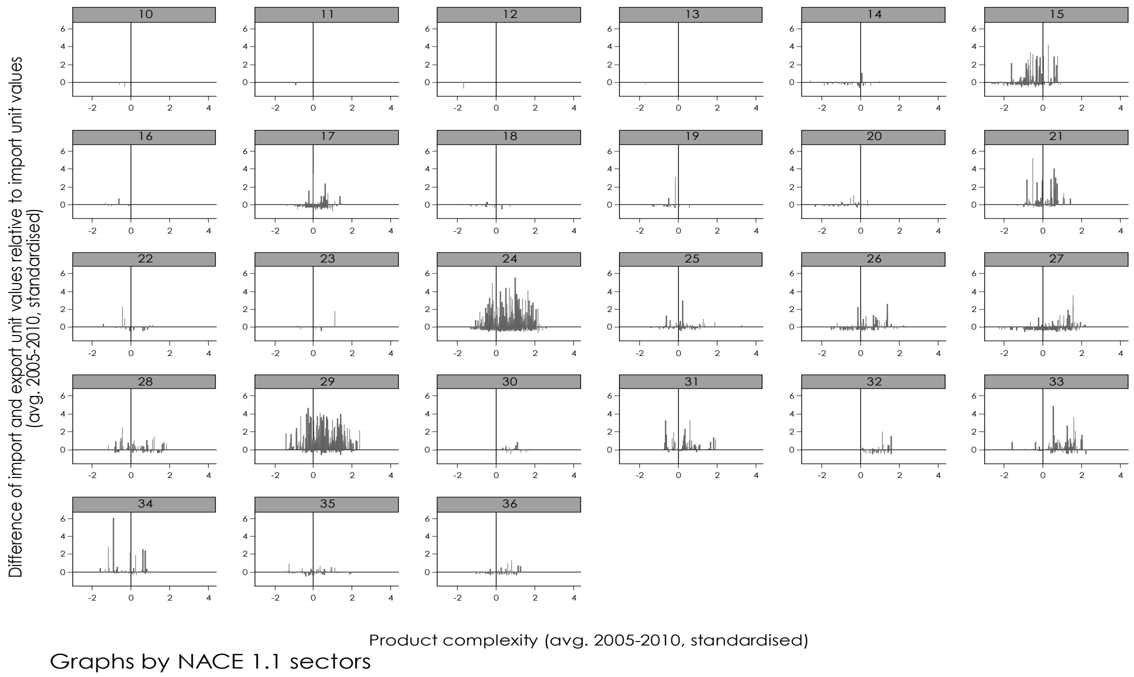
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Note: Skewness >0 indicates a positive skew of the distribution towards mor ecomplex products (yellow-> red); Skewness <0 indicates a negative skew of the distribution towards less complex products (light yellow->green). The means have been normalised to zero.

Table 5 presents additional sector specific results for the EU 27. It shows how the products in which a sector in a country has a comparative advantage are distributed over the complexity scale. This aspect is captured by the skewness statistic of the distribution which indicates whether more observations (or higher probability mass) lie either below (negative skewness value) or above the mean (positive skewness value). The larger the statistic the more the distribution is skewed either in one or the other direction. For the calculation of these statistics also intra-EU exports were taken into account. The table does not reveal whether a country is a strong exporter in terms of the number of product categories in which it is a significant exporter in a sector or whether it captures high world market share. It provides only information of whether the product classes in which they obtain their highest world market shares are mostly complex or not.

The results indicate that across countries the complexity of the products a sector exports is highly sector specific. There is relatively little variation inside sectors. The complexity score therefore seems to capture important characteristics of the knowledge base of each sector. The variation across countries is highest in the publishing and printing sector (NACE 22), in the manufacture of basic metals (NACE 27), electrical machinery and apparatus (NACE 31), motor vehicles (NACE 34), manufacture of other transport equipment (NACE 35) and manufacture of furniture (NACE 36). Here specialisations across EU countries seem to differ more than in other sectors. However, the variation inside each sector is also determined by the fact that several countries have very few products in an industry in which they are significant exporters, but these products are in categories that have either relatively high or relatively low complexity scores. This is for instance the case for Bulgaria (BGR), Lithuania (LTU) or Latvia (LVA) in sector 24, or Poland (POL), Cyprus (CYP) or the Slovak Republic in sector 29 where these countries are significant exporters in only a few products but these have high complexity scores.

If we combine these findings with other studies on the innovation potential and innovation behaviour across sectors (e.g. Reinstaller - Unterlass, 2008, 2011), this evidence shows that the complexity scores are a good proxy for the industrial base of a country, but they do not give indications on where the countries are actually positioned in the quality ladder *inside* specific product categories. This becomes clear from Figure 14. It plots unit value margins in each product category against its complexity scores for all sectors in the EU 27. The unit value margins are defined here as the difference between import and export unit values expressed in terms of the import unit value, i.e. the figure tells us by how much the difference between import and export prices exceeds the import prices. To allow cross country comparison the indicator has also been standardised across countries for each year and product. Hence, high positive scores indicate a very high margin between import and export unit values, and negative scores a low or even negative margin across countries. A high score is therefore an indication that the producers operate in high price segments of the product category and are therefore an indicator for product quality inside each six-digit product category.

Figure 14: Unit value margins at the product level over product complexity by NACE sector, EU 27



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Intra-EU exports excluded.

Figure 14 shows that significant exporters across EU sectors are often active in upper price segments also in product categories with a below average complexity score, especially in the food sectors (NACE 15), the manufacture of textiles (NACE 17), the pulp and paper sector

(NACE 21), fabricated metal products (NACE 28), and also in the less complex product categories in the chemical sector (NACE 24), the machinery and equipment sector (NACE 29), precision instruments (NACE 33) and transportation equipment sectors (NACE 34, 35). Hence, the complexity score does not capture vertical differentiation within product categories.

4.4 Sector performance and product complexity

We explore now the relationship between product complexity and economic performance at the sector level across sectors in the EU 27 countries econometrically. For the analysis the country-product data generated to calculate the country and product complexity score have been aggregated up to NACE 1.1 two digit levels such that they could be combined with the EUKLEMS data.[11] In the aggregation of the product complexity variables as well as the world market shares the observations have been weighted with their share in the trade value of the entire sector. Correspondence tables between the NACE and Harmonised System classification have been used to allocate products to specific sectors. The analysis covers the years 1995-2007 and comprises 25 EU countries. The analysis uses five year averages for all variables to eliminate year-to-year noise in the data.

The analysis is based on OLS regressions with lagged explanatory variables and country dummies. The use of both lagged levels and lagged growth rates of the explanatory variables provides information on the dependence of the growth rate on both between (difference across sectors) and within (difference inside sectors) dimensions. The between dimensions is captured by the level variables (lagged product complexity), whereas the within dimension is mainly covered by the lagged growth rates of the explanatory variables. The dependent variables are the world market share of the sector, the growth of the world market share, as well as employment, value added and gross output growth. The results are reported for the business sector as a whole, i.e. pooled over all two digit sectors.

Table 6 shows that the relationship between the average product complexity and economic performance at the sector level is strong and statistically significant, changes in product complexity do not have an impact. A change of the average product complexity from the country mean by one standard deviation is associated with an increase of the world market share of 42 percentage points. The same change affects employment growth by 7%, and value added and gross output growth by 11% respectively. The coefficients refer to the changes of the five year averages of the dependent variables and explanatory variables.

These results provide evidence that the average level of product complexity is an important determinant of economic performance at the sector level in the EU.

[11] http://www.euklems.net/index.html

Table 6: Product complexity and economic performance at the sector level, 25 EU countries

VARIABLES	(1) world market share	(2) Δ world market share	(3) Δ employment	(4) ΔVA	(5) Δ GO
Value added VA (t-1)				0.00	
				(1.507)	
Gross output GO (t-1)					0.00**
					(1.998)
product complexity (t-1)	0.42***	-0.21	0.07***	0.11***	0.11***
	(3.982)	(-0.915)	(7.611)	(5.093)	(7.339)
Δ product complexity (t-1)	-0.00	0.00	-0.00	-0.00	-0.00
	(-0.200)	(0.317)	(-0.125)	(-0.261)	(-0.492)
Constant	0.5	-0.21	0.02	0.05	0.05
	(0.20)	(0.81)	(0.49)	(0.52)	(0.38)
Observations	500	500	500	500	500
R-squared	0.335	0.061	0.201	0.216	0.349

pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: WIFO calculations; EUKLEMS and BACI data. Pooled OLS. Standard error asymptotically robust to heteroskedasticity and serial correlation. Country dummies not reported. The symbol Δ stands for growth rate over a five year period.

Variable list and definitions:

- Complexity score product: See Box 2 for the definition; standardised across products
- World market share: $s\_ex_{j,i,t}/\sum_j s\_ex_{j,i,t}$, s_ex is the share of exports in a sector
- Δ VA $^{i,j,t} = \ln(p_{i,j,t}) - \ln(p_{i,j,t-1})$ growth in real value added in country j, sector i at time t
- Δ EMP $^{i,j,t} = \ln(EMP_{i,j,t}) - \ln(EMP_{i,j,t-1})$ employment growth in country j, sector i at time t
- Δ GO $^{i,j,t} = \ln(GO_{i,j,t}) - \ln(GO_{i,j,t-1})$ gross output growth in country j, sector i at time t
- (t-1) lagged variables: one period lag between variables representing five year averages

4.5 Summary

In this chapter we have examined the complexity of the productive structures of Europe's economies using the method of reflections (see Hidalgo - Hausmann, 2009) which leads to indicators capturing the diversification of a country and its capability to produce exclusive products. These indicators can be interpreted as measures for trade competitiveness and as such they are closely related to the capability of a country to generate wealth. They reflect also the industrial base of a country and the depth and breadth of its knowledge base as they are constructed from trade data. They neglect however the economic potential of services and non-tradeable commodities and services, and they do not capture quality upgrading and vertical differentiation inside existing product categories adequately. With further work on quality adjusted complexity scores it may be possible to make more progress in this respect.

Keeping these limitations in mind the indicators can provide valuable information on the competitiveness of the manufacturing sector of Europe's economies. The results show that there is a considerable dispersion in the complexity scores across countries. While some countries have upgraded their productive structures and caught up to the most advanced economies inside the EU, for other countries a stasis in the development of their productive structures is evident. In these countries structural renewal in terms of deepening and broadening the knowledge base seem to be necessary.

Looking at the sector level the results show that the average complexity scores of the products in which European firms are significant exporters are high in international comparison. Also in product categories with low complexity scores European producers are often active in the top quality segments. The scores at the sector level have been relatively stable in the EU over the period 1995-2010. As the results show that the BRIC countries and especially China are upgrading the complexity of the output of their business sectors at a high pace European producers will experience even more competitive from below (in terms of the product complexity). To escape this pressure it is necessary to increase the diversification and exclusivity of products inside sectors but also to upgrade to higher quality levels inside existing product categories. We will explore potential pathways for such a strategy in the next chapter. Overall the results indicate that it is important to have exclusive products relying on a broader knowledge base rather or to be positioned in the top quality segments of less complex products to be competitive internationally. These aspects will be explored econometrically in Chapter 6.

5 The product space of the EU and its Member States

5.1 Introduction and background

The analysis in the previous section has shed light on the competitiveness of the EU countries and the business sectors in the EU on the basis of their diversification and the exclusivity of the products they export. The indicators capturing these aspects for both the productive structures of countries and for single products were constructed by analysing which countries are significant exporters of which products. A complementary and closely related view is to look at the pattern of relatedness of products in trade at the global level and how countries are embedded in this network of related commodities. Hidalgo et al. (2007) call this network "*product space*". In this chapter we will examine this approach more in detail for the EU countries.

The location of a country in the product space has important implications for the potential of diversification and long run growth if one takes the Schumpeterian idea seriously that new combinations are a driving force of economic growth. In Schumpeter's view "to produce, means to combine materials and forces within our reach…. To produce other things or the same things by a different method means to combine these materials and forces differently." Changes in the economy therefore arise from "new combinations of productive means." (Schumpeter, 1934, p.66). This perspective has been integrated in recent contributions to the theory of economic growth. Weitzman (1998) and also Arthur (2009), for instance, conceive of economic growth as a process where technologies inherit parts from other technologies that preceded them. Novel technologies and products then arise by combination of existing technologies. The stock of existing technologies provides the parts for the combination, so the growth process becomes highly cumulative. The possibility to generate new products and technologies through recombination presents essentially an unlimited source for growth. Hence, as Weitzman (1998) emphasises, the limits to growth lie not in the ability to generate new ideas, but to transform these into a usable form and exploit them economically.

The implication of this is, as Kauffman - Thurner - Hanel (2008) (see also Hanel - Kauffman - Thurner, 2007) argue, that the capability of a country to generate products that are more apt for recombination is important. This capability is reflected in the location of countries in the product space. In its core products can be recombined more easily as their production and development draw heavily on common factors of production and a common knowledge base. These products can also be used in many economic domains. This is not the case in the peripheral parts of the product space. As a consequence countries located close to the core are more likely to experience self-sustaining long run growth, whereas for countries that are positioned in the periphery the growth potential is more limited.

Hausmann - Klinger (2007) have developed indicators to analyse the product space. They are all based on the idea of proximity between traded commodities. This *proximity* is defined in terms of the conditional probability of countries having a comparative advantage in any two pairs of commodities at the same time. This is a measure of relatedness that is based on outcomes in international trade and is a global characteristic of each product class. From this proximity measure it is then possible to develop a country-product level indicator that relates this product level information to the product mix a country produces and successfully exports. This indicator measures how close a country is to products for which it is not a significant exporter. It is the sum of proximities from a particular product to all other products that are exported divided by the sum of proximities of all products. Hidalgo et al. (2007) and Hausmann - Klinger (2007) call it "density". In the present report we will refer to this indicator as "*neighbourhood density*" to distinguish it from the statistical notion of density, which we use in other places to characterise the distribution of products over complexity scores. Hausmann - Klinger (2007) show that the "neighbourhood density" captures the factor substitutability between products, i.e. to what extent factors used to produce one good can be used to produce another good. It is therefore a good predictor for the likelihood that a country with a specific product mix can develop a comparative advantage in another product.

Another indicator that can be derived from the proximity at the product level is the measure of *centrality*. This indicator captures the proportion of the products in the product space a product is connected to. It is particularly important with respect to the growth potential as more central products are based on factors and capabilities that have more opportunity for recombination and are therefore an important determinant of growth. Box 3 provides the technical details for each of the measures introduced here.

Box 3: Network measures for the product space

Hidalgo et al. (2007) define the product space as a network of related products, and not as in Hidalgo (2009), discussed in Chapter 3, as a bi-partite network linking countries to products. To construct this network, they define a proximity measure, $\varphi_{i,j}$, between two products i and j as the pairwise conditional probability *P* of a country exporting one good given that it exports another. This measure is defined as follows:

$$\varphi_{i,j} = \min \ \{P(RCA_i | RCA_j), P(RCA_j | RCA_i)\}, \text{(proximity)}$$

where RCA_i means that a country has a revealed comparative advantage (RCA) for product i and is therefore a significant exporter of that product (see also Box 1, p. 4). The RCA is taken in order to ensure that marginal exports do not introduce noise into the data. The minimum is taken to avoid that if a country would be a sole exporter of a good the conditional probability would take on the value 1. By taking the minimum of the reciprocal relationship this problem is avoided. Hausmann - Klinger (2007) provide a detailed discussion of this measure. Proximity is therefore a measure that links any product to any other product traded in the world. In terms of a network, the proximity can be conceived as the edges of the network with the products being its nodes.

In order to assess the likelihood that a product becomes a significant export in a country Hidalgo et al. (2007) define a measure called "density". We refer to this indicator as "neighbourhood density" to distinguish it from the statistical notion of density. It measures the average proximity of a product to a countries current productive structure. For products for which the country is not a yet a significant producer this measure therefore indicates how embedded the product would be and by implication to what extent complementary capabilities are already available in a country. It therefore captures the likelihood that a country develops a comparative advantage in any product. The neighbourhood density ω_j^k is calculated as follows:

$$\omega_j^k = \sum_i x_i \ \varphi_{i,j} / \sum_i \varphi_{i,j} , \text{(neighbourhood density)}$$

where x_i is unity if product *i* has an RCA>1 in country *k*. The neighbourhood density takes on the value 1 if a country produces all *i* products to which product *j* is connected in the product space. The neighbouthood density is therefore normalised between 0 and 1 and takes on the maximum when a product is connected to all other products in the product mix of a country. The proximity can also be used to calculate the centrality of a product in the product space (Hausmann - Klinger, 2007), i.e. whether the product *i* is connected to a higher proportion of all products *J* in the product space or not:

$$c_i = \sum_j \varphi_{i,j}/J, \text{ (centrality)}.$$

This measure indicates whether products are positioned in the denser parts of the product space or in its periphery. This is normalised between 0 and 1 and it will be typically close to zero. It takes on the maximum value if all products in the product space are connected to each other. Given that more central products are connected to a higher proportion of goods in the product space centrality is an indicator for the diversification potential of a product.

A final indicator that can be derived from the neighbourhood density of a product is the so-called discovery factor, H_j. It is the ratio between the average neighbourhood densities for product *j* across countries in which it has been developed into a significant export (*D*), relative to the average neighbourhood density across countries where it has not been developed into a significant export (*N-D*)

$$H_j = \frac{\sum_{k=1}^{D} \omega_{j,k}/D}{\sum_{k=D+1}^{N} \omega_{j,k}/(N-D)}. \text{ (discovery factor)}.$$

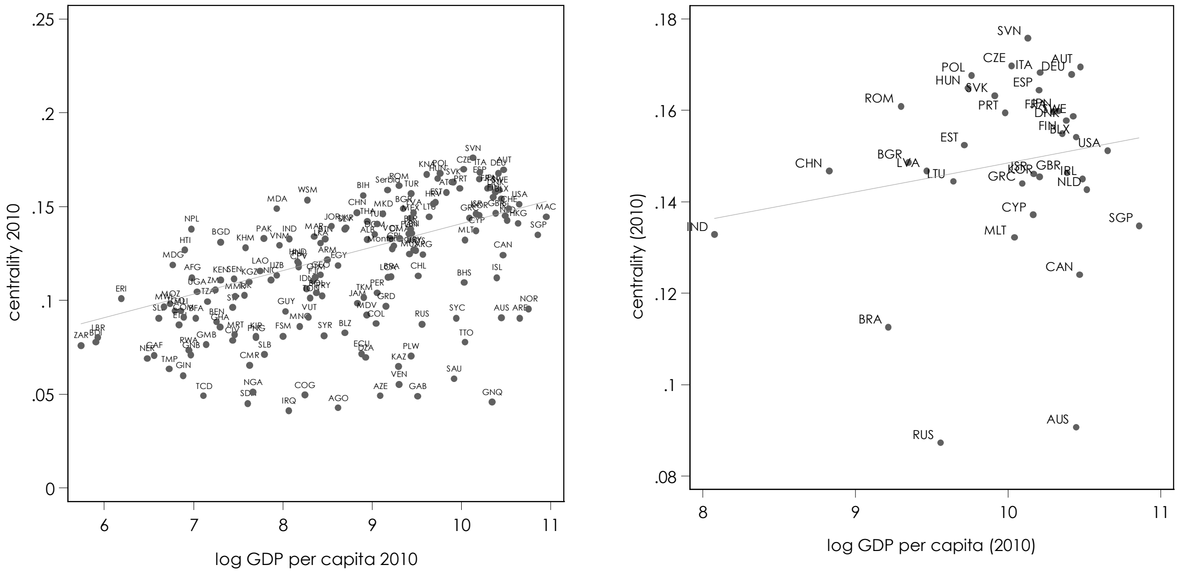
The indicator is larger than one, if the average neighbourhood density across countries where the product has not been developed is smaller than the average density across the countries where it has been developed.

5.2 Product centrality and economic performance at the country and the sector level

Product centrality tells us how dense the product space is around areas where a country has specialised. This is closely related to a countries capacity to generate wealth as more central products are based on factors and capabilities that offer more opportunity for recombination or that can be more easily substituted between products. On the other hand centrality is also a measure for slackness related to the specialisation of a country. It is easier for countries in the more central, denser parts of the product space to change their product mix, than for countries in which it is less central.

The left panel of Figure 15 shows that high income countries are typically specialised in the denser parts of the product space. There is however considerable variation in the plot induced by countries with high income and low centrality. These are countries that typically export scarce natural resources. The right panel of Figure 15 presents a detail of the plot in the right panel for the EU countries and other important competing nations. The natural resource effect can be observed also in this figure. Countries that are strong exporters of scarce natural resources such as Australia, Russia or Brazil have a low centrality and a (relatively) high GPD per capita. However, the figure also shows that there is also strong variation in the other direction.

Figure 15: Relationship between the average centrality of products in an economy and GDP per capita 2010, all countries and EU27



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010); World Bank Data (GDP)

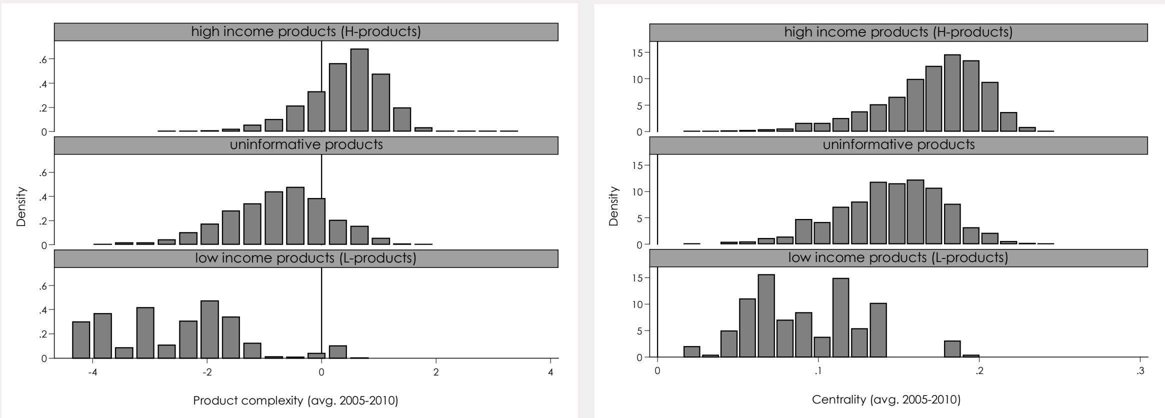
There may be two reasons for this observation. It is possible that countries with a product mix that is situated in very central areas of the product space may still be producing in lower quality ranges of each product category and hence generate less income than if they were producing in the high quality ranges of the same goods. It may also be that there is a critical threshold for centrality beyond which a move into more central areas of the product space has no impact anymore on the capability to generate wealth. At this stage the issue becomes then more to exploit the opportunities offered by the location in the product space rather than increasing the diversification of the product mix.

Unreported results indicate also that there is a non-linear relationship between the centrality and intra-industry trade (measured by the Grubbel-Lloyd index). At first centrality and the intra-industry trade indicator are positively correlated indicating that countries located in the more central parts of the product space trade also more intensely inside industries rather than across industries. As intra-industry trade increases when the traded products inside an industry are less than perfect substitutes this implies that higher centrality comes also with a stronger vertical differentiation and hence specialisation (and monopolistic competition) inside industries (cf. Helpman, 2011, p.70–71). However for the wealthiest countries this relationship at some point becomes negative implying that higher intra-industry trade is associated with lower centrality. This evidence may support the second hypothesis about the relationship between income and centrality above. Wealthier economies reach an optimum level of centrality of their portfolio and at some point start sorting out their productive structures as they perceive competition from below and start focusing on a portfolio of more competitive products or move more heavily into services to improve their product quality and this affects then the centrality negatively as intra-industry trade goes up. It is beyond the scope of this study to explore this issue and we leave this conjecture for future research. However, it should be noted that a move towards more central parts of the product space is an important dimension of upgrading the productive structures of an economy (cf. Box 4). This aspect is then particularly relevant, when we discuss potential pathways for upgrading in the next section.

Box 4: Another view on product upgrading and climbing the quality ladder following Sutton - Trefler (2011)

Sutton - Trefler (2011) argue that countries develop along a quality ladder starting to produce low productivity products (L-products) and gradually moving to high productivity products (H-products). They argue that the best way to do so is through the class of uninformative products. These are products that are traded in vertically differentiated markets produced by low and high income countries at different qualities levels. If low income countries are successful in upgrading uninformative products they will be able to build up capabilities to gradually move to H-products. *Figure 16* illustrates now the rationale of this process by means of product space metrics underlying these different product classes. L-products are not complex and require only limited capabilities to be produced. H-products instead are complex and require more sophisticated capabilities. Uninformative products instead have intermediate complexity skewed towards lower degrees of complexity. H-products are also more in the centre of the product space, whereas uninformative products cluster around intermediate degrees of centrality. Hence, the upgrading envisaged by Sutton - Trefler (2011) is one of the gradual increase of the complexity of the products a country produces, and also a gradual move towards the centre of the product space. Long jumps from low to high products are likely to be difficult as the differences in their complexity are too high. They cannot be bridged without building up capabilities.

