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Structural change in trade and the development of the manufacturing share

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Abstract

This paper examines structural change in global trade and its impact in the development of manufacturing shares across countries over time. It focuses on the dynamics of variety creation and destruction in exports and links the observed outcomes to the development of manufacturing shares across countries. The results show that while there is an inverse-U-shaped relationship with income per capita levels across countries of manufacturing shares, a specialisation in product lines with a high likelihood of displacing other exports and a high propensity to induce a clustering in the uptake of exports in related product lines is positively associated with manufacturing shares. Controlling for income levels more complex export portfolios are weakly associated with smaller manufacturing shares. These effects are mitigated when these parameters combine at the extreme ends of their values range.

JEL – Codes: I25, O11, O14

Key Words: structural change in trade, manufacturing share

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1 Introduction

This paper examines structural change in global trade and its impact in the development of manufacturing shares across countries over time. It focuses on the dynamics of variety creation and destruction in exports and links the observed outcomes to the development of manufacturing shares across countries.

The process of the development of export variety has been extensively studied. A key feature of this process is that it is observable at different levels of an economy: the creation of novelty and the replacement of less varieties can be observed at the level of technological components, technologies, products, product systems, companies. This process it is mediated through markets and leads to changes in the relative frequencies of these entities. While these patterns of change are particularly sharp at the level of companies, they carry also over to industries and sectors leading to their differential growth