Figure 16: The product complexity and centrality for L goods, uninformative products, and H goods



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Table 7 explores the relationship between centrality and economic performance measures at the sector level across sectors in the EU 27 countries econometrically. The econometric set up is identical to the one described in Section 4.4. The dependent variables are again the world market share of the sector, the growth of the world market share, as well as employment, value added and gross output growth.

Table 7: Centrality and economic performance at the sector level, 25 EU countries

VARIABLES	(1) world market share	(2) Δ world market share	(3) Δ employment	(4) ΔVA	(5) Δ GO
Value added VA (t-1)				0.00*	
				(1.840)	
Gross output GO (t-1)					0.00**
					(2.404)
centrality (t-1)	13.78***	-11.14*	1.13***	1.95***	2.11***
	(5.092)	(-1.874)	(4.358)	(3.302)	(5.446)
Δ centrality (t-1)	-0.13	-1.58	0.36***	0.31	-0.15
	(-0.107)	(-0.598)	(3.133)	(1.173)	(-0.894)
Constant	-1.51***	1.41	-0.16***	-0.25**	-0.27***
	(0.01)	(0.23)	(0.00)	(0.03)	(0.00)
Observations	500	500	500	500	500
R-squared	0.349	0.068	0.162	0.196	0.317

pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

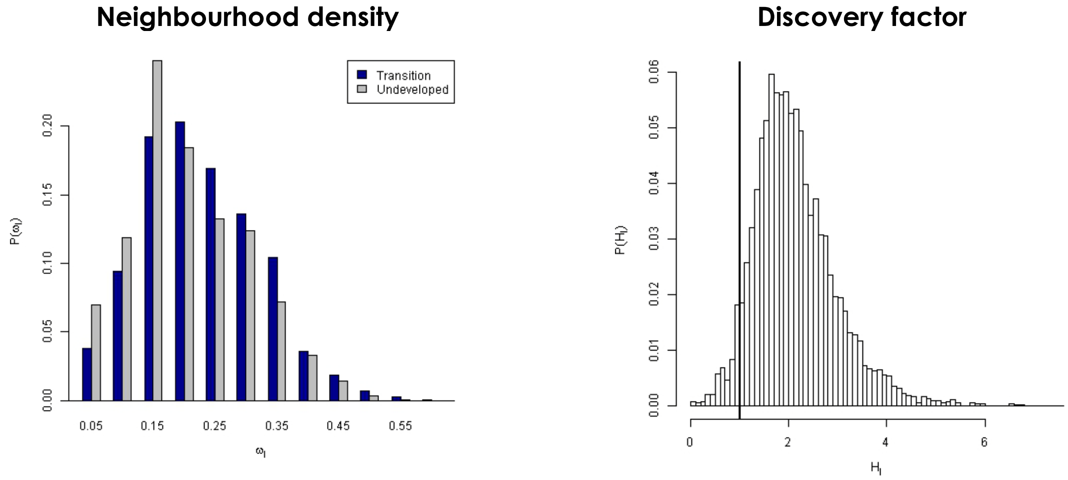
Source: WIFO calculations; EUKLEMS and BACI data. Pooled OLS. Country dummies not reported. The symbol Δ stands for growth rate over a five year period.

Overall the level of lagged centrality explains better the dependent variables, than the rate of change of centrality with the exception of employment growth, on which both variables have a significant impact. World market shares are also better explained by centrality than the rate of change of the world market shares. A change of the lagged centrality value by about 0.01 from the country mean (keeping in mind that the variable is normalised between 0 and 1, and that the indicator varies between 0.1 and 0.2 across sectors in the EU) goes along with an increase of the world market share by 13.8 percentage points. The same change implies an increase of about 1.1 percentage points of the employment growth rate, of close to 2 percentage points in value added and gross output growth over a five year period. The negative impact of centrality on the growth rate of world market shares reflects a catching up and upgrading effect. The market share of sectors that are less centrally positioned in the product space can grow faster as they capture markets on the lower quality range from other sectors starting from generally low market shares whereas it is difficult to achieve high growth rates in world market shares if these are already high. Overall results therefore confirm that a more central position in the product space goes along with a higher capability to generate employment, value and higher world market shares.

5.3 Product neighbourhood and the economic competitiveness of countries and sectors

The "neighbourhood density" captures the factor substitutability between products, i.e. to what extent factors used to produce one good can be used to produce another good. Hidalgo et al. (2007) therefore argue that it is a good predictor for the likelihood that a country with a specific product mix can develop a comparative advantage in another product. The authors show this by analysing the distribution of the neighbourhood density for products in which countries have become a significant exporter over some period (transition products), and for products where countries have not developed a comparative advantage, i.e. that have remained "undeveloped".

Figure 17: The neighbourhood density and discovery factor for developed and undeveloped products over the period 1995-2010.



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);

Note: Distributions for products where countries have developed a comparative advantage between 1995 and 2010 (transition), and where this was not the case (undeveloped)

The left panel of Figure 17 shows the different distributions for the neighbourhood density of transition and undeveloped products for the period 1995 to 2010 and for all countries. The distribution of undeveloped products is skewed slightly more towards lower neighbourhood density values, whereas for transition products it is skewed towards higher values. The difference between these distributions is less clear cut as in the results presented by Hidalgo et al. (2007). This may be related to the lower level of aggregation of our data. However, it is also influenced – as will be discussed later -- by the fact that neighbourhood densities are closely related to country specific characteristics. The right panel of Figure 17 shows the ratio between the average neighbourhood densities across countries where the product has not been developed and the average densities across the countries where it has been developed which Hidalgo and co-authors call "discovery factor" (see Box 3 for details). If this ratio is larger than one then the neighbourhood density has been larger for transition products. The figure proves that this has been the case in the vast majority of cases, as indicated by the vertical line plotted at discovery factor value one.

Table 8: The association between neighbourhood density and revealed comparative advantage, linear probability model for EU 27 countries

VARIABLES	(1) RCA Dummy	(2) RCA Dummy	(3) RCA Dummy	(4) RCA Dummy	(5) RCA Dummy	(6) RCA Dummy
Neighbourhood density	0.371***	0.378***	0.374***	0.374***	0.371***	0.377***
	(158.0)	(160.0)	(169.8)	(168.5)	(168.9)	(172.5)
	0	0	0	0	0	0
Complexity score product		0.0562***				0.0532***
		(29.94)				(28.08)
		0				0
Grubbel Lloyd Index			0.0206***		0.0322***	0.0352***
			(13.11)		(21.15)	(23.53)
			0		0	0
Quantity margin export				0.0946***	0.101***	0.0939***
				(63.84)	(65.13)	(62.58)
				0	0	0
Unit value margin export				0.0233***	0.0242***	0.0235***
				(24.49)	(25.43)	(25.41)
				0	0	0
Constant	0.382***	0.393***	0.493***	0.491***	0.493***	0.505***
	(33.19)	(37.92)	(63.70)	(63.85)	(65.72)	(74.82)
	0	0	0	0	0	0
Observations	649,721	649,721	649,317	636,787	636,787	636,787
R-squared	0.476	0.486	0.482	0.496	0.499	0.508

Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.
Country and time dummies not reported

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). OLS with standard error asymptotically robust to heteroskedasticity and serial correlation.

Variable list and definition:

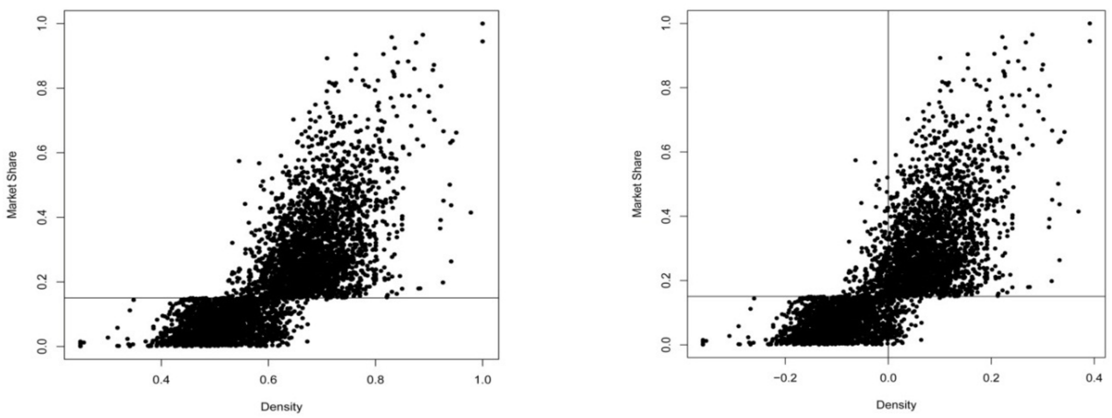
- RCA dummy: dummy taking on value 1 if a country has a revealed comparative advantage in a product, 0 otherwise
- Neighbourhood density: See Box 3 for the definition; standardised across products and countries for each point in time;
- Complexity score product: See Box 2 for the definition; standardised across products
- Grubbel-Lloyd index: intra-industry trade index defined as $GLI_{i,k} = 1 - |ex_{i,k} - imp_{i,k}|/(ex_{i,k} + imp_{i,k})$, with ex_i and imp_i being the value of exports and imports for product *i* in country *k*; standardised for each product and point in time across countries;
- Quantity margin export: $QME_{i,k} = (qexp_{i,k} - qimp_{i,k})/qimp_{i,k}$, $qexp_{i,k}$ quantities exported, $qimp_{i,k}$ quantities exported of product class *i* in country *k*; standardised for each product and point in time across countries;
- Unit value margin export: $UVE_{i,k} = (UVexp_{i,k} - UVimp_{i,k})/UVimp_{i,k}$, standardised for each product and point in time across countries;

Table 8 presents the results of an econometric analysis at the product level of the relationship between the neighbourhood density and revealed comparative advantage by means of a linear probability model. Controlling for different aspects of product quality this analysis sheds light on the probability that a country develops a comparative advantage in a product when the neighbourhood density around it changes. In the analysis we control for product complexity as introduced in Chapter 3, for the substitutability between foreign and domestic products proxied by the Grubbel-Lloyd index that captures the intensity of intra-industry trade, as well as unit value and quantity margins to capture the quality segments in which a national variety of a product is traded. All variables have been standardised so that the reported coefficients should be interpreted as the probability of a country developing a comparative advantage in a product when any of these variables changes by one standard deviation. The complexity score is a product characteristic and is identical across countries for a specific point in time. To capture the cross country variation the Grubbel-Lloyd index and the unit value and quantity margins have been standardised for each product and point in time across countries. The neighbourhood density instead has been standardised across products for each country at a point in time, as the density is closely related to country properties such as diversification and the trade volume. Hence, the standard deviation in this case refers to a relative rank of the density in a country. The results refer to the EU 27 countries. Issues of heteroscedasticity and autocorrelation in the data have been dealt with by using appropriate procedures to obtain correct standard errors.

The results show that a change of the neighbourhood density by one standard deviation increases the likelihood of a country developing a comparative advantage in that product by 37%. This result is very stable with regard to the controls or country and time dummies that are added to the model. The results are very similar if all countries in the sample are considered. We have also estimated alternative model specifications where the neighbourhood density was lagged by three years. In this case the estimated effect of a one standard deviation change of the neighbourhood density on the probability of developing a comparative advantage in a product was in the order of a 20%. These results underscore that the neighbourhood density of a product is a very strong predictor of comparative advantage for a product.

Figure 18 and Figure 19 show that there is also a strong relationship between the competitiveness of a country in a specific product and the neighbourhood density of that product. The figures plot the world market share the EU 27, the USA, Japan, South Korea, and China have in any of the products they export against the neighbourhood density of these products. The left panel shows the raw data whereas the right panel shows the same data but with a centred neighbourhood density, i.e. where the country average of the neighbourhood density has been subtracted from the density of each product. In this way it is possible to highlight better the relationship of the neighbourhood density of product and world market shares relative to the average neighbourhood density in a country. The horizontal line in the figure represents the world market share a country must obtain to develop a comparative advantage.[12]

Figure 18: The relationship between the neighbourhood density in a product and world market share in that product, observed density (left) and centered (right), EU 27 in 2010



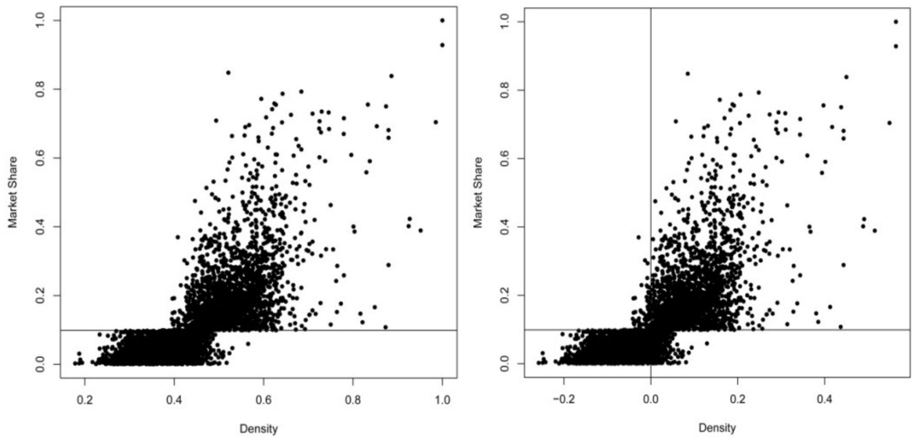
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010); Figure left shows measured neighbourhood density, figure right shows density centred around average country density.

The figures show some remarkable features. Firstly, they confirm the previous results that the neighbourhood density is a strong predictor for achieving a revealed comparative advantage and more generally for the success in world markets in specific product categories. Secondly, they show that the neighbourhood density of a product developing a revealed comparative advantage is close to or slightly above the average neighbourhood density of the country. Once this density threshold is passed the product will develop a comparative advantage and capture significant world market shares. Unreported results show that the average of the neighbourhood density of the products a country exports is closely related to its diversification and its overall trade volume, i.e. its extensive margin. Larger economies are clearly more diversified and a higher diversification ensures also, as suggested by the results in Chapter 3, that more capabilities are available to produce and export more products. However, if we recall that the neighbourhood density essentially captures the factor substitutability across products, then this implies that the benefits of diversification can only be appropriately reaped if the mechanisms through which factor substitution across products works operate properly in the economy. While at the regional or national level this goal is easier to obtain for a highly heterogeneous economic area like the EU this implies that deficits in economic integration will reflect negatively on the exploitation of the potential diversification offers.

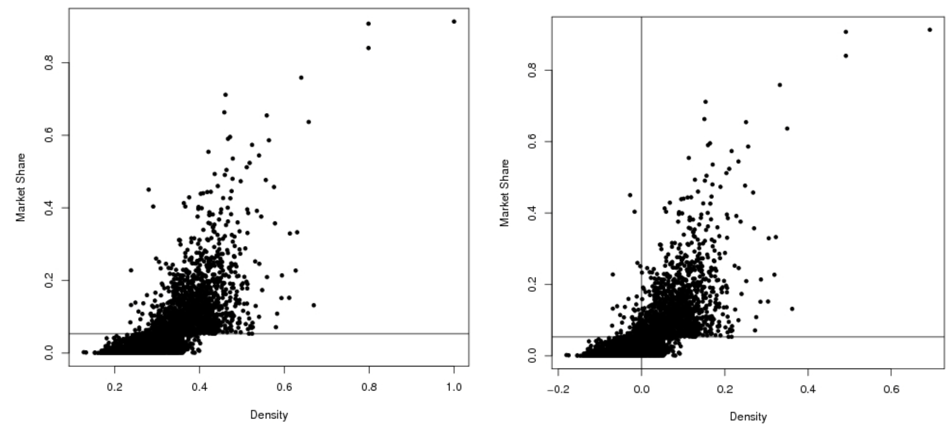
[12] The horizontal line in Figure 18 and Figure 19 represents the threshold in the world market share a product must pass to have a comparative advantage. This follows from the fact that $RCA_{c,p} > 1 \rightarrow \frac{x_{c,p}}{\sum_c x_{c,p}} \Big/ \frac{\sum_p x_{c,p}}{\sum_c \sum_p x_{c,p}} > 1 \rightarrow \frac{x_{c,p}}{\sum_c x_{c,p}} > \frac{\sum_p x_{c,p}}{\sum_c \sum_p x_{c,p}}$, with $\frac{\sum_p x_{c,p}}{\sum_c \sum_p x_{c,p}}$ being the constant used to draw the line in the figure. Hence, products that lie above that line have a comparative advantage and products below the line have not.

Figure 19: The relationship between the neighbourhood densityin a product and world market share in that product, observed density (left) and centred (right)

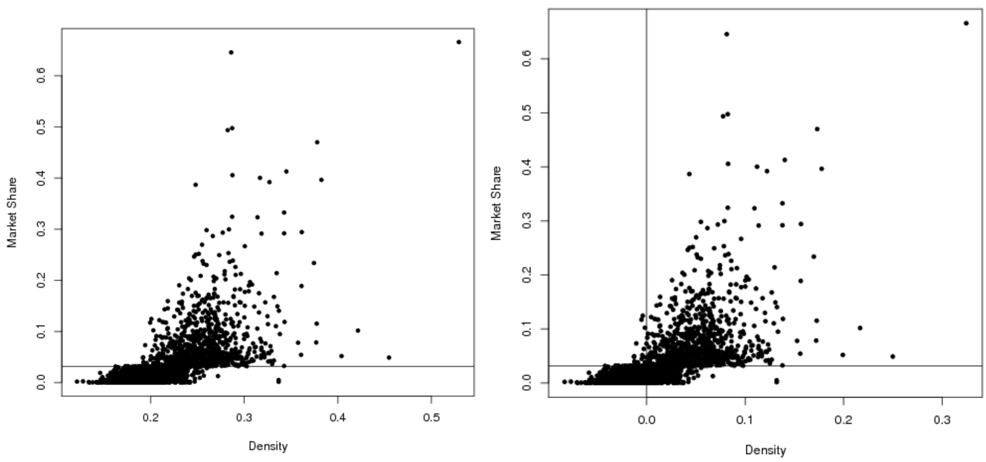
USA 2010



Japan 2010



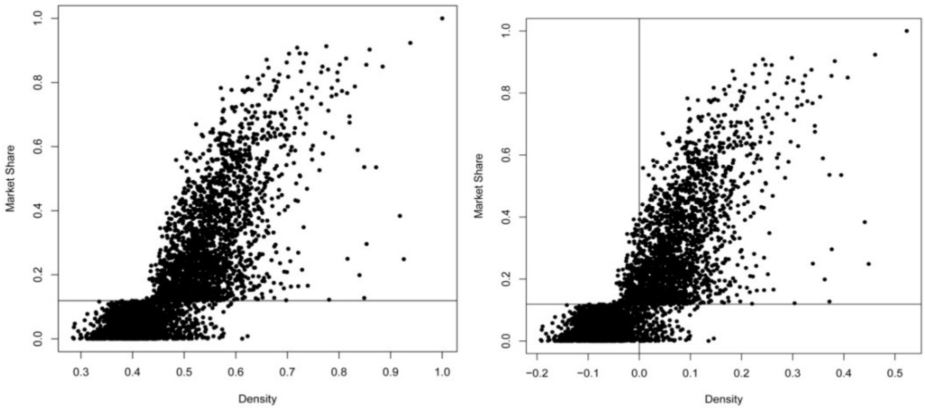
South Korea 2010



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010); Figure left shows measured neigbourhood density, figure right shows density centred around average country density.

Figure 19 continued

China 2010



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Figure left shows measured neighbourhood density, figure right shows density centred around average country density.

A final implication from the relationship shown in the figures is that the more products in the neighbourhood of a product an economy produces the higher is the world market share it captures for this product. This highlights the importance to develop unique specialisations or more complex products (in terms of their complexity score). However, these have to develop out of the existing competence base. This suggests that the diversification out of an existing product base into exclusive products relying on an exclusive knowledge base is likely to be an important driver of the development of comparative advantage and international competitiveness.

Table 9 provides further evidence on the importance of the neighbourhood density for the competitiveness; this time relying on sector data. The econometric setup and the data of the regressions are the same as the one described in Section 4.4. The dependent variables are again the world market share of the sector, the growth of the world market share, as well as employment, value added and gross output growth averaged over a five year period. The lagged neighbourhood density has a high and significant relationship with world market shares. A change in the neighbourhood density from the country mean by about 0.01 is associated with an increase in the average world market share in the subsequent five years of close to 15 percentage points. The rate of change of the neighbourhood density is instead significantly related to employment, value added and gross output growth. A 1% increase of the rate of change of the neighbourhood density affects the average employment growth in the following five years by 0.8%, value added growth by 0.88% and gross output growth by 0.99%.

Table 9: Neighbourhood density and economic performance at the sector level, 25 EU countries

VARIABLES	(1) world market share	(2) Δ world market share	(3) Δ employment	(4) ΔVA	(5) Δ GO
Value added VA (t-1)				0.00*	
				(1.663)	
Gross output GO (t-1)					0.00**
					(2.197)
neighbourhood density (t-1)	14.78***	-1.25	-0.30	-0.10	-0.13
	(6.893)	(-0.260)	(-1.413)	(-0.197)	(-0.392)
Δ neighbourhood density (t-1)	0.34	-5.84	0.80***	0.88**	0.99***
	(0.213)	(-1.645)	(5.171)	(2.467)	(4.245)
Constant	-1.88***	-0.68	0.15***	0.15	0.16**
	(0.00)	(0.57)	(0.00)	(0.22)	(0.04)
Observations	500	500	500	500	500
R-squared	0.375	0.065	0.156	0.183	0.301

pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010) EUKLEMS and BACI data. Pooled OLS. Country dummies not reported. The symbol Δ stands for growth rate over a five year period.

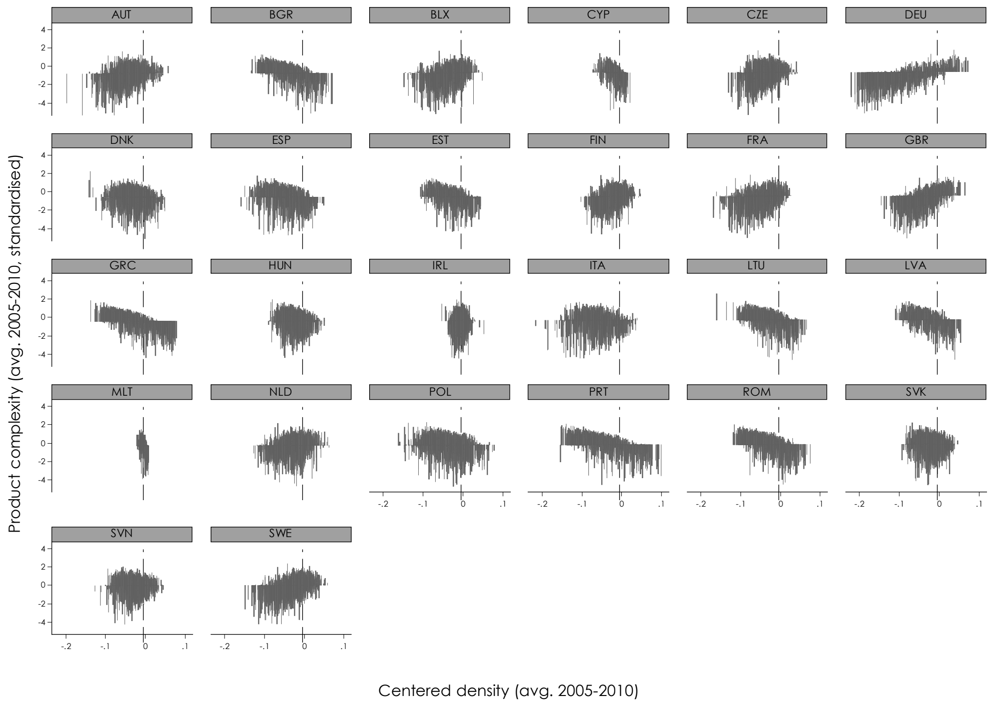
5.4 Product neighbourhood and opportunity in trade

The fact that the neighbourhood density of products in a country is a strong predictor for the development of a comparative advantage can be used to explore opportunities and pathways for upgrading the product mix of countries. Figure 18 shows that there are many products that have a neighbourhood density that is close to the area where for many products a transition to a comparative advantage takes place but that have not yet made that transition. This set of products presents on the one hand an opportunity if these are products with a high competitive potential, but it may also contain non-competitive products.

In this section we will examine this set of products and try to characterise it for the EU Member States and manufacturing sectors. The aim is not to develop guidelines with regard to which types of products should be supported by policy action. The reasons for products not having captured large world market shares may be manifold and in order to derive concrete policy guidelines each product should be examined separately for each sector and country, which is beyond the scope of this study. We will however try to establish how opportunity in trade is distributed across countries and sectors.

We identify two types of sets: an opportunity set that combines all products that will strengthen the competitiveness of the EU countries, and a non-competitive set that combines products that may be considered not to be competitive given the economic characteristics of each member state. We will limit our analysis to products with an RCA<0.5. This cut-off point is arbitrary. However, it has been chosen in order to identify products that are still far away from developing a comparative advantage. We have carried out a sensitivity analysis using the alternative cut-off point RCA<1 and the overall nature of the results presented here does not change. Figure 20 gives a first characterisation of the set of products with an RCA<0.5. It plots their (centred) neighbourhood density against the standardised product complexity score. Products with higher density close to or beyond the mean (vertical line) have a high probability of developing a comparative advantage. The picture clearly shows that the set of undeveloped products varies quite substantially across countries. While for some countries products with higher density seem also to be associated with higher product complexity (e.g. Austria AUT, Germany DEU, Great Britain GBR), for others the reverse is true (e.g. Bulgaria, BGR, Cyprus CYP, Greece, GRC) for other again no clear cut pattern is visible at first glance (e.g. Hungary HUN, Italy ITA, Slovak Republic SVK). This indicates that upgrading potentials in terms of more complex products are unevenly distributed across countries.

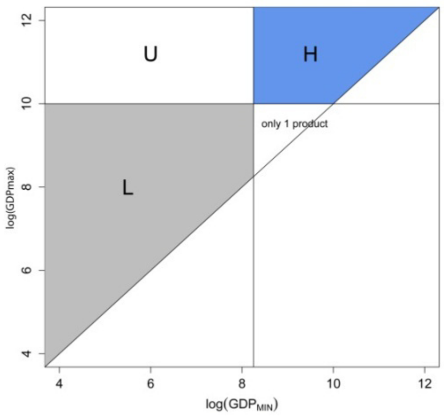
Figure 20: Characterisation of products where EU Member States are not significant exporters



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

The criteria by which we determine the opportunity set and the set of non-competitive products are based on theoretical considerations put forward by Sutton - Trefler (2011). These authors split the set of all traded products into subgroups based on the minimum and maximum GDP per capita of the countries producing these goods (see Figure 21). From this result three product categories: products only high income countries produce (H-products), products both high and low income countries produce (uninformative or U-products) and products only low income countries produce (L-products). They argue that low-income countries should upgrade their production by starting to produce U-products at the lowest quality level and then climb the quality ladder in these product categories to eventually start producing H goods. The implicit productivity (PRODY, see Box 1) of the products relevant for this upgrading process should lie above the average implicit productivity of the products they currently export. For high income countries this implies that they should strive to produce either U- or H-products with implicit productivity levels above the average implicit productivity of the products in their export basket. In terms of the product space this implies to move to products that are more central and that are more complex (see Box 4 for details). We adopt this criterion to identify the opportunity set. The non-competitive set encompasses instead all products that are either L-products or U- or H-products with an implicit productivity below the average of their export product mix.[13]

Figure 21: Sutton - Trefler (2011) subdivision of products



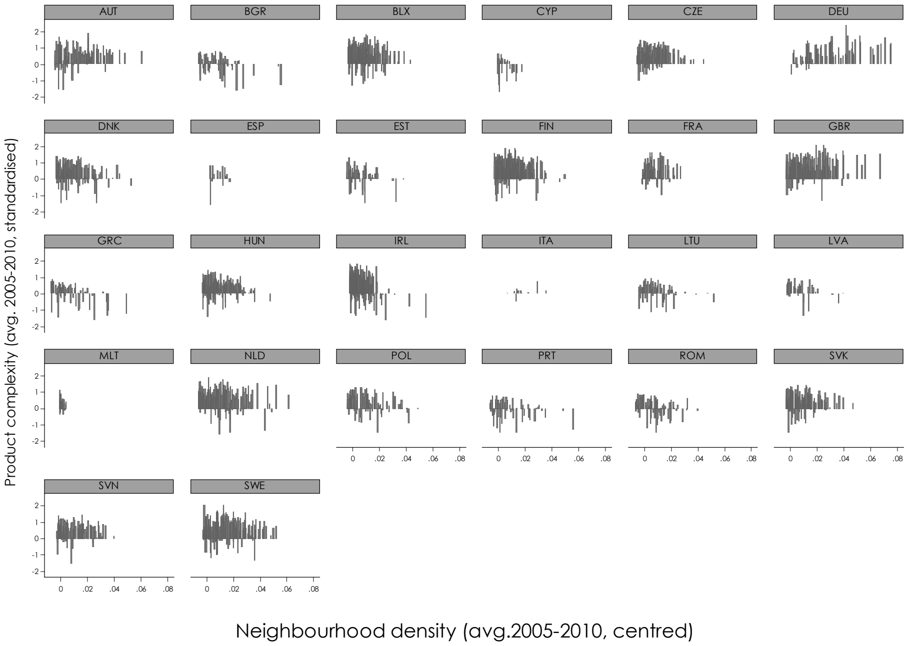
Source: WIFO representation based on Sutton - Trefler (2011);

The selection criterion for the opportunity and non-competitive sets are very restrictive due to the requirement that products should have an implicit productivity above the average implicit productivity of the country and high neighbourhood density. The resulting opportunity set is therefore very small (see Figure 34 trough Figure 41 starting on page 86 of the appendix). It also penalises more advanced economies that have already a product portfolio with high implicit productivity as it becomes increasingly difficult to produce exclusively in product classes that are produced only by countries with a similar or higher GDP per capita. The opportunity set should therefore not be understood to reflect competitiveness. It rather captures the unexploited opportunity for diversification of a country. The non-competitive set can instead be viewed as a measure for the competitiveness of a country or sector. It indicates whether and to what extent resources in an economy are allocated to non-competitive products.

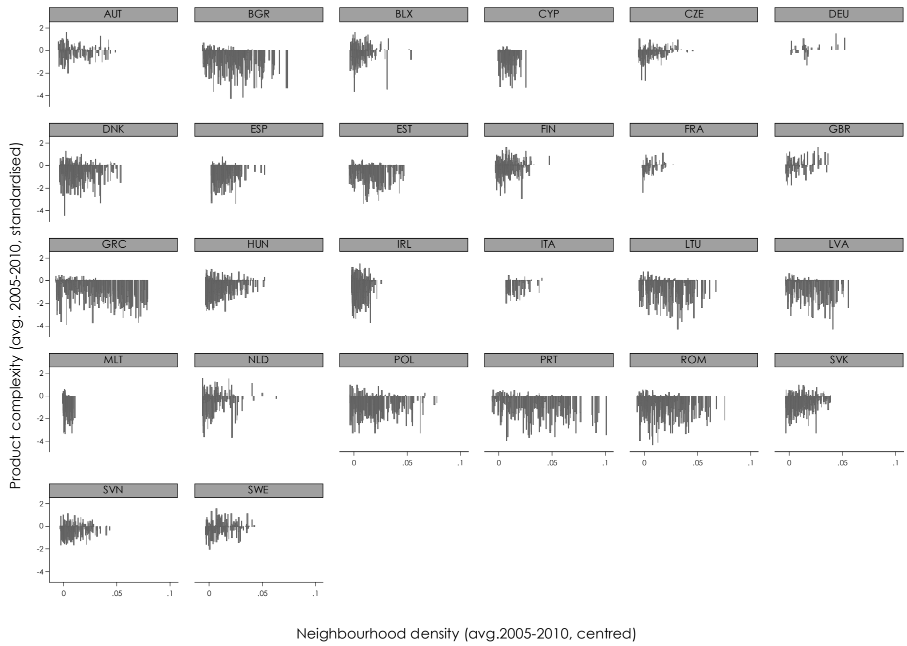
[13] We have carried out the analysis also following other selection criteria based on the work of Aiginger (1997, 1998). The results are presented in the appendix.

Figure 22: The opportunity and the non-competitive sets of products across EU Member States, Sutton - Trefler (2011) definition

Opportunity set



Non-competitive set

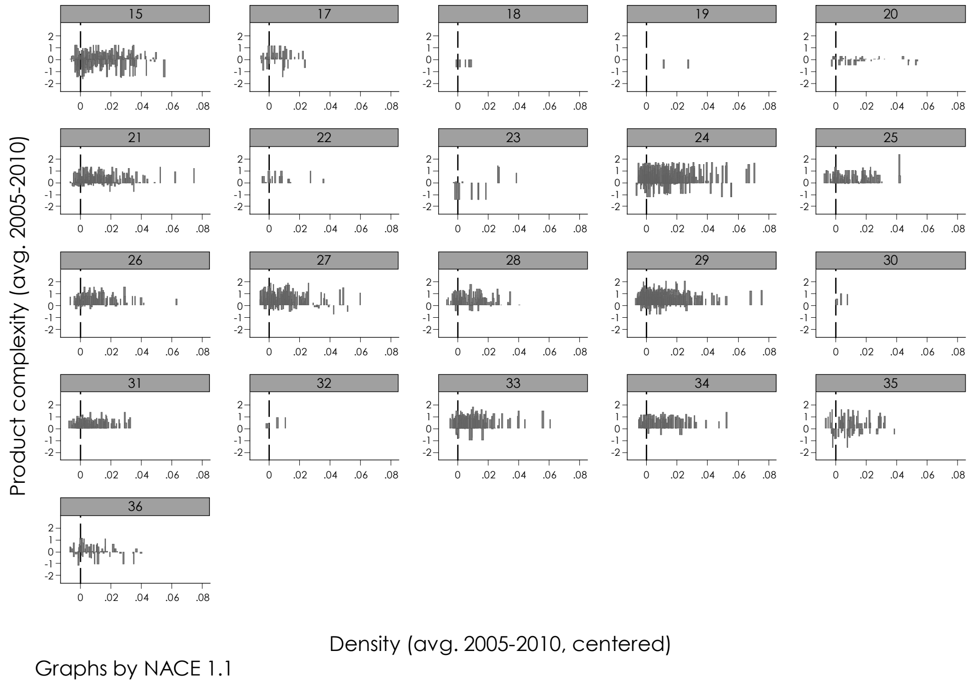


Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);

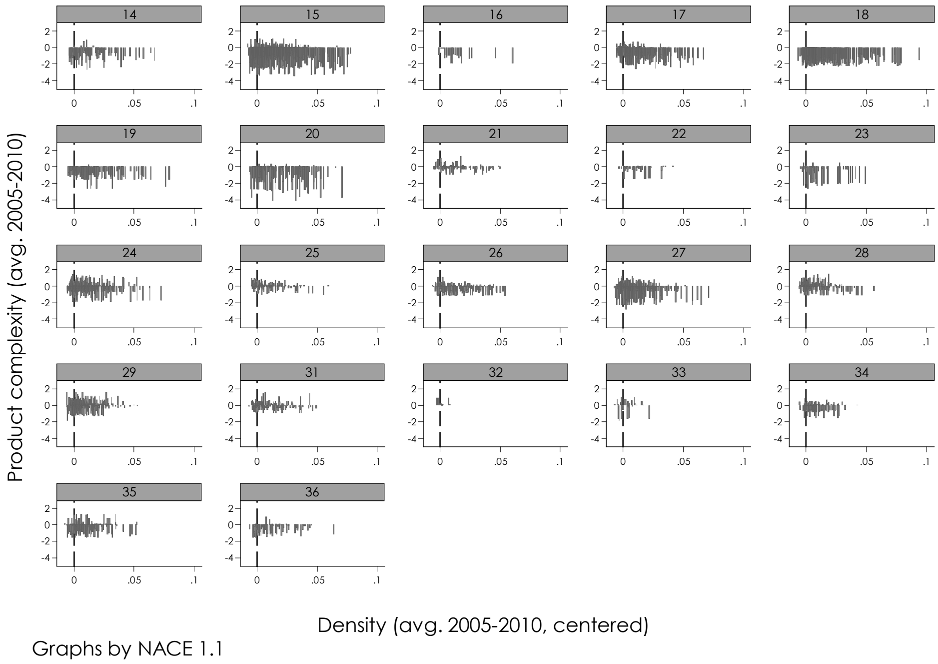
Note: Definition opportunity set: RCA <0.5; H-product and $PRODY_p$ > avg. $PRODY_c$ or uninformative product and $PRODY_p$ > avg. $PRODY_c$ (see Box 4 for definition of H and uninformative products; see Box 1 for definition of PRODY) Definition non-competitive set: . H-product and $PRODY_p$ < avg. $PRODY_c$ or uninformative product and $PRODY_p$ < avg. $PRODY_c$ or L-product.

Figure 23: The opportunity and the non-competitive sets of products across manufacturing and mining sectors in the EU, Sutton - Trefler (2011) *definition*

Opportunity set



Non-competitive set



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);

Note: Definition opportunity and non-competitive sets see Figure 22. Sectors covered: NACE 10-NACE 37. For NACE sectors missing in the figure (e.g. NACE 10-14, NACE 16 in the upper panel) the product set is empty.

Table 10: The opportunity set across EU 27 countries and manufacturing sectors: share of all products in the opportunity set

NACE 1.1	AUT	BGR	BLX	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GBR	GRC	HUN	IRL	ITA	LTU	LVA	MLT	NLD	POL	PRT	ROM	SVK	SVN	SWE	sector share	Total sector
15	7.7%	12.1%	6.7%	20.8%	7.5%	11.1%	7.5%	12.5%	6.7%	10.2%	7.0%	11.9%	16.9%	5.9%	4.7%	20.0%	9.6%	2.4%	2.9%	6.4%	8.5%	15.4%	16.3%	8.0%	8.9%	13.9%	8.8%	272
16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
17	2.6%	3.0%	0.0%	0.0%	2.5%	0.0%	2.7%	0.0%	3.3%	1.5%	0.0%	0.5%	3.1%	2.1%	1.3%	0.0%	2.7%	0.0%	0.0%	0.5%	2.1%	3.8%	8.1%	2.9%	3.0%	1.0%	1.8%	55
18	0.0%	1.5%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.6%	0.0%	0.0%	0.2%	5
19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.1%	2
20	0.0%	3.0%	2.1%	4.2%	1.9%	2.8%	2.7%	12.5%	0.0%	0.4%	4.2%	0.5%	6.2%	1.1%	0.8%	20.0%	0.0%	0.0%	0.0%	2.7%	1.1%	1.9%	0.0%	0.6%	0.0%	0.5%	1.4%	43
21	6.8%	7.6%	6.7%	8.3%	7.5%	16.7%	14.3%	0.0%	13.3%	1.5%	8.5%	9.7%	6.2%	8.0%	6.5%	10.0%	12.3%	7.1%	2.9%	6.9%	7.4%	1.9%	4.7%	6.9%	8.9%	1.4%	7.0%	216
22	0.0%	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	1.1%	0.8%	0.0%	0.0%	0.0%	2.9%	0.0%	0.0%	3.8%	2.3%	0.0%	1.0%	0.5%	0.5%	16
23	0.0%	1.5%	0.5%	0.0%	0.0%	0.0%	1.4%	0.0%	1.7%	0.4%	0.0%	0.5%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	2.1%	1.9%	0.0%	0.6%	0.0%	0.0%	0.4%	13
24	23.1%	13.6%	9.2%	12.5%	22.6%	37.5%	14.3%	12.5%	16.7%	10.9%	25.4%	24.9%	9.2%	12.8%	23.3%	10.0%	17.8%	21.4%	17.6%	22.3%	14.9%	11.5%	10.5%	12.6%	6.9%	26.9%	17.9%	552
25	2.6%	4.5%	1.5%	8.3%	1.3%	1.4%	3.4%	6.3%	6.7%	3.6%	1.4%	1.6%	3.1%	4.3%	4.1%	10.0%	6.8%	14.3%	11.8%	2.7%	0.0%	1.9%	8.1%	3.4%	3.0%	3.4%	3.5%	109
26	4.3%	9.1%	3.1%	0.0%	0.6%	1.4%	3.4%	6.3%	1.7%	4.7%	2.8%	2.7%	6.2%	4.8%	3.1%	10.0%	4.1%	0.0%	2.9%	4.8%	0.0%	3.8%	12.8%	5.7%	4.0%	3.4%	3.9%	119
27	6.8%	6.1%	6.7%	4.2%	13.8%	15.3%	8.2%	6.3%	13.3%	13.5%	1.4%	9.2%	4.6%	6.9%	7.0%	10.0%	13.7%	9.5%	5.9%	9.0%	9.6%	13.5%	4.7%	10.3%	11.9%	7.7%	9.0%	278
28	4.3%	9.1%	6.2%	20.8%	3.1%	0.0%	5.4%	6.3%	8.3%	6.6%	12.7%	2.2%	9.2%	8.0%	3.1%	0.0%	5.5%	7.1%	8.8%	2.7%	5.3%	3.8%	2.3%	4.6%	4.0%	2.4%	4.9%	152
29	23.1%	7.6%	29.2%	12.5%	23.3%	6.9%	12.9%	18.8%	20.0%	23.7%	22.5%	23.8%	16.9%	31.4%	24.3%	0.0%	12.3%	28.6%	23.5%	17.0%	29.8%	13.5%	18.6%	31.0%	27.7%	20.7%	22.5%	694
30	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	3
31	2.6%	3.0%	4.1%	0.0%	2.5%	0.0%	5.4%	0.0%	0.0%	3.3%	1.4%	1.6%	6.2%	4.3%	3.4%	0.0%	11.0%	7.1%	5.9%	5.3%	7.4%	3.8%	3.5%	5.7%	6.9%	3.4%	4.0%	122
32	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.1%	4
33	7.7%	1.5%	14.9%	4.2%	6.9%	0.0%	3.4%	12.5%	1.7%	7.3%	7.0%	2.7%	0.0%	1.6%	9.6%	0.0%	1.4%	2.4%	8.8%	6.4%	6.4%	0.0%	0.0%	1.1%	3.0%	5.3%	5.4%	168
34	5.1%	4.5%	4.6%	0.0%	2.5%	2.8%	8.8%	0.0%	0.0%	6.2%	2.8%	3.2%	1.5%	1.6%	3.6%	0.0%	2.7%	0.0%	0.0%	6.9%	1.1%	0.0%	0.0%	2.9%	5.9%	2.4%	3.6%	112
35	1.7%	1.5%	2.6%	0.0%	1.3%	2.8%	2.7%	0.0%	3.3%	2.9%	1.4%	4.3%	1.5%	2.1%	2.6%	0.0%	0.0%	0.0%	0.0%	4.8%	2.1%	3.8%	0.0%	1.1%	3.0%	4.3%	2.5%	77
36	0.9%	6.1%	2.1%	4.2%	1.9%	1.4%	2.7%	6.3%	1.7%	2.9%	1.4%	0.0%	6.2%	3.2%	1.8%	10.0%	0.0%	0.0%	5.9%	1.1%	2.1%	11.5%	8.1%	1.7%	2.0%	2.4%	2.5%	76
country share	3.8%	2.1%	6.3%	0.8%	5.1%	2.3%	4.8%	0.5%	1.9%	8.9%	2.3%	6.0%	2.1%	6.1%	12.5%	0.3%	2.4%	1.4%	1.1%	6.1%	3.0%	1.7%	2.8%	5.6%	3.3%	6.7%	100.0%	
Total country	117	66	195	24	159	72	147	16	60	274	71	185	65	188	387	10	73	42	34	188	94	52	86	174	101	208		3088

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 22 and Figure 23 present the opportunity and the non-competitive set for each EU Member State and across manufacturing and mining sectors in the EU (NACE 10- NACE37). Sectors for which the opportunity or non-competitive set are empty are not shown. As in Figure 20 we plot the neighbourhood density (as a predictor of potential transition to revealed comparative advantage) and the product complexity score against each other. The data show that the opportunity set contains mostly products with higher complexity scores, whereas the non-competitive set contains products with low complexity scores. Products in the opportunity set and in the non-competitive set are also unevenly distributed across countries and manufacturing sectors.

Looking at Figure 22 first, the data show that products representing opportunity are more frequent in some countries whereas non-competitive products are more concentrated in others.[14] Austria (AUT), Germany (DEU), Finland (FIN), the UK (GBR) or Sweden (SWE) are among the countries with not only large opportunity sets, but also with opportunity sets in which the products have on average high complexity scores. The countries with large sets of non-competitive products are among others Bulgaria (BGR), Greece (GRC), Lithuania (LTU), Latvia (LVA), Poland (POL), Portugal (PRT) or Romania (ROM). The number of non-competitive products is a potential indicator of the need for structural adjustment of a country's productive structures. For a few countries such as Italy (ITA) or Spain (ESP) and to a lesser extent with regard to the size of the opportunity set France (FRA) the number of non-competitive products is relatively small, but also the size of the opportunity set is rather limited. While it should be kept in mind that the data do not display the potential to improve competitiveness by moving to higher quality ranges in existing and potentially not so complex products they show that challenges for upgrading and improving competitiveness differ considerably across member states. While in some countries the problem is more to reap opportunity in others there is a clear need for structural adjustment as well as an upgrading and diversification into more competitive products.

The opportunity set reflects unexploited opportunities in the EU countries. It is not a measure for the competitiveness of a country. Smaller opportunity sets may also imply that the related countries are very efficient in exploiting opportunity. Figure 32 on page 85 in the appendix shows the distribution of complexity scores for the products in which EU countries have a comparative advantage (RCA>1). This figure is complementary to the opportunity and the non-competitive sets. It shows that several countries that have very large non-competitive sets also the distribution of complexity scores for the products in which they have a comparative advantage is skewed towards low complexity scores (e.g. Greece, Portugal, Romania, Bulgaria or to a lesser extent Poland). This may point towards the need for structural adjustments in the medium run. Countries with relatively small non-competitive sets instead tend to have a comparative advantage mostly in product classes with higher complexity scores (e.g. Germany, Czech Republic, United Kingdom, France, Austria).

[14] Statistical indicators reported in Table 18 on page 77 in the appendix underpin the visual impression from Figure 22.

Figure 23 shows that opportunity is unevenly distributed across sectors. This is a well-known fact from the literature on technological regimes (cf. Malerba - Orsenigo, 1993, 1995). Across the EU 27 the sectors with the largest opportunity sets are the chemical sector (NACE 24), the manufacture of basic metals (NACE 27), the machinery and equipment sector (NACE 29), the manufacture of electrical apparatus (NACE 31), the production of medical, precision and optical instruments (NACE 33), the manufacture of vehicles and transportation equipment (NACE 34 and 35).[15] Surprisingly, also the food sector (NACE 15) has a larger opportunity set, however, unlike most other sectors with larger opportunity sets here most products score low on the complexity scale. The food sector is also one of the sectors with the largest non-competitive set of products. Other sectors with large non-competitive sets are the textile and apparel sectors (NACE 17 and 18), the manufacture of wood products (NACE 20) or the basic metals sector (NACE 27). A few sectors such as publishing and printing sector (NACE 22), or the electrical equipment, the production of medical, precision and optical instruments and the manufacture of vehicles (NACE 32, 33, and 34 respectively) have very small sets of non-competitive products. A particular case is the electrical equipment sector (NACE 32) that has neither a large opportunity set, nor a large non-competitive set.

These pure counts are only indicative for the competitive potential of sectors. Many other aspects influencing the composition of these sets are not considered here (e.g. tradability, within upgrading). Figure 33 trough Figure 37 in the appendix (from page 85 onwards) provide again a complementary view on the opportunity and non-competitive sets for the NACE sectors. Figure 33 shows the distribution of complexity scores for the products in which EU sectors have a comparative advantage, whereas Figures 34 through 37 (page 86 onwards) show the share of products that are exported with comparative advantage in each sector in the EU, but also in the US and China. This additional evidence confirms country level results: The sectors with small non-competitive sets are also the sectors which turn out to have the highest share in products exported with RCA>1 (e.g. NACE 21, 22, 29, 31, 34, 35). Other sectors again have large opportunity and non-competitive sets (e.g. NACE 24, 25, 27, 28, 29). These sectors are competitive but they also have a potential for upgrading and structural readjustment. Sectors with little opportunity, a small share of products exported with comparative advantage and large non-competitive sets are under increasing competitive pressure and are likely to experience further decline (e.g. NACE 15, 18, 19, 20).

The analysis reveals the competitive weakness of the EU in some high tech industries such as the manufacture of office machinery and computers (NACE 30) and radio, television and telecommunication equipment (NACE 32) where the opportunity and the non-competitive sets are small (or empty) and the share of products traded with comparative advantage is also small. There is more opportunity in the optical, medical, and precision instruments sector (NACE 36). However, the share of products traded with comparative advantage lies below the cross sector average. For the manufacture of other transportation equipment (NACE 35)

[15] Test statistics for data shown from Figure 23 are reported in Table 19 on page 79 in the appendix.

that comprises also the high-tech aircraft industry and the chemical sector (NACE 24) that comprises the high-tech pharmaceutical industry we obtain a mixed picture: there is the potential and need for upgrading and restructuring, but the share of products traded with comparative advantage is high relative to the mining and manufacturing sector taken as a whole. Competitive strengths and opportunity across the EU is highest clearly in sectors typically classified as medium-high and medium-low tech.

Table 10 finally breaks down the results to the country-sector dimension for the EU 27 countries. The table shows that –based on a pure count of the competitive sets – the countries with the largest opportunity sets are Ireland, Finland, Sweden, Belgium and Luxemburg, the Netherlands, and the UK. The sectors with the largest opportunity sets are instead the chemical industry and the machinery and equipment sector. These are also sectors in which across countries the EU has a large share of products in which it is a significant exporter (see Figure 36 page 87 in the appendix).

From the analysis of the distribution of opportunity across countries and Member States results the need to consider potential pathways for industrial upgrading and restructuring away from sectors with low potential towards sectors with higher potential. Given that any upgrading is highly dependent on existing capabilities it is necessary to examine the relationship between sectors and the related capabilities for each country and sector. Such a detailed analysis is beyond the scope of this study. However, by evaluating the proximity relationships that exist at the product level it is possible to get a general picture on how manufacturing sectors are in general related to each other.

Table 11: Pathways for upgrading: proximity between manufacturing sectors

NACE	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
15	0.17	0.17	0.13	0.14	0.13	0.14	0.16	0.15	0.12	0.13	0.16	0.15	0.13	0.14	0.14	0.09	0.14	0.09	0.11	0.16	0.12	0.11
16	0.15	0.45	0.13	0.20	0.16	0.14	0.15	0.17	0.13	0.13	0.17	0.16	0.14	0.14	0.13	0.10	0.15	0.10	0.11	0.14	0.12	0.11
17	0.11	0.13	0.24	0.20	0.19	0.16	0.13	0.06	0.08	0.16	0.18	0.18	0.14	0.19	0.16	0.13	0.17	0.15	0.13	0.14	0.13	0.17
18	0.23		0.25	0.36	0.28	0.17	0.13	0.07	0.04	0.09	0.15	0.17	0.11	0.16	0.13	0.10	0.17	0.12	0.10	0.12	0.12	0.16
19	0.16		0.18	0.20	0.25	0.12	0.11	0.13	0.07	0.12	0.16	0.16	0.12	0.16	0.14	0.11	0.17	0.13	0.11	0.13	0.13	0.16
20	0.13		0.13	0.16	0.16	0.21	0.15	0.15	0.09	0.10	0.15	0.15	0.12	0.15	0.14	0.08	0.15	0.10	0.10	0.15	0.12	0.11
21	0.13		0.13	0.12	0.13	0.24	0.23	0.18	0.22	0.14	0.19	0.18	0.17	0.18	0.19	0.11	0.18	0.12	0.15	0.20	0.15	0.13
22	0.16		0.17	0.19	0.19	0.25	0.25	0.26	0.14	0.15	0.20	0.20	0.17	0.21	0.20	0.14	0.20	0.14	0.16	0.18	0.16	0.16
23	0.11		0.10	0.09	0.09	0.10	0.12	0.12	0.23	0.11	0.13	0.13	0.13	0.11	0.12	0.08	0.12	0.08	0.10	0.14	0.11	0.08
24	0.11	0.18	0.13	0.09	0.10	0.10	0.16	0.15	0.17	0.18	0.17	0.16	0.16	0.17	0.17	0.14	0.16	0.14	0.17	0.16	0.14	0.13
25	0.12		0.18	0.17	0.16	0.16	0.20	0.20	0.15	0.17	0.25	0.22	0.18	0.22	0.22	0.14	0.22	0.16	0.17	0.23	0.17	0.16
26	0.16		0.15	0.16	0.15	0.16	0.18	0.13	0.15	0.13	0.21	0.22	0.17	0.21	0.20	0.13	0.21	0.15	0.16	0.21	0.16	0.16
27	0.16		0.14	0.15	0.11	0.17	0.18	0.09	0.17	0.13	0.20	0.18	0.18	0.18	0.19	0.12	0.17	0.13	0.15	0.18	0.15	0.13
28			0.18		0.16	0.22		0.09	0.15	0.11	0.27	0.24	0.16	0.24	0.22	0.16	0.22	0.17	0.18	0.21	0.17	0.18
29			0.16	0.11	0.13	0.21		0.08	0.12	0.11	0.29	0.23	0.15	0.22	0.24	0.14	0.22	0.16	0.20	0.22	0.18	0.17
30			0.12		0.16	0.09		0.05		0.17	0.14	0.14		0.19	0.17	0.25	0.17	0.24	0.19	0.12	0.13	0.17
31			0.19		0.15	0.22		0.04		0.13	0.27	0.24		0.22	0.20	0.11	0.25	0.20	0.20	0.22	0.18	0.18
32			0.13		0.19	0.10		0.08		0.17	0.15	0.16		0.22	0.12	0.19	0.19	0.30	0.21	0.12	0.13	0.19
33			0.11		0.17	0.13		0.16		0.15	0.20	0.13		0.20	0.18	0.17	0.19	0.21	0.24	0.24	0.20	0.17
34			0.17		0.08	0.25		0.09		0.13	0.32	0.24		0.16	0.22	0.09	0.20	0.15	0.15	0.30	0.16	0.14
35			0.14		0.12	0.17		0.10		0.11	0.22	0.18		0.18	0.15	0.10	0.15	0.15	0.15	0.19	0.18	0.14
36	0.11		0.16	0.13	0.14	0.13	0.14	0.12	0.08	0.15	0.20	0.13	0.11	0.15	0.13	0.14	0.15	0.15	0.15	0.11	0.12	0.18

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)
Note: The numerical values in the matrix represent the average minimum conditional probability of sector i (row) developing a comparative advantage in its products, given that sector *j* (column) develops a comparative advantage in its products to which sector *i* is related. White areas: Not related.

Table 11 presents the average proximity between manufacturing sectors. The figures in the table are the average conditional probability of a sector developing a comparative advantage in any of its products given that another sector develops a comparative advantage in its own products. Hence, high figures in Table 11 indicate high relatedness between two sectors. As can be seen from the high scores in the diagonal of the matrix it is apparent that products in most sectors are close to other products in a sector. However, some sectors are closely related to others as well. For instance, across all countries and products there exists a close relationship between the fabricated metals sector (NACE 28, row) and the plastic and rubber sector (NACE 24, column) or the manufacture of machinery and equipment (NACE 29, column). Taking this as a starting point detailed analyses for a country could work out whether such relationships exist, for which products and to what extent and under what conditions a restructuring from the fabricated metals sector to the machinery and equipment sector is possible.

5.5 Summary

The results in this chapter have shown that changes in the revealed comparative advantage of nations are governed by the pattern of relatedness of products at the global level. As countries change their export mix, there is a strong tendency to move towards related goods rather than to goods that are farther away. Because of this it is very difficult for countries to make considerable advances to more sophisticated product baskets in short time. There is a considerable amount of path dependence in the productive structures of countries.

The results in this chapter also show that the development of a comparative advantage is strongly determined by its country specific neighbourhood density. This is an indicator that captures the presence or absence of specific capabilities in a country. It can be interpreted as the degree of factor substitutability between a single product and the other products a country successfully exports. The results show that once the neighbourhood density passes some threshold the product will develop a comparative advantage and capture significant world market shares. It is therefore a strong predictor of future success in the world markets. This feature can be used to explore opportunities and pathways for upgrading the product mix of countries. This has also important policy implications that will then be discussed at the end of this report.

Taking into account that the upgrading of the productive structures of a country is equivalent to a move towards more central parts of the product space and to products with a higher complexity score as well as higher value (in terms or their implicit productivity) the neighbourhood density can be used to identify products that have a high competitive potential but in which comparative advantage has not yet been achieved. The results of this exercise show that the challenges for upgrading and improving competitiveness differ considerably across member states and sectors. While in some countries the problem is more to reap opportunity in others there is a clear need for structural adjustment as well as an upgrading and diversification into more competitive products. Some sectors instead show little opportunity and large non-competitive sets. These are likely to experience further decline. Some other sectors seem to have a potential for upgrading and structural readjustment, whereas others again have very strong prospects in terms of their opportunities.

6 The relationship between product space indicators and indicators for national capability and institutional framework conditions

An important assumption underlying all product space metrics is that they capture complementary and non-tradable inputs to which Hidalgo - Hausmann (2009) refer as "capabilities". They conceive of these capabilities broadly. In their view they encompass property rights, regulation, infrastructure, specific labour skills and other important determinants of national capability. In this section we will briefly explore this proposition in order to develop a better understanding of the indicators used throughout this report. We will explore to which indicators capturing important aspects of national capability the measures of economic complexity, centrality and neighbourhood density are related.

A problem in this type of analysis is that it is well known that many macroeconomic indicators capturing different aspects of capabilities such as institutional variables, R&D and educational variables are highly correlated. For this reason simple regression analysis cannot be used to uncover the relationship between these indicators and the product space indicators directly. Thus, we perform a principal component analysis in order to construct new summary variables that capture and summarise different aspects of national capabilities. The set of variables we use in our analysis are given in Table 12 below. Apart from the economic complexity score the centrality and neighbourhood density have been aggregated up from the product level using the share of the export value for each product in the total value of exports as weight.

Table 12: Variable list for analysing the relationship between product space indicators and indicators of national capabilities

Variable list	Source
Gov ernment Effectiv eness	World Bank
Regulatory quality	World Bank
Rule of Law	World Bank
R&D intensity	World Bank
Researcher intensity	World Bank
Education Expenditures as % of GNI	World Bank
labour force with secondary education (% of total labour force)	World Bank
labour force with tertiary education (% of total labour force)	World Bank
FDI flows in % of GDP	World Bank
Employment in industry (% of total employment)	World Bank
Trade in serv ices (% of GDP)	World Bank

Table 13 presents the results of the principal component analysis. It leads to the identification of four distinct principal components. The first component explains most of the variation in the capability data.

Table 13: Principal components capturing important characteristics of national capability

	Factor loadings					Correlation			
VARIABLE	PC1	PC2	PC3	PC4	Unexplained	PC1	PC2	PC3	PC4
Government Effectiveness	0.43	0.06	-0.07	-0.23	0.05	0.97	0.08	0.13	0.47
Regulatory quality	0.40	0.19	-0.03	-0.21	0.11	0.91	0.24	0.20	0.39
Rule of Law	0.42	0.06	-0.05	-0.31	0.05	0.96	0.06	0.15	0.40
R&D intensity	0.38	-0.25	0.02	0.02	0.20	0.81	-0.32	0.19	0.61
Researcher intensity	0.40	-0.19	0.00	0.18	0.12	0.85	-0.23	0.21	0.74
Education Expenditures as % of GNI	0.30	0.02	0.00	-0.04	0.56	0.66	0.02	0.17	0.40
labour force with secondary education (% of total labour force)	0.14	0.07	0.66	0.15	0.22	0.26	-0.02	0.88	0.11
labour force with tertiary education (% of total labour force)	0.25	-0.12	-0.20	0.82	0.08	0.45	-0.03	-0.03	0.95
FDI flows in % of GDP	0.04	0.63	-0.04	0.28	0.24	0.06	0.85	0.12	0.06
Employment in industry (% of total employment)	0.03	0.14	0.70	0.06	0.22	0.03	0.05	0.87	-0.13
Trade in services (% of GDP)	0.05	0.65	-0.19	0.03	0.20	0.14	0.88	-0.07	-0.04

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010), World Bank data.

The four components have a quite clear interpretation:

1. Principal component 1 (PC 1) is a stage of development indicator that combines institutional quality with high knowledge intensity. The factor loadings and the correlation analysis in Table 13 show that it is highly correlated with quality of governance indicators, R&D intensity and education expentitures as % of GNI.
2. Principal component 2 (PC 2) is an indicator of FDI flows and trade in services and captures most likely lower order temporal effects. FDI flows can be quite volatile, the low correlation with quality of governance indicators suggests that PC 2 is not as strongly related to the institutional quality of countries, as is often emphasized in the FDI literature.
3. Principal compontent 3 (PC 3) captures the industrial base (share of labour force with secondary education in total labour force and employment share in industry). The trade data we consider concern primarily manufacturing products. This suggests that the manufacturing base of a country could be an important capability explaining the level and performance of our indicators derived from the trade data (economic complexity scores, neighbourhood density and centrality).
4. Principal compenent 4 (PC 4) captures again competencies. This factor is highly correlated with tertiary education, but also with quality of governance indicators. The difference to PC 1 is primarily its focus on tertiary education (share labour force with tertiary education in total labour force).

We use these four principal components to assess the claim whether our indicators derived from the network analysis of trade data are related to capabilities. We use the identified principal components in OLS regressions as explanatory variables. In order to provide a "more causal" interpretation, we used lagged values. However, given the persistent nature of most capability variables, this temporal structure is not enough to confirm causality.

The results of this analysis are presented in Table 14. For each of the three indicators economic complexity, neighbourhood density and centrality we present 5 regressions. In four of the regressions we use just one of the principal components as explanatory variables. In the fifth regression we use then all four principal components (PC 1 to PC 4) at the same time. The results clearly confirm that the economic complexity of countries, the average neighbourhood density and the average centrality of the products they export are closely related to competencies and capabilities of countries. The highest share of the variation of the data is explained for the economic complexity score followed by the centrality and density measures, respectively.

Table 14: The relationship between aggregate product space indicators and national capability

VARIABLES	(1) n. density	(2) n. density	(3) n. density	(4) n. density	(5) n. density	(6) complexity score	(7) complexity score	(8) complexity score	(9) complexity score	(10) complexity score	(11) centrality	(12) centrality	(13) centrality	(14) centrality	(15) centrality
PC1 (t-1)	0.01***				0.02***	0.17***				0.14***	0.00***				0.00***
	(2.763)				(3.360)	(11.280)				(9.488)	(2.715)				(3.466)
PC2 (t-1)		-0.02***			-0.02***		-0.06*			-0.06***		0.00			-0.00
		(-3.227)			(-3.863)		(-1.910)			(-3.289)		(0.407)			(-0.076)
PC3 (t-1)			0.03***		0.02***			0.23***		0.18***			0.01***		0.01***
			(3.938)		(3.445)			(8.029)		(8.864)			(7.818)		(7.295)
PC4 (t-1)				-0.00	-0.02**				0.19***	0.04				-0.00	-0.01***
				(-0.397)	(-2.561)				(5.439)	(1.340)				(-1.652)	(-3.697)
Constant	0.27***	0.27***	0.27***	0.27***	0.27***	0.99***	0.99***	0.99***	0.99***	0.99***	0.14***	0.14***	0.14***	0.14***	0.14***
	(31.896)	(32.153)	(32.619)	(31.193)	(34.680)	(31.579)	(23.959)	(27.969)	(25.745)	(39.136)	(84.207)	(82.417)	(96.512)	(83.059)	(100.511)
Observations	166	166	166	166	166	166	166	166	166	166	166	166	166	166	166
R-squared	0.044	0.060	0.086	0.001	0.207	0.437	0.022	0.282	0.153	0.640	0.043	0.001	0.271	0.016	0.341

pval in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010), World Bank data.

Principal component 1 (PC 1) has an impact on all three indicators but explains most of the variation only for the economic complexity score of a country. Neighbourhood density and centrality, in contrast, are related to PC 3 (industrial base). Interestingly PC 2 has a statistically significant negative effect on the average neighbourhood density of a country and the economic complexity score, but not on centrality. However, this result should not be over interpreted, as we use flow data. PC 4 (tertiary education) has a weak positive impact on the economic complexity score and a weak negative impact on centrality.

Overall the regression results confirm that the product space indicators are related to capabilities and competencies at the national level. However, the analysis also clearly shows that the three indicators differ in important dimensions. The economic complexity score is closely related to the institutional quality of countries, while centrality is related to the industrial base of countries. The neighbourhood density is also most closely related to the industrial base. However, it is generally not so well explained by institutional factors. Our other results suggest that it is more closely related to the diversification of countries and their extensive margin.

After having established that the product space indicators are at least partly related to capabilities and competencies of countries, let us next analyse the implications of the regressions on growth. For this purpose let us consider simple regressions that are able to gauge the impact of the economic complexity score, average neighbourhood density and centrality on

1. The growth rate (Δ) of real GDP per capita,
2. the growth rate (Δ) of exports, and

3. the change (D) in the current account.

As explanatory variables we use the lagged levels of the network indicators and lagged growth rates, respectively. The regressions are estimated using OLS. The use of both lagged levels and lagged growth rates should provide information on the relative importance of between effects (levels) and within effects (growth rates). In order to account for catch-up effects we include also the GDP per capita level in 1995 as control variable, as suggested by the empirical literature on economic growth. Using lagged levels and lagged growth rates provides a more robust analysis than simple contemporaneous correlation. Nevertheless, the analysis should be considered as exploratory. The results of this analysis are in Table 14.

Table 15: Aggregate measures for economic performance and the product space indicators

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Δ GDP	Δ GDP	Δ GDP	Δ Exports	Δ Exports	Δ Exports	D current account	D current account	D current account
GDP level 1995	-0.00***	-0.00***	-0.00***	-0.00*	-0.00	0.00	0.00	0.00	0.00
	(-7.607)	(-6.692)	(-6.596)	(-1.653)	(-1.064)	(0.105)	(0.178)	(0.909)	(1.577)
Complexity score (t-1)	0.04***			0.03			0.38		
	(5.352)			(1.384)			(0.981)		
Δ complexity score (t-1)	-0.02			0.12			-1.67		
	(-0.756)			(1.600)			(-1.052)		
Neighbourhood density (t-1)		0.19***			0.06			0.12	
		(3.895)			(0.547)			(0.047)	
Δ neighbourhood density (t-		-0.05			0.06			-0.17	
		(-1.534)			(0.703)			(-0.095)	
Centrality (t-1)			0.57***			-0.32			-12.76
			(3.070)			(-0.689)			(-1.290)
Δ centrality (t-1)			-0.29***			1.00***			4.82
			(-4.039)			(5.762)			(1.294)
Constant	0.22***	0.18***	0.15***	0.07***	0.05**	0.07	-0.45	-0.61	0.62
	(28.295)	(20.918)	(7.465)	(3.511)	(2.121)	(1.273)	(-1.089)	(-1.274)	(0.564)
Observations	510	510	510	452	452	452	452	452	452
R-squared	0.105	0.085	0.093	0.014	0.004	0.071	0.006	0.002	0.009

pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010), World Bank data.

Let us consider the growth regressions first. The GDP per capita level in 1995 has a negative impact on the growth rates, indicating that catch-up takes place, which is independent of the product space indicators considered. The level of the product space indicators has a positive impact on the growth rate of GDP per capita. This suggests that countries with a higher economic complexity score or neighbourhood density have a higher growth rate in GDP per capita. For centrality the evidence is similar, with the important distinction that here the rate of change of centrality has a statistically significant effect. This echoes sector level results. For export growth, we find that only the growth rate of centrality has a statistically significant impact, this time positive. For changes in the current account we do not find any statistically significant impact of the trade network indicators. This last result should not surprise, as current account surpluses or deficits are also related in changes in the exchange rate and other macroeconomic variables.

7 Summary and policy implications

This study has examined the development of the productive structures of the EU and its Member States by drawing on recent developments in the analysis of economic complexity and international trade patterns. It provides evidence that the sophistication of the productive structure of an economy is intrinsically related to its economic performance. Indeed, the product mix a country exports reflects the technological and organisational capabilities as well as skills that are available in that country. If competitors from low wage countries build up capabilities and move into products already produced by firms in high wage countries these have to move further up the quality ladder and diversify into more complex and sophisticated products. This implies that new capabilities have to be built up. The higher up a country therefore is in the income ladder the more important investment into R&D and other innovation activities becomes for the generation of higher-quality, lower-cost products than those previously available at prevailing factor prices (see Sutton - Trefler, 2011; Reinstaller - Unterlass, 2012). This gives producers in these countries a competitive edge over low wage competitors and increases also the entry barriers into their markets.

This study takes a closer look at this process by drawing on recent developments in the analysis of economic complexity and international trade patterns. The "product space" literature conceives of globally traded products either as i) a network linking successful exporters to products or as ii) a network of related products, where two products are considered to be related if countries are likely to develop a revealed comparative advantage in both (see Hidalgo - Hausmann, 2009, Hidalgo et al., 2007). The analysis of these networks reveals unobserved information on the capabilities of countries, the characteristics of products and the structure of the economies. This information has been examined in this study for the EU, its Member States and important competitors. As the product space approach relies on international trade data the results mostly refer to the manufacturing sector. Given the renewed importance the European Commission attaches to this sector, the results of this study are therefore relevant for the unfolding debates about reindustrialisation (European Commission, 2012) and smart specialisation (European Commission, 2010b).

One summary indicator derived from the analysis of the network linking products to successful exporters is the complexity score. It reflects the breadth of the competence base of a country insofar as it captures the diversification of its economy: More complex economies are more diversified and can therefore draw on and combine a higher number of different capabilities into the commodities they produce. The complexity score reflects also the depth of the knowledge base of a country, insofar as it captures its capability to produce exclusive products for which more thorough knowledge of markets and technologies is necessary. Hence, more complex economies are therefore also more likely to be competitive. The assessment of Europe's economies on the basis of this indicator shows that there is a considerable dispersion in this indicator across Member States. While some countries figure among the most complex economies worldwide (e.g. Germany, Sweden or Finland), others have upgraded their productive structures and are in the process of catching up to the most advanced economies inside the EU (several of the eastern European Member States). For other countries again (e.g. Greece, Portugal or Romania) a stasis in the development of their productive structures is evident for the observed period. In these countries structural renewal in terms of a deepening and broadening of their knowledge base but also Industrial restructuring seem to be necessary.

Sector level results show that the average complexity of product categories in which European firms are significant exporters are high in international comparison. As regards product categories with low complexity scores, European producers are often active in the top quality segments. The results also show that product complexity is sector specific. We observe less dispersion in the product complexity scores in sectors across countries rather than between sectors. This suggests that the high degree of dispersion in economic complexity observed at country level is more closely related to the industrial structure of countries. The average product complexity scores at the sector level have been relatively stable in the EU over the period 1995-2010. Over the same period the BRIC countries and especially China have upgraded the complexity of their business sector output. The average complexity score of the products exported by the Chinese electrical machinery and apparatus (NACE 31), the manufacture of television and telecommunication equipment (NACE 32) and the production of medical, precision and optical instruments (NACE 33) are close to those in Europe. Overall the output of China and other BRIC countries remains however biased towards products with lower complexity. The evidence underscores that the competitive pressure on European producers is likely to increase further. To escape this pressure it is necessary to increase the diversification and exclusivity of products across sectors but also to upgrade to even higher quality levels inside existing product categories.

The development of the productive structures of a country is however a highly cumulative process and any change is necessarily rooted in its current knowledge base and industrial specialisation. Products are related to one another through common knowledge bases and similar factors of production. The more capabilities two products share the more likely it is that a country successfully exporting one product will also develop a comparative advantage in the other product. The presence or absence of specific capabilities therefore determines export success. This circumstance is captured by another product space indicator which we have called neighbourhood density. It can be interpreted as the degree of factor substitutability between the products in which a country is a significant exporter. Neighbourhood density is strongly related to export success. Once this indicator passes a critical threshold for a product it is very likely that the country will develop a comparative advantage in that product. This strong empirical evidence has significant policy implications:

- Firstly, if the export success of one product is intrinsically related to the factor substitutability across products the benefits of diversification can only be appropriately reaped if the factor substitution mechanisms operate properly in the economy (e.g. mobility of knowledge workers, common standards for production technologies etc.). For a highly heterogeneous economic area like the EU this implies that deficits in economic integration will reflect negatively on the exploitation of the potential offered by diversification.

- Secondly, the results show that each country needs to have a minimum set of specific capabilities for a product, to become a significant exporter and obtain high world market shares in products. It is not possible to develop internationally competitive products out of the blue. Complementary factors and competencies have to be built up. Policies aiming at strengthening the competitiveness of countries or regions should therefore carefully assess existing productive structures as well as the knowledge base of institutions like universities and take these competencies as a starting point to develop strategies for their diversification or upgrading.
- Thirdly, the results show that a higher neighbourhood density, i.e. higher production factor substitutability across products, goes along with higher world market shares. This empirical result highlights the importance to develop unique specialisations to produce commodities. These unique specialisations are likely to be an important driver of the development of comparative advantage and international competitiveness. However, they have to develop out of the existing competence base. Hence, the results support the view of some authors that outsourcing and offshoring is a potential threat for competitiveness (e.g. Pisano - Shin, 2009). It may lead to the loss of capabilities to develop and manufacture competitive products. Nevertheless, it should be kept in mind that the neighbourhood density indicator is not granular enough to capture the fact that trade and competition is taking place also at the level of tasks (Grossman - Rossi-Hansberg, 2008). Countries should make sure that they do not only produce related products with a high level of complexity. They should also ensure that the know-how developed in the region is also difficult to codify and reproduce and hence more difficult to outsource or offshore. This requires that critical knowledge is embodied in people and organisations; and it requires highly skilled and well paid people. These knowledge carriers must be able to work with knowledge, using it for the transformation of ideas into real products and production processes (as such, higher education has a central role to play).
- Finally, the fact that the upgrading of productive structures is a highly cumulative process implies that it is more difficult to develop new products and diversify into new fields of activities. This poses a particular challenge for those EU countries in which industrial restructuring is necessary as our results show that across the EU Member States opportunities for upgrading are concentrated in the more complex and more competitive economies and in technology intense sectors. Our results show that the complexity of productive structures is closely related to the general quality of institutions. Policies to foster the upgrading of the product mix should therefore be conceived broadly, comprising education policies research, technology and innovation policies or the general quality of governance.

The results of this study and their implications are particularly relevant for current policy making in the European Union. In its outline of regional cohesion policy for the period 2014-2020 the European Commission has pledged to pursue a smart specialisation strategy (European Commission, 2010b). As the document makes clear, smart specialisation "*means identifying the unique characteristics and assets of each country and region, highlighting each region's competitive advantages, and rallying regional stakeholders and resources around an excellence-driven vision of their future.*" It implies also the "*strengthening of regional innovation systems, maximising knowledge flows and spreading the benefits of innovation throughout the entire regional economy.*" The development of regional strategies that take this strategic goal into account will be a precondition to get access to funds from the European Regional Development Fund (ERDF) in 2014-2020.

In the light of the results of this study this approach seems to be well placed to foster the competitiveness of the European Union in general and the European regions in particular. The development of new or better products is highly dependent on prior capabilities and the diversification into economic activities generating higher value added and employment can only successfully develop out of the existing competence base.

From the point of view of this study a potential point of critique is that the regional focus of this approach – implying administrative boundaries – might be too narrow. As our results show countries are likely to develop a strong position in the world market with their products if these draw on common factors of production and a common knowledge base. Regional smart specialisation strategies focusing uniquely on the competitive strength of a region may ignore or underestimate the importance of varieties of products that are not developed or produced in that region. Their knowledge and factor bases may be related and complementary to the local industrial base. This point may even be aggravated by the explicit goal of the smart specialisation strategy to avoid the duplication of efforts across regions. The development of regional strategies should therefore comprise an assessment on how the competence and factor base of one region is related to neighbouring or even far distant regions and implement measures that support the exchange of knowledge and production factors between these regions.

Another issue related to the results of this study is that the focus on areas where a region has a competitive advantage does not sufficiently take into account that diversification is a process in which areas of weakness develop into areas of strength by drawing on the knowledge and factor base of current areas of strength. Diversification is likely to be successful if a competence base for the new area is gradually built up to the point where a critical mass is reached and it takes off. Hence, regional strategies of smart specialisation should also consider how the current regional competence base can be used to develop related areas in which the region has not yet a competitive advantage. For instance, one could consider ways to support spin-offs from competitive enterprises or universities in the region that combine aspects of the knowledge base in which the region has competitive strengths with the knowledge bases of areas in which the region is still weak but in which there is a strong economic prospect in the longer run.

Our results show that opportunities are distributed very unevenly across countries and sectors.[16] These disparities typically increase as one gets to the regional level. The smart specialisation strategy says little about how to deal with regions where there is no or very little opportunity and where the local competence base is unrelated or very distant to sectors with the potential to generate high value added and employment. Regions may get trapped in inferior productive structures if the strategy focuses too narrowly on regional characteristics. As specialisation in a completely new economic area is difficult to achieve complementary instruments (such as heavy investments in education) may be needed. One way to minimise necessary competency build-up would be to assess to what extent it is possible with the current competence base to join international value chains and develop know-how necessary for just one of several production stages or production tasks, rather than for the whole product (cf. Baldwin, 2006).

Both the outline of European Cohesion Policy 2014-2020 (see European Commission, 2010b) and the recent initiative "Partnership for a stronger European industry" (European Commission, 2012) put an investment focus on specific technologies, such as key enabling technologies to foster the competitiveness of the European economy. Both documents pledge to support the technological and applied research as well as the development of pilot lines up to the market introduction of these technologies. While our results show (see Figure 29 p. 76) that key enabling technologies are indeed complex technologies that are likely to have a strong competitive potential, it should be clear from the results and their discussion so far, that investments into and support for these technologies should take place only if they are linked to the competence base of countries or regions.

Finally, we have highlighted before that the benefits of diversification can only be appropriately reaped if the mechanisms through which factor substitution across products works operate properly in the economy. From this point of view, the call of the communication "Partnership for a stronger European industry" for improvements of the functioning of the Single Market gets renewed urgency. It underscores also the importance to make progress in the development of the European Research Area and in the Bologna Process.

These results and conclusions come of course with come caveats. The methods used here do not take into account the role of services in an economy. They also do not adequately take into account quality improvement and upgrading in existing product categories. More research is needed to improve these indicators and understand their economic implications better. The general picture that emerges is however consistent with prior studies analysing structural change and competitiveness in the European Union (cf. Janger et al., 2011).

[16] We have quantified these opportunities simply by counting the number of products in which countries have not yet developed a comparative advantage, but that have a high implicit productivity and are highly related to the existing basket of products where countries or sectors have a comparative advantage.

Glossary of key concepts used in the product space analysis

Revealed comparative advantage (RCA): The revealed comparative advantage is a standard measure in the trade literature to establish whether a country given its overall export intensity is a significant exporter in a product. It is the ratio between the world market share a product exported by a country captures relative to the world market share the country has in world trade. It is a product indicator varying across countries.

Product space: By conceiving of globally traded products as a network linking products we obtain the product space. The nodes in this network are products and the linkages are the proximity relationship to other products (-> Proximity). An alternative conception of the product space is by linking products to countries. This type of network is used to calculate the complexity score for products and countries. (-> complexity score of countries; complexity score of products).

Complexity score of countries: The complexity score of countries is an indicator that captures the **diversification** of a country and the **ubiquity or exclusivity** of the product a country produces. This indicator is calculated in a recursive fashion by taking into account all direct and indirect relationships that exist between all countries and products. So information on the productive structures of countries producing the same product is used to characterise a product and through the product the country successfully exporting it. The complexity score can be interpreted as capturing latent information on the depth (capability to produce exclusive products due to high levels of accumulated knowledge) and the breadth of the knowledge base (capability to produce many products with different knowledge bases) underlying the a production system in a country.

Complexity score of products: This is the twin indicator of the complexity score for countries. The calculation of the complexity scores of countries and products are interdependent. The complexity score of a product may be interpreted to capture on how many different knowledge bases a product relies and how exclusive it is. Products with a higher complexity score are therefore more difficult to produce as they rely on more diversified knowledge bases and because they require specific know-how only few countries have. The results in this report show that the process of economic upgrading is closely related to the adoption of more complex products.

Diversification: In this report diversification is the number of products a country exports and in which it has developed a comparative advantage. It is therefore a close relative to the notion of “extensive margin in exports”. However, unlike the latter it does not simply refer to the number of products a country exports, but to the products in which the country is a significant exporter (captured by a revealed comparative advantage).

Proximity: Proximity is a measure for the relatedness of traded products. Products are related to one another through common knowledge bases and similar factors of production. This is measured in terms of the likelihood that a country develops a comparative advantage in a product given that it has developed a comparative advantage in other products. It is a product measure. This measure avoids any priors in terms of vertical input-output relationships, or similarity in patent citations and is based on trade outcomes. Two products have high proximity if the likelihood of countries developing a comparative advantage in that product is high given that all other countries exporting that product have also a revealed comparative advantage in the other product.

Centrality: The centrality measure is based on the proximity measure and indicates to how many other products a product is related based on their proximity. It is also a product measure. More central products rely on more knowledge bases and have a higher likelihood of being recombined with other products to give new products. Hence, higher centrality captures higher growth potential. The results in this report show that the technological upgrading process of countries goes hand in hand with moving to more central parts of the product space.

Neighbourhood density: The neighbourhood density (or "density" in the original contributions to the product space literature) is a country-product level indicator that relates the proximity of each product a country produces to the product mix it already exports successfully. It is a measure for the factor substitutability across products. If it is high between products where a country has a comparative advantage and a product where this is not yet the case then it is likely that the country will develop a comparative advantage in that product. By relating each product to the set of products for which a country has already a comparative advantage in international trade the neighbourhood density is a strong predictor for the type of products in which it will develop a comparative advantage.

Implicit productivity of a product (PRODY): The implicit productivity of a product is the RCA (-> revealed comparative advantage) weighted sum of the GDP per capita of all countries exporting that product.

Implicit productivity of the export basket of a country (EXPY): The implicit productivity of the export basket of a country is the sum of the implicit productivity (PRODY) of all the products it exports weighted by the share these products have in the total exports of a country.

H-, U-, L-products: H-products are products that are exported only by high income countries. U-products are product that both high income and low income countries export. L-products are products that only low income countries export. See Figure 21on p.49 for the exact income thresholds.

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Appendix:

Results for alternative calculations of the complexity score of countries using the method of reflections

One important shortcoming of the analytical framework by Hidalgo and co-authors is that they construct the network shown in Figure 3 by using the simple revealed comparative advantage measure

$$RCA(c,i) = \frac{v(c,i)}{\sum_i v(c,i)} \Big/ \frac{\sum_c v(c,i)}{\sum_{i,c} v(c,i)},$$

where $v(c,i)$ corresponds to the value of the exports of country *c* in good i. The RCA takes on a value larger than one when the share of exports of a country on a given product *i* is larger than that the share of that product in world trade. As the assumption is that by examining the network in Figure 3 it is possible to reveal the competencies underlying the production of any commodity, the question arises what these competencies actually are, and what competencies can be revealed if the indicator for the presence of such competencies is an RCA value above one.

The reason that countries have a revealed comparative advantage in trade of any commodity can have many causes and therefore next to country specific factor endowments that lead especially to specialisation, countries can also have a comparative advantage due to the existence of an extensive margin or economies of scale and scope. As Helpman (2011) notes, economies of scale introduce a degree of arbitrariness into the patterns of trade as high output leads to high productivity such that a country ends up with a high output level, high productivity and low unit costs, while countries producing small volumes end up with low output levels, low productivity and high unit costs. As a consequence, a country needs no special characteristics to gain a comparative advantage in the production of any commodity where the underlying technology leads to increasing returns. On the other hand, for understanding the competitive position of developed countries it is necessary to look at the product quality. Producing high quality products requires a broader and deeper knowledge base.

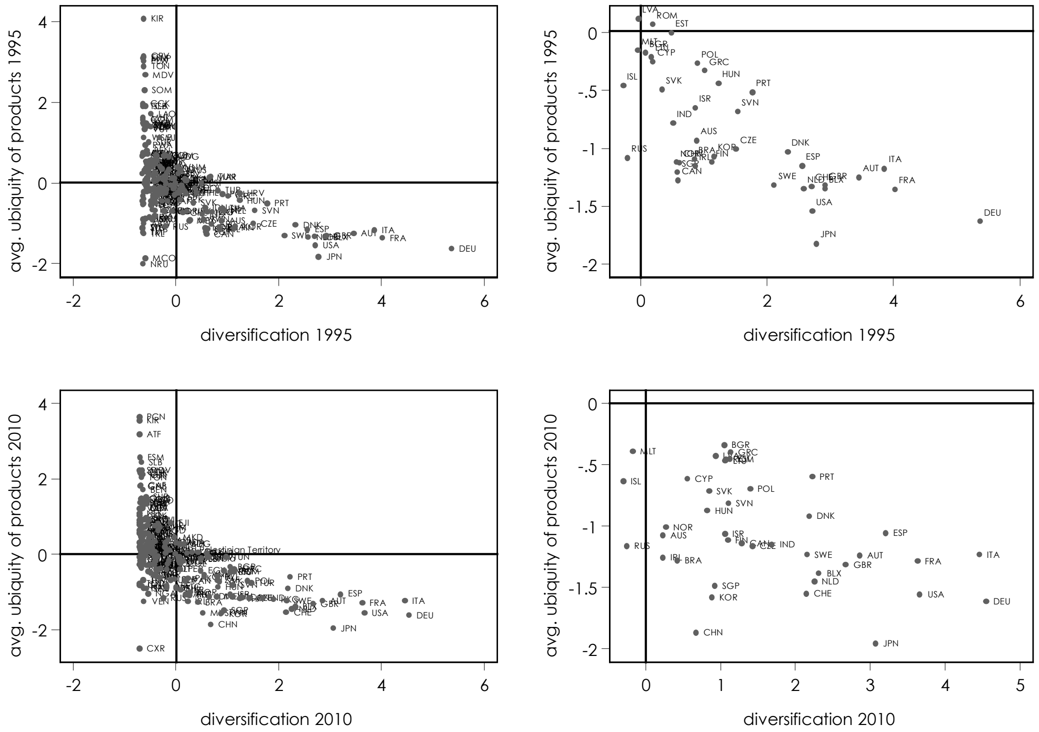
We have therefore also analysed the product space taking into account the shortcomings of the standard RCA based approach. We have constructed the product space for quality competition. In this case the matrix in Figure 3 gets an entry of 1 if

$$RCA(c,i) = \frac{v(c,i)}{\sum_i v(c,i)} \Big/ \frac{\sum_c v(c,i)}{\sum_{i,c} v(c,i)} > 1, \text{and}, RCPA(c,i) = \frac{uv(c,i)}{\sum_i uv(c,i)} \Big/ \frac{\sum_c uv(c,i)}{\sum_{i,c} uv(c,i)} > 1,$$

i.e., high quality producers must have a comparative advantage in both an export share in the product that lies above the world market share of the product and a unit price (measured by unit values) that is above the average price obtained across countries.

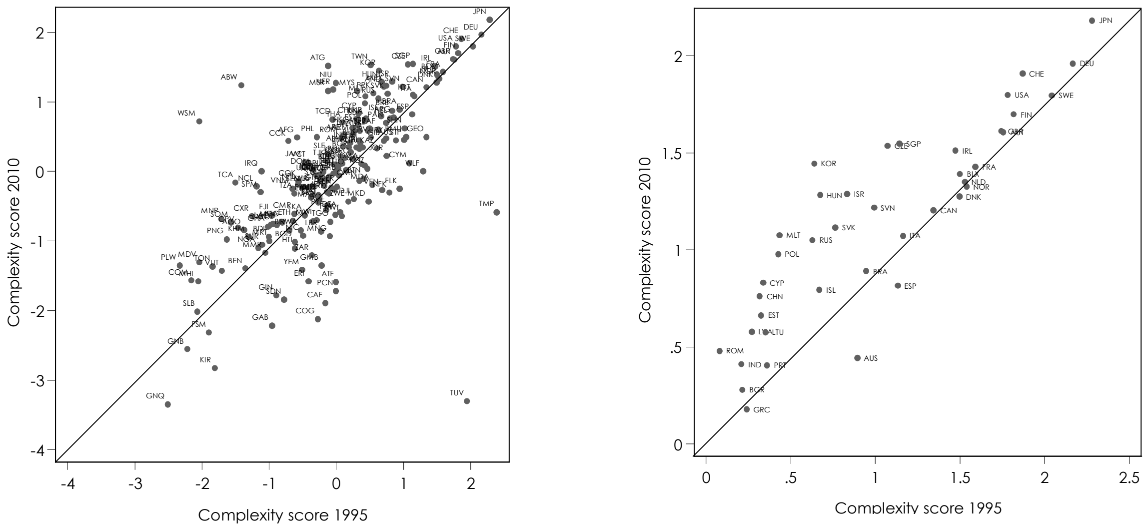
The results from the complexity scores in Figure 24 and Figure 25 show that this procedure leads to a downward adjustment of the complexity scores of countries that have experienced a fast catching up process such as several New Member States or China.

Figure 24: The relationship between the diversification ($k_{c,0}$) of the average ubiquity of the products ($k_{c,1}$) exported, all countries and EU Member States 1995 and 2010 (standardised k-values); quality adjusted complexity score



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 25: Changes in the complexity of the world economies between 1995 and 2010; quality adjusted complexity score



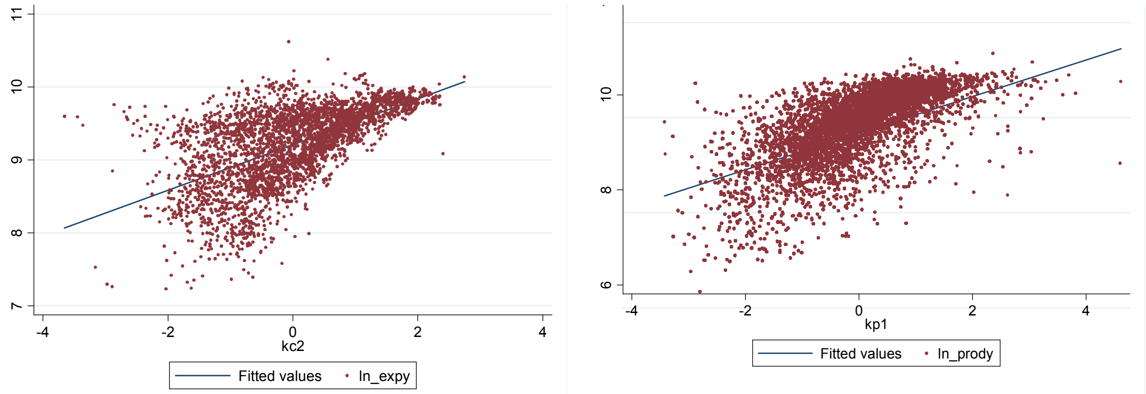
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

As the notion of competitiveness adopted in this study does not exclusively refer to competitiveness in quality and for the comparability of our results with prior research on the network construction used in the original study by Hidalgo - Hausmann (2009).

The relationship between the product space indicators and indicators for the implicit productivity of products (PRODY) and export baskets (EXPY), as well as H-L goods

In Box 1 on p. 4, we have briefly discussed the contribution Hausmann - Hwang - Rodrik (2007) that has examined the relationship between the implicit productivity of the export basket of a country EXPY and economic performance. One critique of this approach is that it involves circularity in its construction as the implicit productivity of the export basked of a country is constructed from the implicit productivity of products PRODY which in turn is a weighted average of the GDP per capita of the countries producing that good. Hidalgo (2009) has shown that these two indicators are closely related to the network based indicators presented in chapter 3 of this report. If one leaves apart the income information, the way the implicit productivity of a product, PRODY, is calculated corresponds to the indicator for the average diversification of the products exporting a product, $k_{p,1}$. EXPY, the implied productivity of the export basket of a country, in turn is related to the indicator capturing the average diversification of countries with a similar export basket as a specific country, $k_{c,2}$. From this he concludes that the information contained in the PRODY and EXPY indicators derives from the structure of the network connecting countries rather than from the income per capita used to calculate these values. The relationship between these indicators is shown in Figure 26.

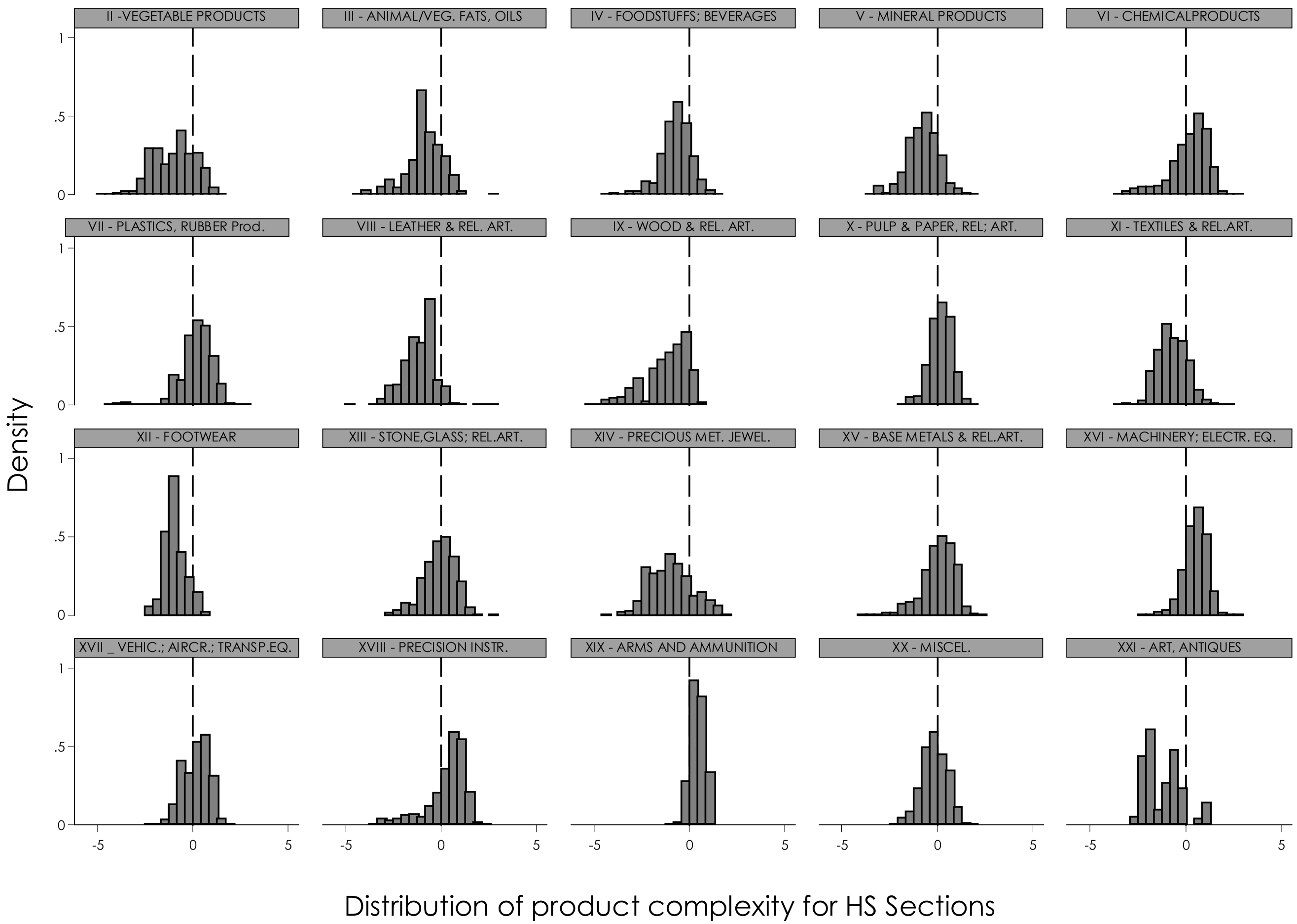
Figure 26: The relationship between the implicit productivity at the country level (EXPY) and the product level (PRODY) and measures of complexity



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Average diversification of products exported by a country $k_{c,2}$ vs. EXPY on left panel and average diversification of the countries exporting a product, $k_{p,1}$ for vs. PRODY on the right panel.

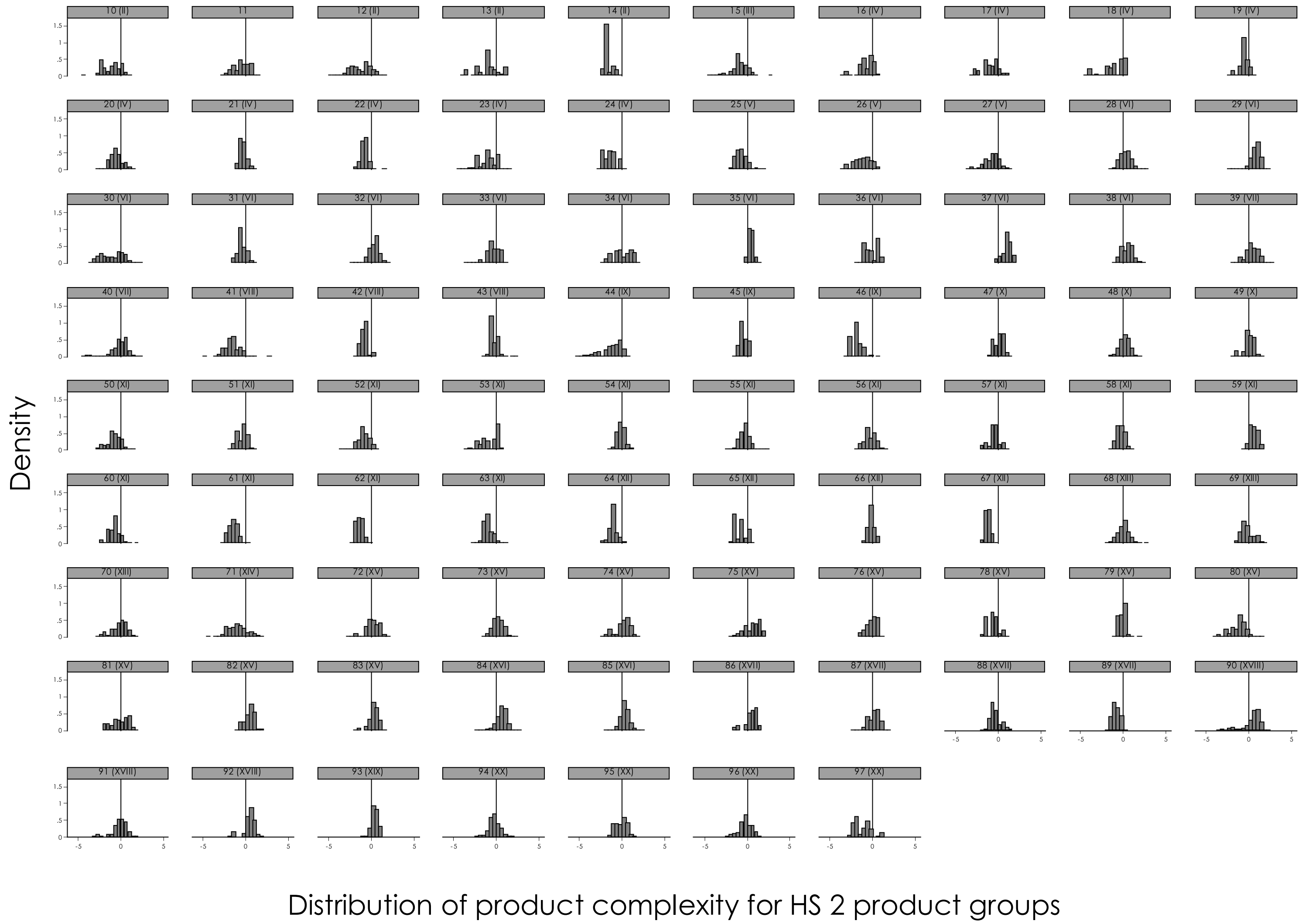
Complexity scores for different product categories

Figure 27: Distribution of the level of complexity across HS Level 1 sections



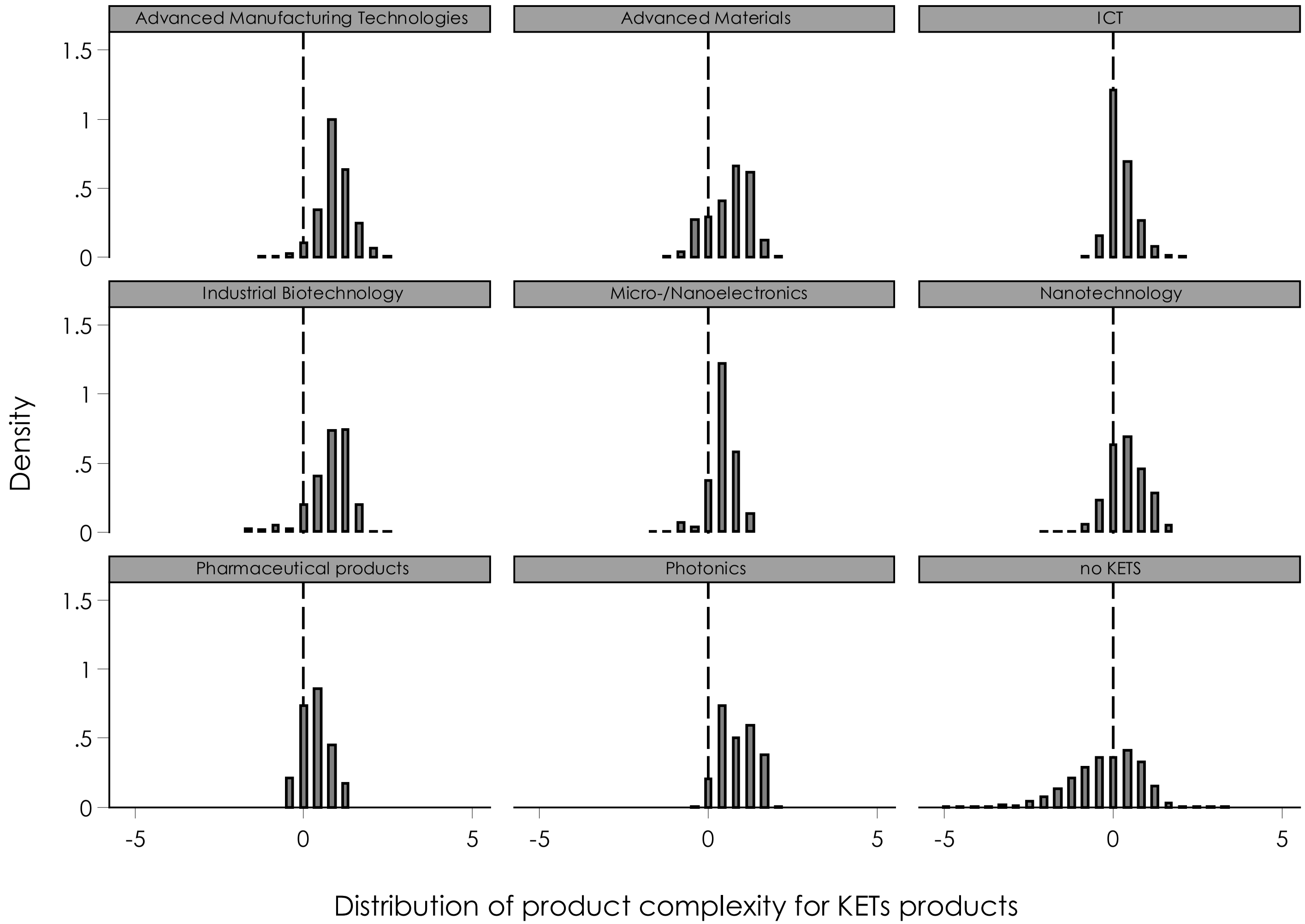
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 28: Distribution of the level of complexity across HS - 2 digit codes (Roman numerals in brackets indicate higher level section)



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 29: Distribution of the level of complexity for products classified as key enabling technologies (KETs)



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Skewness tests for the distributions shown in Figure 8, Figure 9, Figure 11, Figure 12 and Figure 13

The skewness statistics indicate whether the distribution can take on positive, negative, zero values. A positive skew indicates that the tail of the distribution is longer on the right side of the mean and that the bulk of observations (including potentially the median) lie there. A negative skew instead indicates that the tail of the distribution is longer on the left side of the mean and that the bulk of observations lies there. A skew close to zero indicates that the distribution is symmetric with respect to the mean. Hence, high positive skewness scores indicate that more complex products are more prevalent the export basket, whereas a negative skew indicates that less complex products are more important in the export basket.

Table 16: Skewness of the export basket of countries; world market share weighted complexity score for exported products; Figure 8 and Figure 9

EU 27			Other countries		
country	mean	skewness	country	mean	skewness
AUT	0.00527	7.72	AUS	-0.00614	-11.11
BGR	-0.00083	-13.65	BRA	-0.0046	-11.26
BLX	0.0071	3.373	CAN	-0.00106	-17.04
CYP	-0.000193	-11.31	CHE	0.0086	4.463
CZE	0.00318	5.54	CHN	-0.0269	-2.598
DEU	0.0443	3.757	IND	-0.0118	-8.581
DNK	0.00144	5.592	ISL	-0.00151	-1.15
ESP	-0.00234	-4.363	ISR	0.00107	4.751
EST	-0.000176	0.824	JPN	0.0305	5.691
FIN	0.00361	7.972	KOR	0.006	1.107
FRA	0.00812	1.412	NOR	-0.000379	-9.675
GBR	0.0072	-1.573	RUS	0.00033	-1.638
GRC	-0.0019	-18.48	SGP	0.00388	6.313
HUN	0.000777	5.253	USA	0.0229	-0.958
IRL	0.00219	14.53			
ITA	0.00358	-1.084			
LTU	-0.000424	8.639			
LVA	-0.000299	-4.274			
MLT	-0.000121	-10.08			
NLD	0.00508	3.322			
POL	0.0003	2.285			
PRT	-0.0021	-13.45			
ROM	-0.00129	-6.159			
SVK	0.000855	13.97			
SVN	0.000679	8.756			
SWE	0.00572	8.607			
EU27	0.0042	6.084			

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Note: Skewness >0 indicates a positive skew of the distribution towards mor ecomplex products; Skewness <0 indicates a negative skew of the distribution towards less complex products. Larger values for skewness indicate a stronger skew in the direction of the sign.

Table 17: Mean and skewness of world market share weighted complexity of products by NACE sectors, EU27, USA, Japan, China and Korea, Figure 11, Figure 12, and Figure 13.

NACE 1.1	EU 27		USA		Japan		Korea		China	
	mean	skewness	mean	skewness	mean	skewness	mean	skewness	mean	skewness
10	-0.04	-1.44	-0.05	-0.89	0.00	-1.14	-0.03	-1.42	-0.04	-1.28
11	-0.03	-0.20	-0.05	-0.85	0.00	-0.70	-0.07	-2.30	0.00	0.17
12	-0.01	.	0.03	.	.	.	0.00	-0.69	0.01	.
13	-0.05	-2.11	-0.07	-1.07	0.00	-2.69	-0.05	-2.44	-0.02	-2.76
14	-0.06	0.96	-0.04	0.85	0.00	1.98	-0.04	-2.57	-0.06	-0.58
15	-0.13	-1.66	-0.09	-1.88	-0.01	-4.67	-0.04	-4.47	-0.08	-2.96
16	-0.19	-0.18	-0.07	-0.83	-0.01	-1.60	-0.05	-3.58	-0.06	-1.67
17	0.00	2.11	0.00	-0.20	0.01	4.14	-0.03	-2.33	-0.06	-0.84
18	-0.10	-1.91	-0.02	-9.73	0.00	-0.11	-0.14	-1.74	-0.43	-0.02
19	-0.11	-1.19	-0.03	-3.54	0.00	5.00	-0.09	-2.95	-0.27	-1.11
20	-0.15	-1.34	-0.09	-2.39	0.00	-2.62	-0.08	-4.16	-0.21	-2.11
21	0.01	0.19	0.00	0.54	0.01	3.93	0.00	-2.73	-0.01	-1.16
22	-0.03	0.49	0.00	0.93	0.02	4.27	-0.01	-0.14	-0.03	0.34
23	-0.04	0.42	-0.06	-0.87	-0.01	-1.28	-0.01	3.30	-0.04	-2.37
24	0.15	1.30	0.11	2.10	0.08	4.05	0.03	3.30	0.08	1.84
25	0.04	0.48	0.03	0.37	0.07	8.78	0.00	-1.48	0.00	-0.69
26	0.03	0.67	0.04	2.74	0.05	4.57	0.00	-1.00	0.00	-0.70
27	0.07	0.79	0.03	0.86	0.05	2.25	0.01	1.31	0.03	0.95
28	0.08	0.63	0.05	1.13	0.05	3.61	0.02	0.60	0.07	-0.40
29	0.21	0.18	0.07	0.03	0.09	2.40	0.02	2.62	0.07	0.68
30	0.14	1.99	0.10	1.98	0.09	1.57	0.08	1.98	0.22	1.08
31	0.08	1.04	0.04	0.99	0.06	2.77	0.02	2.36	0.06	0.51
32	0.10	2.89	0.08	2.24	0.11	1.82	0.06	2.62	0.18	1.26
33	0.19	0.54	0.14	0.73	0.13	2.93	0.05	3.61	0.15	1.73
34	-0.03	-0.30	-0.03	-1.09	0.02	3.37	0.00	-7.01	-0.01	-3.89
35	0.00	0.47	-0.02	-0.32	0.03	3.04	0.00	1.73	0.01	0.78
36	0.04	1.40	0.02	1.67	0.04	3.05	0.01	0.83	0.04	0.13
Total	0.06	0.91	0.03	1.16	0.05	5.76	0.00	-1.80	0.00	-0.96

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010). Note: Skewness >0 indicates a positive skew of the distribution towards mor ecomplex products; Skewness <0 indicates a negative skew of the distribution towards less complex products. Larger values for skewness indicate a stronger skew in the direction of the sign. Excluding intra-EU exports.

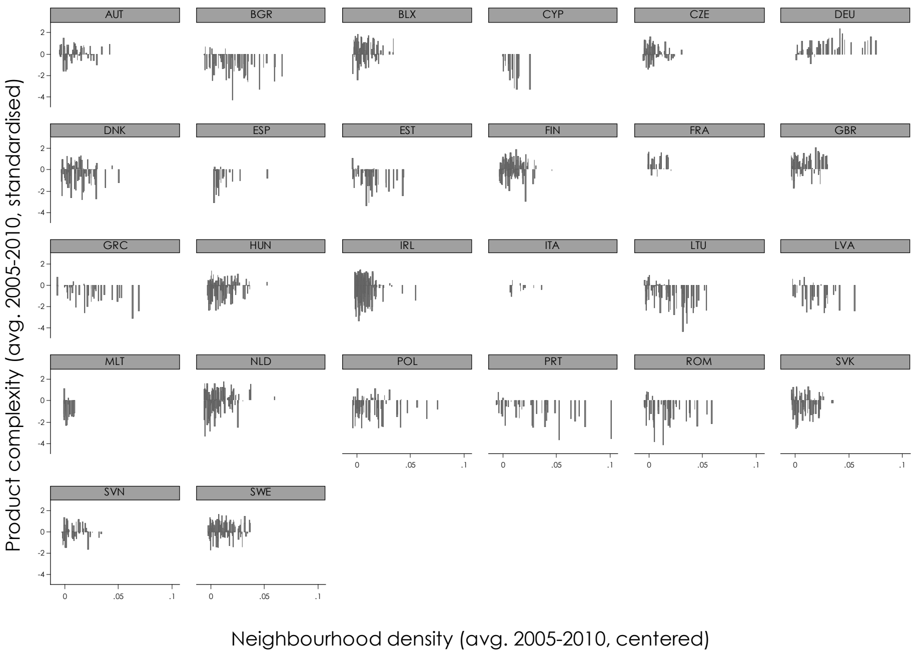
Additional results and alternative calculations of opportunity set

Instead of using the work of Sutton - Trefler (2011) to develop selection criteria for the opportunity and the non-competitive set of products, we have used the criteria advanced by Aiginger (1997, 1998). These criteria try to discriminate between price and quality competition. A product for which a country sustains quality competition has a quality and a quantity advantage in the exports of a product, i.e., high quality producers must have a comparative advantage in both an export share in the product that lies above the world market share of the product and a unit price (measured by unit values) that is above the average price obtained across countries.

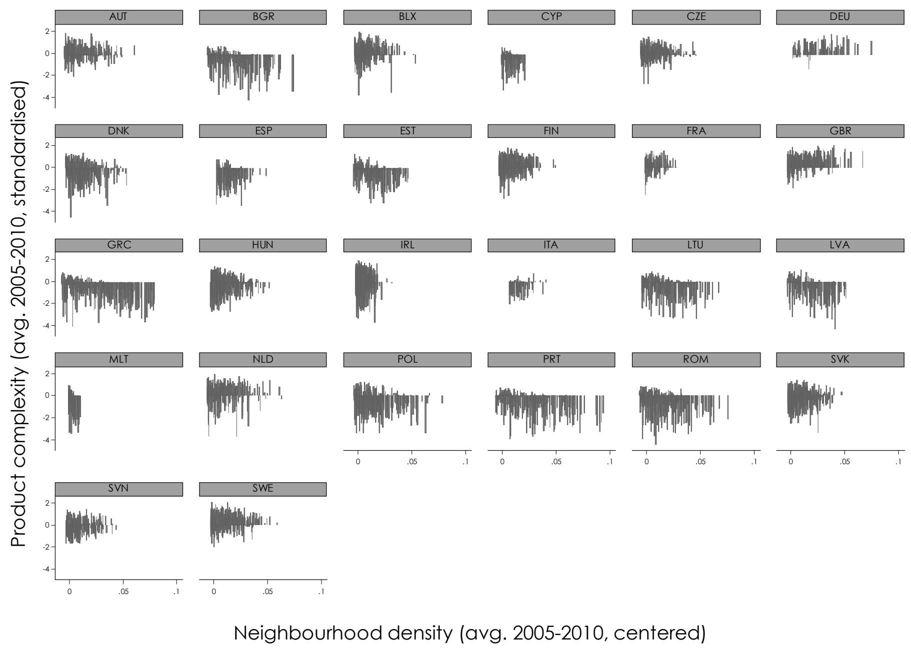
The results presented in Figure 30 and Figure 31 as well as in Table 18 through Table 20 show that the general patterns of sector and country opportunity do not change considerably and are consistent with the analysis on the basis of the Sutton - Trefler (2011) criteria. However, if the opportunity set is constructed according to the alternative criteria the products in the set are downward biased in terms of the average product complexity of the opportunity set.

Figure 30: The opportunity and the non-competitive sets of products across EU Member States, alternative definition

The Opportunity Set



Non-competitive set



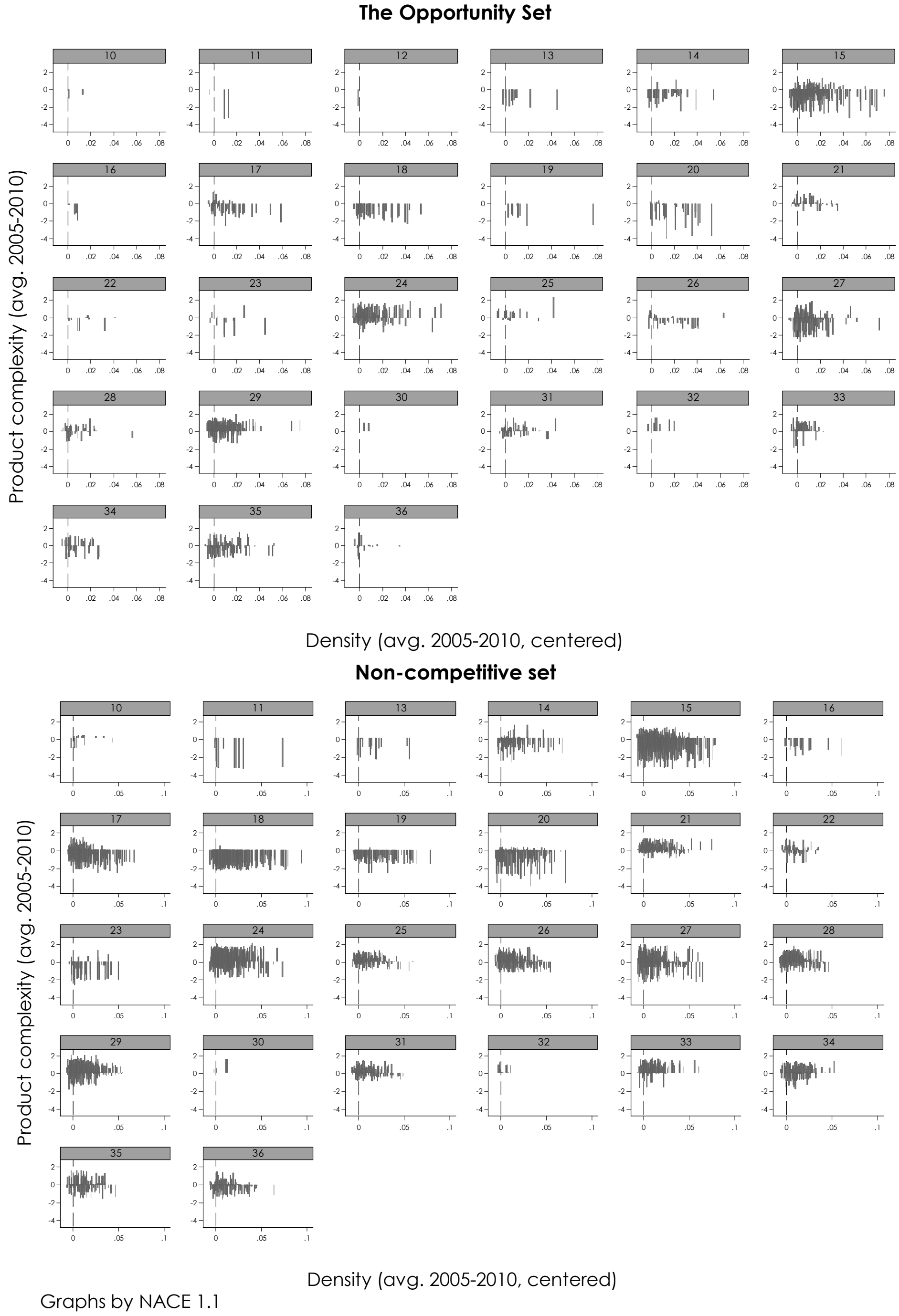
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);
Note: Definition opportunity set: RCA <0.5; Selection criteria: exp_q > imp_q and exp_uv>imp_uv; _q quantity, _uv unit value and $PRODY_p$ > avg. $PRODY_c$

Table 18: Mean score and skewness of the set of undeveloped products (avg. 2005-2010) in the EU Member States

country	all products in product complexity (mean score)	skew	Sutton-Treffler criteria: opportunity set product complexity (mean score)	skew	Sutton-Treffler criteria: non-competitiv e set product complexity (mean score)	skew	Aiginger criteria: opportunity set product complexity (mean score)	skew	Aiginger criteria: non-competitiv e set product complexity (mean score)	skew
AUT	-0.23	-0.53	0.54	-0.91	-0.18	-0.09	0.08	-0.56	0.19	-0.23
BGR	0.11	-1.03	-0.02	-0.98	-1.03	-0.82	-1.17	-0.56	-0.74	-0.96
BLX	-0.18	-0.68	0.63	-0.84	-0.33	-0.63	0.30	-0.59	0.31	-0.93
CYP	0.00	-0.89	-0.17	-0.77	-1.09	-0.57	-1.69	-0.27	-0.79	-0.52
CZE	-0.17	-0.50	0.58	-0.53	-0.31	-0.59	0.10	-0.20	0.16	-0.46
DEU	-0.65	-0.31	0.72	0.20	0.17	-0.20	0.72	-0.08	0.66	-0.26
DNK	-0.03	-0.72	0.43	-0.88	-0.71	-0.73	-0.40	-0.38	-0.27	-0.64
ESP	0.03	-0.91	0.21	-1.59	-1.09	-0.30	-1.07	-0.50	-0.89	-0.23
EST	0.09	-0.86	0.25	-1.08	-0.93	-0.63	-1.04	-0.33	-0.57	-0.46
FIN	-0.07	-0.51	0.68	-0.97	-0.19	-0.47	0.11	-0.57	0.32	-0.63
FRA	-0.29	-0.54	0.57	-0.43	-0.23	-0.52	0.64	-0.25	0.26	-0.48
GBR	-0.32	-0.52	0.82	-0.84	-0.06	-0.08	0.50	-0.72	0.66	-0.79
GRC	0.15	-0.99	0.04	-1.03	-1.13	-0.54	-1.00	-0.31	-0.89	-0.56
HUN	-0.03	-0.56	0.43	-0.70	-0.73	-0.20	-0.42	-0.29	-0.26	-0.43
IRL	-0.04	-0.74	0.62	-0.96	-0.62	-0.55	-0.20	-0.66	0.13	-0.79
ITA	-0.14	-0.76	0.14	0.23	-0.70	-0.10	-0.42	0.53	-0.60	-0.10
LTU	0.14	-1.03	0.15	-0.78	-1.03	-0.58	-1.11	-0.48	-0.63	-0.67
LVA	0.10	-0.90	0.26	-1.26	-1.07	-0.62	-1.07	0.14	-0.75	-0.66
MLT	0.00	-0.90	0.30	-0.01	-0.97	-0.50	-1.05	0.82	-0.69	-0.68
NLD	-0.14	-0.67	0.67	-1.02	-0.56	-0.66	0.07	-0.83	0.24	-1.17
POL	0.01	-0.81	0.37	-0.67	-1.10	-0.11	-0.81	-0.02	-0.63	-0.26
PRT	0.18	-1.12	-0.11	-0.47	-1.10	-0.69	-1.14	-0.74	-0.85	-0.82
ROM	0.08	-0.93	0.09	-0.74	-1.07	-0.85	-1.16	-0.57	-0.72	-0.88
SVK	-0.04	-0.73	0.48	-0.90	-0.75	-0.31	-0.29	-0.43	-0.23	-0.45
SVN	-0.09	-0.58	0.53	-1.14	-0.50	0.13	-0.05	-0.07	-0.15	-0.14
SWE	-0.22	-0.47	0.62	-0.64	-0.19	-0.06	0.21	-0.47	0.32	-0.26
Total	-0.08	-0.71	0.51	-0.71	-0.75	-0.59	-0.27	-0.50	-0.19	-0.62

Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010).

Figure 31: The opportunity and the non-competitive sets of products in the business sector across EU Member States, alternative definition



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);
Note: Definition opportunity set: RCA <0.5; Selection criteria: exp_q > imp_q and exp_uv>imp_uv; _q quantity, _uv unit value and $PRODY_p$ > avg. $PRODY_c$

Table 19: Mean score and skewness of the set of undeveloped products (avg. 2005-2010) in the EU business sector

			Sutton - Treffler criteria				Aiginger criteria			
	all products in sector		opportunity set		non-competitiv e set		opportunity set		non-competitiv e set	
NACE 1.1	Product complexity (mean score)	skew	Product complexity (mean score)	skew	Product complexity (mean score)	skew	Product complexity (mean score)	skewn	Product complexity (mean score)	skew
10	-0.48	0.47	.	.	-0.25	-0.44	0.26	0.00	-0.18	-0.69
11	-2.31	0.47	.	.	-2.85	1.38	-2.42	.	-2.54	0.75
12	-1.81	-0.12	.	.	-1.80	.	-1.471	.	.	.
13	-1.81	-0.09	.	.	-1.49	0.09	-1.35	0.46	-1.47	0.09
14	-0.76	0.22	-0.47	0.13	-0.93	-0.35	-0.900	0.34	-0.64	0.10
15	-0.83	-0.42	-0.04	-0.40	-0.93	-0.61	-0.92	-0.54	-0.64	-0.52
16	-1.03	0.04			-1.07	0.20	-1.313	0.71	-1.07	0.19
17	-0.55	-0.10	0.23	-0.71	-0.87	-0.02	-0.62	-0.45	-0.57	0.01
18	-1.37	0.32	-0.62	0.41	-1.50	0.26	-1.147	-0.15	-1.43	0.37
19	-1.00	-0.89	-0.80	.	-1.08	-0.82	-1.26	-1.11	-1.03	-0.73
20	-1.30	-0.62	-0.06	-0.28	-1.30	-0.61	-1.114	-0.90	-1.00	-0.90
21	0.41	-0.29	0.41	0.05	-0.17	0.98	0.15	-0.06	0.31	-0.06
22	-0.15	-0.26	0.49	0.15	-0.58	-0.91	-0.767	0.23	-0.11	-0.23
23	-0.70	-0.06	-0.50	0.53	-1.19	0.20	-0.40	-0.57	-1.01	0.32
24	0.57	-0.69	0.57	-0.42	-0.25	-0.11	0.126	-0.13	0.28	-0.22
25	0.22	-0.13	0.56	0.98	-0.03	-0.21	0.00	-0.93	0.22	-0.28
26	0.21	-0.22	0.66	-0.13	-0.33	-0.02	-0.07	0.02	0.14	-0.12
27	0.24	-0.73	0.65	-0.04	-0.40	-0.89	-0.24	-0.29	0.14	-0.54
28	0.33	-0.52	0.59	0.11	-0.09	0.16	-0.01	0.89	0.23	-0.21
29	0.66	-0.90	0.73	-0.38	-0.03	-0.19	0.38	-0.83	0.54	-0.86
30	0.41	0.91	0.86	-0.67	.	.	0.358	0.36	1.06	-0.01
31	0.31	-0.18	0.63	0.58	-0.05	0.61	-0.03	0.55	0.27	-0.25
32	0.37	0.44	0.67	0.00	0.36	0.57	0.00	0.51	0.53	0.16
33	0.68	-0.74	0.79	-1.33	-0.12	-0.87	-0.24	-0.08	0.75	-1.46
34	0.33	-0.75	0.79	-1.63	-0.31	-0.37	-0.36	0.56	0.21	-0.49
35	-0.02	0.10	0.33	-0.23	-0.45	0.59	0.05	-0.01	-0.02	0.15
36	-0.18	-0.13	0.15	-0.33	-0.61	0.23	-0.53	-0.18	-0.22	0.19
Total	0.01	-0.62	0.53	-0.68	-0.64	-0.46	-0.43	-0.47	-0.10	-0.52

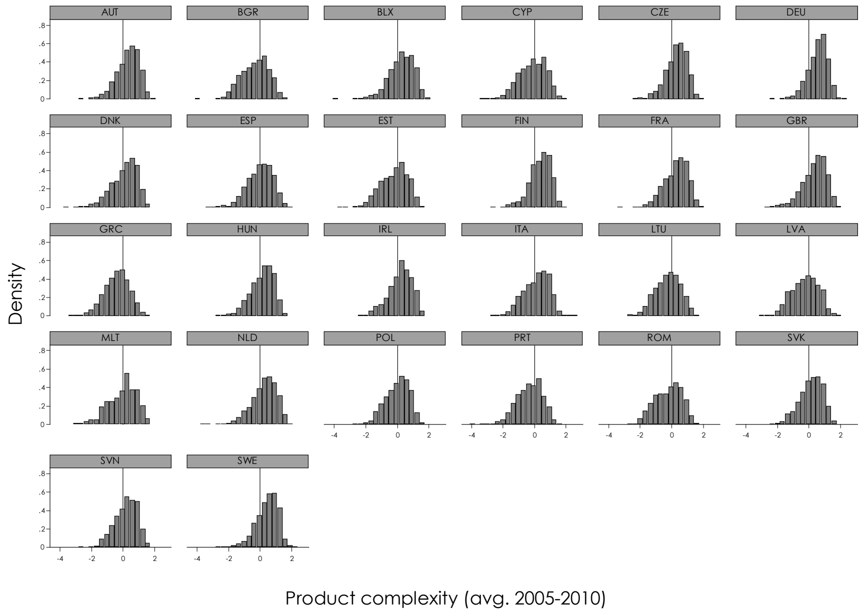
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Table 20: The opportunity set across EU 27 countries and manufacturing sectors, alternative criteria.

NACE 1.1	AUT	BGR	BLX	CYP	CZE	DEU	DNK	ESP	EST	FIN	FRA	GBR	GRC	HUN	IRL	ITA	LTU	LVA	MLT	NLD	POL	PRT	ROM	SVK	SVN	SWE	Sector share	Total secor
15	16.7%	22.0%	16.7%	20.0%	12.1%	15.2%	12.3%	41.2%	30.6%	22.7%	8.7%	17.5%	18.5%	15.4%	21.0%	11.1%	16.4%	22.7%	4.8%	11.2%	28.6%	29.4%	37.5%	15.9%	26.5%	12.5%	18.5%	292
16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	4
17	7.4%	17.1%	0.0%	0.0%	3.0%	2.2%	6.8%	5.9%	2.8%	0.8%	0.0%	0.0%	0.0%	6.5%	3.9%	0.0%	6.6%	9.1%	0.0%	2.6%	4.1%	2.9%	6.3%	1.6%	4.1%	1.0%	3.6%	57
18	0.0%	0.0%	0.0%	0.0%	7.6%	0.0%	1.4%	5.9%	5.6%	0.0%	0.0%	0.0%	7.4%	7.3%	0.0%	0.0%	8.2%	9.1%	23.8%	5.2%	0.0%	0.0%	0.0%	11.1%	2.0%	1.0%	3.0%	47
19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	2.8%	0.0%	0.0%	0.0%	3.7%	1.6%	0.4%	0.0%	0.0%	0.0%	4.8%	0.0%	2.0%	2.9%	0.0%	0.0%	0.0%	0.0%	0.6%	9
20	0.0%	9.8%	2.2%	0.0%	1.5%	2.2%	2.7%	0.0%	0.0%	0.8%	4.3%	1.8%	0.0%	0.8%	1.3%	0.0%	3.3%	0.0%	0.0%	0.9%	6.1%	5.9%	9.4%	1.6%	0.0%	2.1%	2.0%	31
21	1.9%	4.9%	1.1%	0.0%	1.5%	2.2%	2.7%	0.0%	2.8%	2.3%	4.3%	3.5%	0.0%	1.6%	2.6%	0.0%	1.6%	4.5%	4.8%	3.4%	6.1%	0.0%	3.1%	4.8%	0.0%	3.1%	2.5%	40
22	0.0%	0.0%	0.0%	10.0%	0.0%	0.0%	0.0%	0.0%	5.6%	0.0%	0.0%	0.0%	3.7%	0.8%	0.4%	0.0%	0.0%	0.0%	4.8%	0.0%	4.1%	0.0%	0.0%	0.0%	2.0%	0.0%	0.6%	10
23	0.0%	0.0%	2.2%	10.0%	0.0%	0.0%	4.1%	0.0%	2.8%	2.3%	0.0%	1.8%	0.0%	0.0%	0.9%	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	14
24	20.4%	0.0%	17.8%	10.0%	9.1%	50.0%	9.6%	5.9%	5.6%	9.4%	13.0%	22.8%	0.0%	10.6%	16.7%	22.2%	6.6%	4.5%	4.8%	19.0%	4.1%	11.8%	6.3%	6.3%	4.1%	19.8%	13.3%	210
25	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%	1.4%	0.0%	0.0%	1.6%	0.0%	0.0%	7.4%	0.8%	1.3%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	1.6%	6.1%	0.0%	1.0%	16
26	0.0%	7.3%	1.1%	0.0%	0.0%	2.2%	0.0%	0.0%	5.6%	3.9%	0.0%	0.0%	0.0%	0.8%	1.3%	22.2%	8.2%	0.0%	4.8%	1.7%	2.0%	2.9%	9.4%	3.2%	2.0%	1.0%	2.2%	35
27	3.7%	12.2%	4.4%	40.0%	10.6%	4.3%	15.1%	11.8%	16.7%	16.4%	8.7%	3.5%	33.3%	10.6%	14.6%	0.0%	19.7%	13.6%	23.8%	8.6%	8.2%	23.5%	21.9%	12.7%	4.1%	11.5%	12.3%	194
28	1.9%	7.3%	1.1%	0.0%	3.0%	2.2%	4.1%	0.0%	0.0%	3.1%	0.0%	0.0%	0.0%	1.6%	1.3%	22.2%	3.3%	4.5%	4.8%	1.7%	4.1%	0.0%	0.0%	1.6%	6.1%	2.1%	2.3%	36
29	35.2%	0.0%	22.2%	0.0%	33.3%	6.5%	15.1%	5.9%	11.1%	20.3%	39.1%	40.4%	7.4%	24.4%	15.0%	11.1%	9.8%	13.6%	4.8%	19.8%	14.3%	2.9%	6.3%	28.6%	30.6%	26.0%	19.5%	307
30	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	2
31	1.9%	4.9%	4.4%	0.0%	1.5%	2.2%	4.1%	0.0%	0.0%	2.3%	4.3%	0.0%	3.7%	4.9%	2.6%	0.0%	9.8%	9.1%	4.8%	5.2%	6.1%	0.0%	0.0%	3.2%	2.0%	5.2%	3.5%	55
32	1.9%	0.0%	3.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.4%	7
33	1.9%	0.0%	7.8%	10.0%	6.1%	2.2%	0.0%	5.9%	0.0%	2.3%	13.0%	0.0%	0.0%	2.4%	5.6%	0.0%	1.6%	4.5%	4.8%	4.3%	0.0%	0.0%	0.0%	1.6%	0.0%	0.0%	2.9%	46
34	1.9%	7.3%	4.4%	0.0%	0.0%	2.2%	4.1%	5.9%	0.0%	4.7%	4.3%	3.5%	7.4%	0.8%	4.7%	0.0%	3.3%	0.0%	4.8%	0.9%	0.0%	2.9%	0.0%	1.6%	4.1%	0.0%	2.8%	44
35	3.7%	7.3%	8.9%	0.0%	9.1%	4.3%	13.7%	5.9%	5.6%	6.3%	0.0%	5.3%	7.4%	6.5%	4.7%	11.1%	0.0%	4.5%	0.0%	12.1%	8.2%	8.8%	0.0%	4.8%	4.1%	10.4%	6.6%	104
36	1.9%	0.0%	2.2%	0.0%	1.5%	0.0%	0.0%	5.9%	2.8%	0.0%	0.0%	0.0%	0.0%	0.8%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9%	0.0%	0.0%	2.0%	3.1%	1.0%	16
country share	3.4%	2.6%	5.7%	0.6%	4.2%	2.9%	4.6%	1.1%	2.3%	8.1%	1.5%	3.6%	1.7%	7.8%	14.8%	0.6%	3.9%	1.4%	1.3%	7.4%	3.1%	2.2%	2.0%	4.0%	3.1%	6.1%		
total country	54	41	90	10	66	46	73	17	36	128	23	57	27	123	233	9	61	22	21	116	49	34	32	63	49	96		1576

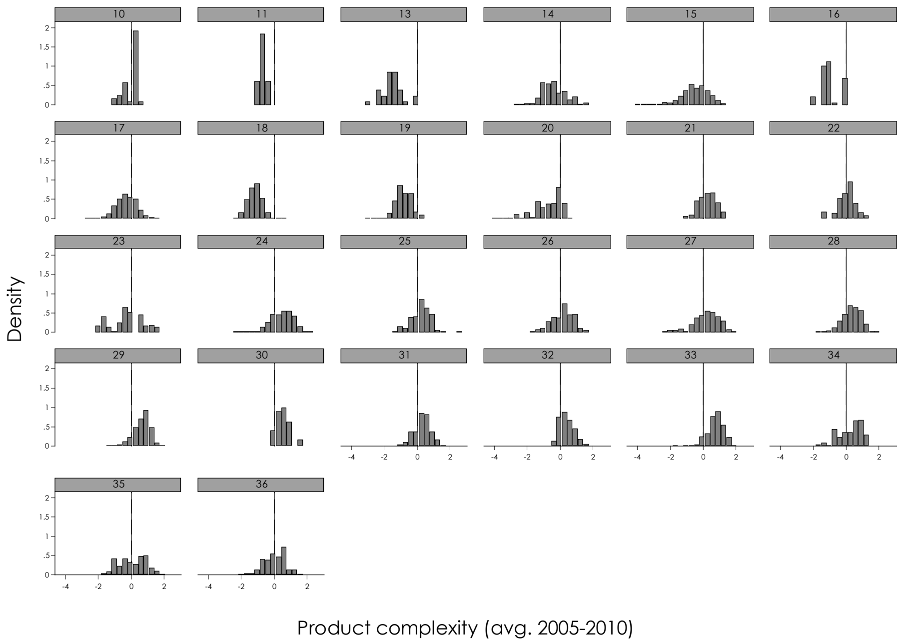
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 32: Distribution of product complexity scores for the EU27 countries for products where the country has an RCA>1



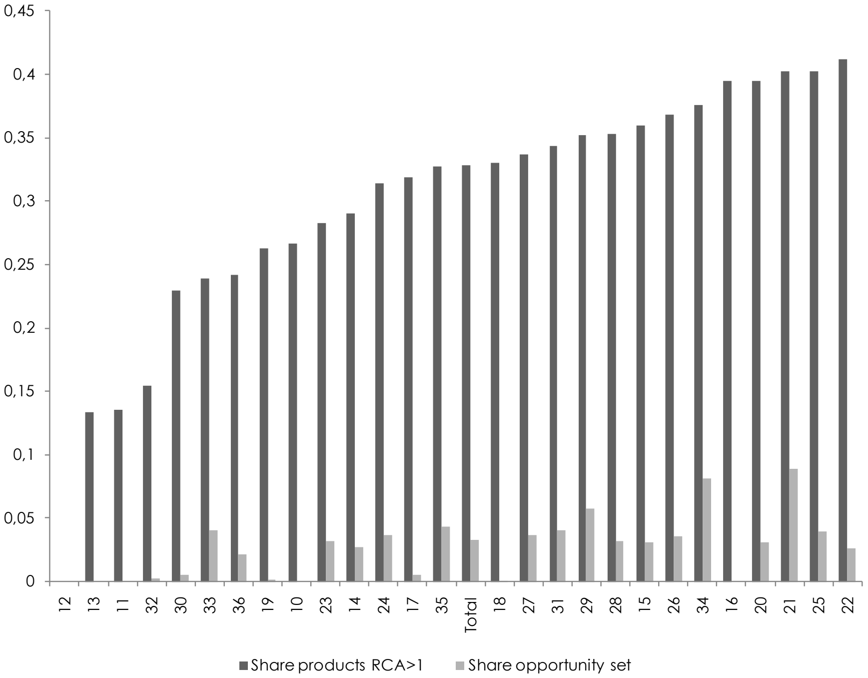
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);

Figure 33: Distribution of product complexity scores over NACE sectors in the EU27 for products where the sector in a country has an RCA>1



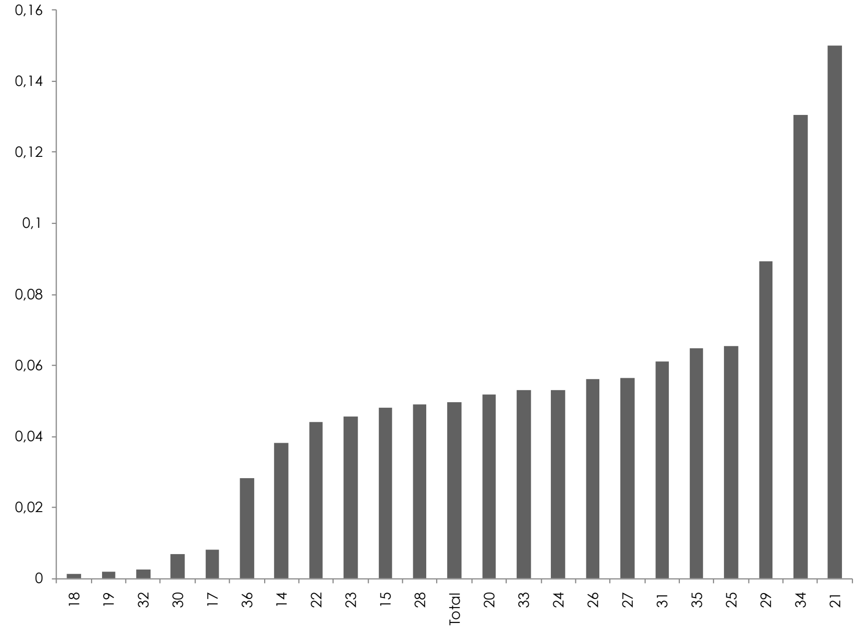
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010);

Figure 34: Share of products with comparative advantage(RCA>1) and share of products in opportunity set, EU 27 sectors including intra-EU trade



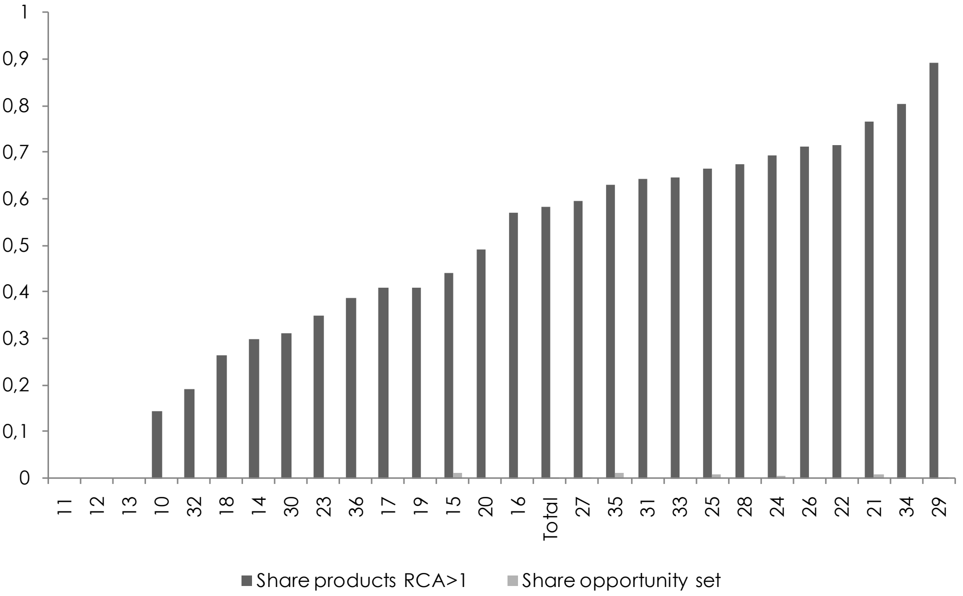
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 35: Share of products in opportunity set in set of undeveloped products (RCA<1), EU 27 sectors including intra-EU trade



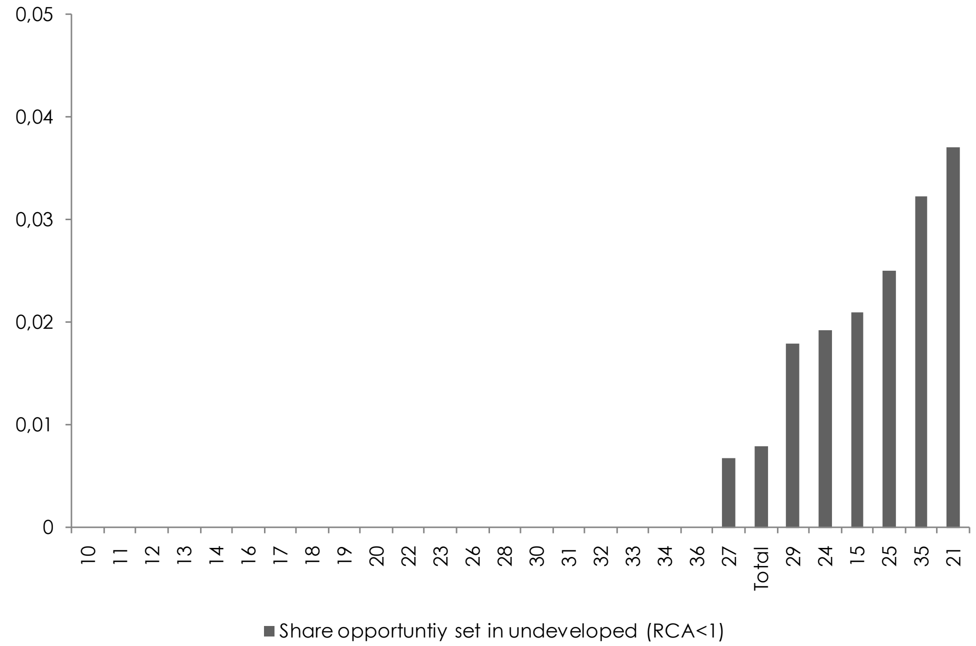
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 36: Share of products with comparative advantage (RCA>1) and share of products in opportunity set, EU 27 sectors excluding intra-EU trade



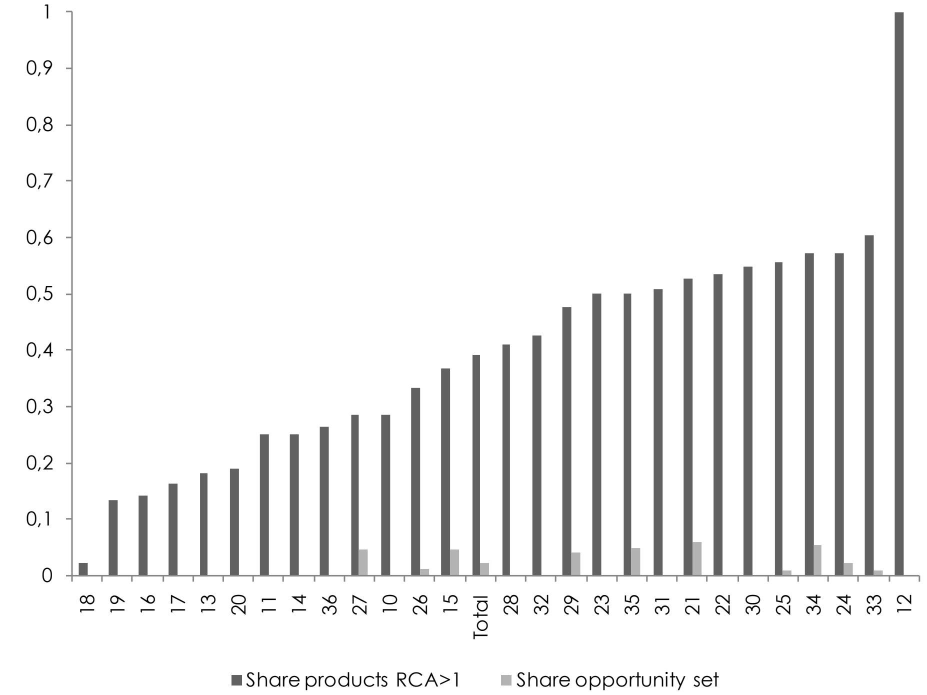
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 37: Share of products in opportunity set in set of undeveloped products (RCA<1), EU 27 sectors excluding intra-EU trade



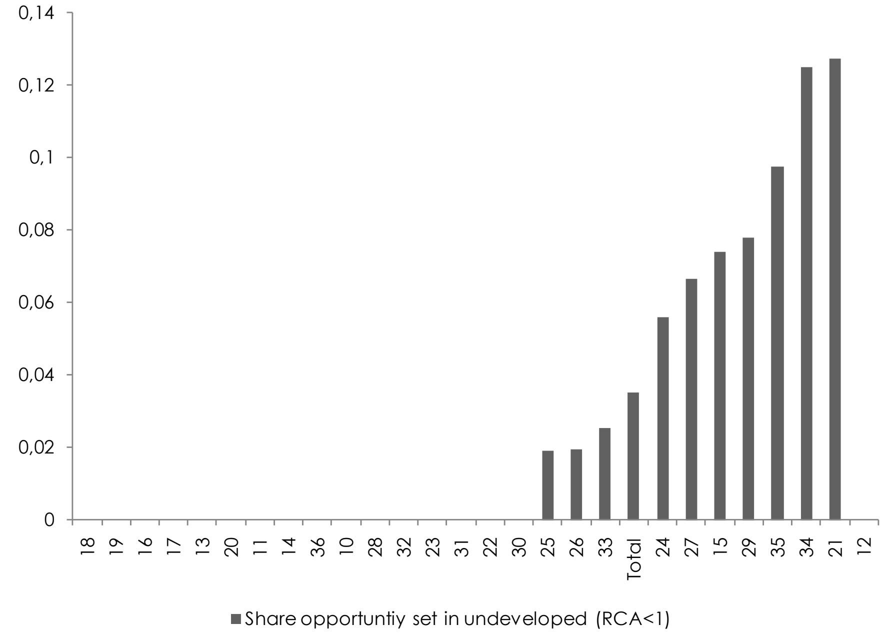
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 38: Share of products with comparative advantage (RCA>1) and share of products in opportunity set, USA



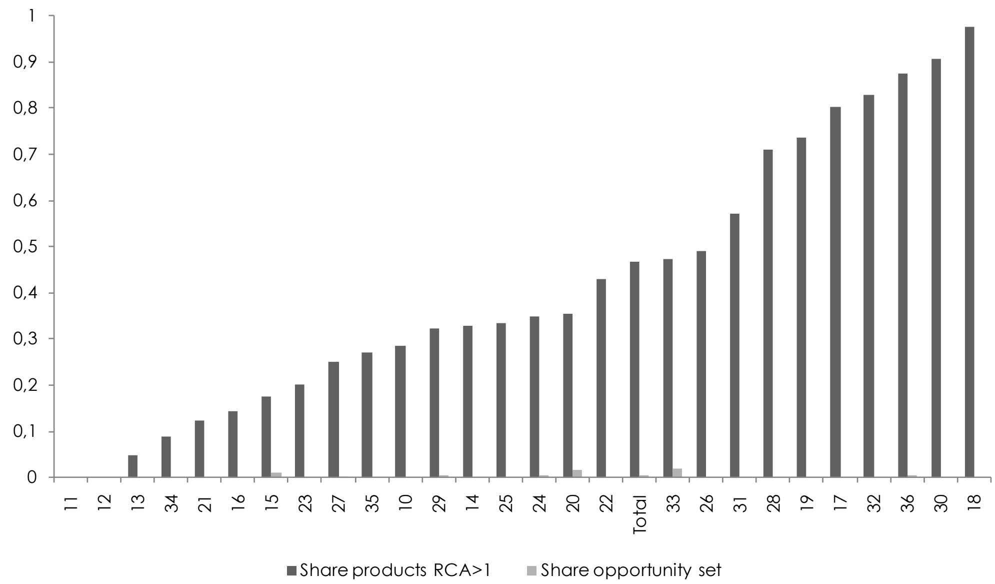
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 39: Share of products in opportunity set in set of undeveloped products (RCA<1), USA



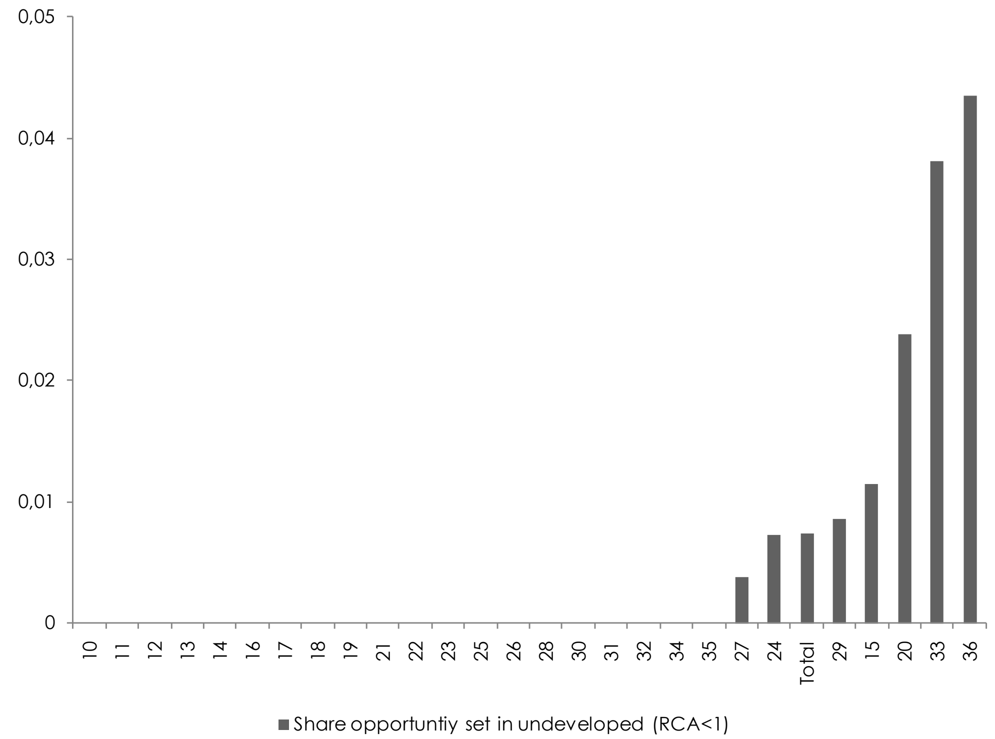
Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 40: Share of products with comparative advantage (RCA>1) and share of products in opportunity set, China



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 41: Share of products in opportunity set in set of undeveloped products (RCA<1), China



Source: WIFO calculations; BACI dataset (Gaulier - Zignago, 2010)

Tables of country, sector and product codes

Table 21: Country abbreviations ISO 3166 alpha 3 (EU 27 bold characters)

ISO_3166_3	NAME	ISO_3166_3	NAME	ISO_3166_3	NAME
ABW	Aruba	GLP	Guadeloupe	PAK	Pakistan
AFG	Afghanistan	GMB	Gambia	PAN	Panama
AGO	Angola	GNB	Guinea-Bissau	PCN	Pitcairn Islands
AIA	Anguilla	GNQ	Equatorial Guinea	PER	Peru
ALA	Åland Islands	**GRC**	**Greece**	PHL	Philippines
ALB	Albania	GRD	Grenada	PLW	Palau
AND	Andorra	GRL	Greenland	PNG	Papua New Guinea
ANT	Netherlands Antilles	GTM	Guatemala	**POL**	**Poland**
ARE	United Arab Emirates	GUF	French Guiana	PRI	Puerto Rico
ARG	Argentina	GUM	Guam	PRK	Korea (North)
ARM	Armenia	GUY	Guyana	**PRT**	**Portugal**
ASC	Ascension	HKG	Hong Kong	PRY	Paraguay
ASM	American Samoa	HMD	Heard and McDonald Islands	PSE	Gaza Strip
ATG	Antigua and Barbuda	HND	Honduras	PSE	West Bank
AUS	Australia	HRV	Croatia	PYF	French Polynesia
AUT	**Austria**	HTI	Haiti	QAT	Qatar
AZE	Azerbaijan	**HUN**	**Hungary**	REU	Réunion
BDI	Burundi	IDN	Indonesia	**ROU**	**Romania**
BEL	**Belgium**	IMN	Isle of Man	RUS	Russia
BLX	**Belgium and Luxemburg**	IND	India	RWA	Rwanda
BEN	Benin	**IRL**	**Ireland**	SAU	Saudi Arabia
BES	Bonaire, Saint Eustatius and Saba	IRN	Iran	SCG	Serbia and Montenegro
BFA	Burkina Faso	IRQ	Iraq	SDN	Sudan
BGD	Bangladesh	ISL	Iceland	SEN	Senegal
BGR	**Bulgaria**	ISR	Israel	SGP	Singapore
BHR	Bahrain	**ITA**	**Italy**	SHN	Saint Helena
BHS	Bahamas	JAM	Jamaica	SLB	Solomon Islands
BIH	Bosnia and Herzegovina	JEY	Jersey	SLE	Sierra Leone
BLM	Saint Barthélemy	JOR	Jordan	SLV	El Salvador
BLR	Belarus	JPN	Japan	SMR	San Marino
BLZ	Belize	KAZ	Kazakhstan	SOM	Somalia
BMU	Bermuda	KEN	Kenya	SPM	Miquelon
BOL	Bolivia	KGZ	Barak	SPM	Saint Pierre und Miquel
BRA	Brazil	KGZ	Kyrgyzstan	SRB	Serbia
BRB	Barbados	KHM	Cambodia	SSD	South Sudan
BRN	Brunei Darussalam	KIR	Kiribati	STP	São Tomé und Príncipe
BTN	Bhutan	KNA	Saint Kitts and Nevis	SUR	Suriname
BVT	Bouvet Islands	KOR	Korea (South)	**SVK**	**Slovakia**
BWA	Botswana	KWT	Kuwait	**SVN**	**Slovenia**
CAF	Central African Republic	LAO	Laos	**SWE**	**Sweden**
CAN	Canada	LBN	Lebanon	SWZ	Swaziland
CCK	Keeling Islands	LBR	Liberia	SXM	Sint Maarten
CCK	Cocos Islands	LBY	Libya	SYC	Seychelles
CHE	Switzerland	LCA	Saint Lucia	SYR	Syria
CHL	Chile		Liechtenstein	TCA	Caicos Islands
CHN	China	LKA	Sri Lanka	TCA	Turks and Caicos Islands
CIV	Ivory Coast	LSO	Lesotho	TCD	Chad
CMR	Cameroon	**LTU**	**Lithuania**	TGO	Togo
COD	Kongo (Kinshasa)	**LUX**	**Luxembourg**	THA	Thailand
COG	Kongo (Brazzaville)	**LVA**	**Latvia**	TJK	Sarvan
COK	Cook Islands	MAC	Macao	TJK	Tajikistan
COL	Colombia	MAF	Saint Martin	TJK	Vorukh
COM	Comoros	MAR	Morocco	TKL	Tokelau
CPT	Clipperton	MCO	Monaco	TKM	Turkmenistan
CPV	Cape Verde	MDA	Moldova	TLS	Oecusse District
CRI	Costa Rica	MDG	Madagascar	TLS	East Timor
CUB	Cuba	MDV	Maldives	TON	Tonga
CUW	Curaçao	MEX	Mexico	TTA	Tristan da Cunha
CXR	Christmas Islands	MHL	Marshall Islands	TTO	Tobago
CYM	Cayman Islands	MKD	Macedonia	TTO	Trinidad and Tobago
CYP	**Cyprus**	MLI	Mali	TUN	Tunisia
CZE	**Czech Republic**	**MLT**	**Malta**	TUR	Turkey
DEU	**Germany**	MMR	Myanmar	TUV	Lagoon Island
DJI	Djibouti	MNE	Montenegro	TUV	Tuvalu
DMA	Dominica	MNG	Mongolia	TWN	Taiwan
DNK	**Denmark**	MNP	Northern Mariana Islands	TZA	Tanzania
DOM	Dominican Republic	MOZ	Mozambique	UGA	Uganda
DZA	Algeria	MRT	Mauritania	UKR	Ukraine
ECU	Ecuador	MSR	Monserrat	URY	Uruguay
EGY	Egypt	MTQ	Martinique	USA	United States
ERI	Eritrea	MUS	Mauritius	UZB	Uzbekistan
ESH	Western Sahara	MWI	Malawi	VAT	Vatican City
ESP	**Spain**	MYS	Malaysia	VCT	Saint Vincent
EST	**Estonia**	MYT	Mayotte	VDR	South Vietam
ETH	Ethiopia	NAM	Namibia	VEN	Venezuela
FIN	**Finland**	NCL	New Caledonia	VGB	British Virgin Islands
FJI	Fiji	NER	Niger	VIR	US Virgin Islands
FLK	Falkland Islands	NFK	Norfolk Island	VNM	Vietnam
FRA	**France**	NGA	Nigeria	VUT	Vanuatu
FRO	Faeroe Islands	NIC	Nicaragua	WLF	Wallis and Futuna Islanc
FSM	Micronesia	NIU	Niue	WSM	Samoa
GAB	Gabon	**NLD**	**Netherlands**	XXK	Kosovo
GBR	**United Kingdom**	NOR	Norway	YEM	Yemen
GEO	Georgia	NPL	Nepal	ZAF	South Africa
GHA	Ghana	NRU	Nauru	ZAR	Zaire
GIB	Gibraltar	NZL	New Zealand	ZMB	Zambia
GIN	Guinea	OMN	Oman	ZWE	Zimbabwe

Table 22: NACE 1.1 classification for the business sector

01 : Agriculture, hunting and related service activities
02 : Forestry, logging and related service activities
05 : Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
10 : Mining of coal and lignite; extraction of peat
11 : Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying
12 : Mining of uranium and thorium ores
13 : Mining of metal ores
14 : Other mining and quarrying
15 : Manufacture of food products and beverages
16 : Manufacture of tobacco products
17 : Manufacture of textiles
18 : Manufacture of wearing apparel; dressing and dyeing of fur
19 : Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20 : Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21 : Manufacture of pulp, paper and paper products
22 : Publishing, printing and reproduction of recorded media
23 : Manufacture of coke, refined petroleum products and nuclear fuel
24 : Manufacture of chemicals and chemical products
25 : Manufacture of rubber and plastic products
26 : Manufacture of other non-metallic mineral products
27 : Manufacture of basic metals
28 : Manufacture of fabricated metal products, except machinery and equipment
29 : Manufacture of machinery and equipment n.e.c.
30 : Manufacture of office machinery and computers
31 : Manufacture of electrical machinery and apparatus n.e.c.
32 : Manufacture of radio, television and communication equipment and apparatus
33 : Manufacture of medical, precision and optical instruments, watches and clocks
34 : Manufacture of motor vehicles, trailers and semi-trailers
35 : Manufacture of other transport equipment
36 : Manufacture of furniture; manufacturing n.e.c.
37 : Recycling
40 : Electricity, gas, steam and hot water supply
41 : Collection, purification and distribution of water
45 : Construction
50 : Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel
51 : Wholesale trade and commission trade, except of motor vehicles and motorcycles
52 : Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
55 : Hotels and restaurants
60 : Land transport; transport via pipelines
61 : Water transport
62 : Air transport
63 : Supporting and auxiliary transport activities; activities of travel agencies
64 : Post and telecommunications
65 : Financial intermediation, except insurance and pension funding
66 : Insurance and pension funding, except compulsory social security
67 : Activities auxiliary to financial intermediation
70 : Real estate activities
71 : Renting of machinery and equipment without operator and of personal and household goods
72 : Computer and related activities
73 : Research and development
74 : Other business activities

Table 23: HS Codes (HS 1992): Major Sections

I	LIVE ANIMALS, ANIMAL PRODUCTS
II	VEGETABLE PRODUCTS
III	ANIMAL OR VEGETABLE FATS AND OILS AND THEIR CLEAVAGE PRODUCTS, PREPARED EDIBLE FATS ANIMAL OR VEGETABLE WAXES
IV	PREPARED FOODSTUFFS, BEVERAGES, SPIRITS AND VINEGAR, TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES
V	MINERAL PRODUCTS
VI	PRODUCTS OF THE CHEMICAL OR ALLIED INDUSTRIES
VII	PLASTICS AND ARTICLES THEREOF RUBBER AND ARTICLES THEREOF
VIII	RAW HIDES AND SKINS, LEATHER, FURSKINS AND ARTICLES THEREOF, SADDLERY AND HARNESS, TRAVEL GOODS, HANDBAGS AND SIMILAR , ARTICLES OF ANIMAL GUT (OTHER THAN SILKWORM GUT)CONTAINERS
IX	WOOD AND ARTICLES OF WOOD WOOD CHARCOAL CORK AND ARTICLES OF CORK MANUFACTURES OF STRAW, OF ESPARTO OR OF OTHER PLAITING BASKETWARE AND WICKERWORKMATERIALS
X	PULP OF WOOD OR OF OTHER FIBROUS CELLULOSIC MATERIAL RECOVERED (WASTE AND SCRAP) PAPER OR PAPERBOARD PAPER AND PAPERBOARD AND ARTICLES THEREOF
XI	TEXTILES AND TEXTILE ARTICLES
XII	FOOTWEAR, HEADGEAR, UMBRELLAS, SUN UMBRELLAS, WALKING-STICKS, SEAT-STICKS, WHIPS, RIDING-CROPS AND PARTS THEREOF PREPARED FEATHERS AND ARTICLES MADE THEREWITH ARTIFICIAL FLOWERS ARTICLES OF HUMAN HAIR
XIII	ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS CERAMIC PRODUCTS GLASS AND GLASSWARE
XIV	NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METAL, AND ARTICLES THEREOF IMITATION JEWELLERY COIN
XV	BASE METALS AND ARTICLES OF BASE METAL
XVI	MACHINERY AND MECHANICAL APPLIANCES ELECTRICAL EQUIPMENT PARTS THEREOF SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES
XVII	VEHICLES, AIRCRAFT, VESSELS AND ASSOCIATED TRANSPORT EQUIPMENT
XVIII	OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS CLOCKS AND WATCHES, MUSICAL INSTRUMENTS PARTS AND ACCESSORIES THEREOF
XIX	ARMS AND AMMUNITION PARTS AND ACCESSORIES THEREOF
XX	MISCELLANEOUS MANUFACTURED ARTICLES
XXI	WORKS OF ART, COLLECTORS' PIECES AND ANTIQUES

Table 24: HS Codes (HS 1992): 2 – digit product group descriptions

SECTION	HS 1992, 2 digit description
I	1, Live animals
I	2, Meat and edible meat offal
I	3, Fish & crustacean, mollusc & other aquatic inv
I	4, Dairy prod, birds' eggs, natural honey
I	5, Products of animal origin, nes or included.
II	6, Live tree & other plant bulb, root cut flowe
II	7, Edible vegetables and certain roots and tubers
II	8, Edible fruit and nuts peel of citrus fruit or
II	9, Coffee, tea, mat‹ and spices.
II	10, Cereals
II	11, Prod.mill.indust malt starches
II	12, Oil seed, oleagi fruits miscell grain, seed,
II	13, Lac gums, resins & other vegetable saps & ext
II	14, Vegetable plaiting materials vegetable produc
III	15, Animal/veg fats & oils & their cleavage produc
IV	16, Prep of meat, fish or crustaceans, molluscs et
IV	17, Sugars and sugar confectionery.
IV	18, Cocoa and cocoa preparations.
IV	19, Prep.of cereal, flour, starch/milk pastrycook
IV	20, Prep of vegetable, fruit, nuts or other parts
IV	21, Miscellaneous edible preparations.
IV	22, Beverages, spirits and vinegar.
IV	23, Residues & waste from the food indust prepr a
IV	24, Tobacco and manufactured tobacco substitutes
V	25, Salt sulphur earth & ston2 & plastering mat.
V	26, Ores, slag and ash.
V	27, Mineral fuels, oils & product of their distill
VI	28, Inorgn chem compds of prec mtl, radioact elem
VI	29, Organic chemicals.
VI	30, Pharmaceutical products.
VI	31, Fertilisers.
VI	32, Tanning/dyeing extract, tannins & derivs, pigm
VI	33, Essential oils & resinoids, perf, cosmetic/toi
VI	34, Soap, organic surface-active agents, washing p
VI	35, Albuminoidal subs
VI	36, Explosives,
VI	37, Photographic or cinematographic goods.
VI	38, Miscellaneous chemical products.
VII	39, Plastics and articles thereof.
VII	40, Rubber and articles thereof.
VIII	41, Raw hides and skins (other than furskins) and
VIII	42, Articles of leather, saddlery/harness, travel bags
VIII	43, Furskins and artificial fur, manufactures ther

XIX	44, Wood and articles of wood
XIX	45, Cork and articles of cork.
XIX	46, Manufactures of straw, esparto/other plaiting
XIX	47, Pulp of wood/of other fibrous cellulosic mat
XIX	48, Paper & paperboard, art of paper pulp, paper/p
XIX	49, Printed books, newspapers, pictures & other pr
XI	50, Silk.
XI	51, Wool, fine/coarse animal hair, horsehair yarn
XI	52, Cotton.
XI	53, Other vegetable textile fibres
XI	54, Man-made filaments.
XI	55, Man-made staple fibres.
XI	56, Wadding, felt & nonwoven
XI	57, Carpets and other textile floor coverings.
XI	58, Special woven fab
XI	59, Impregnated, coated, cover/laminated textile f
XI	60, Knitted or crocheted fabrics.
XI	61, Art of apparel & clothing access, knitted or c
XI	62, Art of apparel & clothing access, not knitted/
XI	63, Other made up textile articles
XII	64, Footwear, gaiters and the like, parts of such
XII	65, Headgear and parts thereof.
XII	66, Umbrellas, walking-sticks, seat-sticks, whips,
XII	67, Prepr feathers & down, arti flower
XIII	68, Art of stone, plaster, cement, asbestos, mica/
XIII	69, Ceramic products.
XIII	70, Glass and glassware.
XIV	71, Natural/cultured pearls, prec stones & metals,
XV	72, Iron and steel.
XV	73, Articles of iron or steel.
XV	74, Copper and articles thereof.
XV	75, Nickel and articles thereof.
XV	76, Aluminium and articles thereof.
XV	78, Lead and articles thereof.
XV	79, Zinc and articles thereof.
XV	80, Tin and articles thereof.
XV	81, Other base metals, cermets, articles thereof.
XV	82, Tool, implement, cutlery, spoon & fork, of bas
XV	83, Miscellaneous articles of base metal.
XVI	84, Nuclear reactors, boilers, mchy & mech applian
XVI	85, Electrical mchy equip parts thereof, sound rec
XVII	86, Railw/tramw locom, rolling-stock & parts there
XVII	87, Vehicles o/t railw/tramw roll-stock, pts & acc
XVII	88, Aircraft, spacecraft, and parts thereof.
XVII	89, Ships, boats and floating structures.
XVIII	90, Optical, photo, cine, meas, checking, precisio

XVIII	91, Clocks and watches and parts thereof.
XVIII	92, Musical instruments parts and access of such
XIX	93, Arms and ammunition, parts and accessories the
XX	94, Furniture, bedding, mattress, matt support, cu
XX	95, Toys, games & sports requisites parts & acces
XX	96, Miscellaneous manufactured articles.
XXI	97, Works of art, collectors' pieces and antiques.
XXI	98, UN Special Code
XXI	99, UN Special Code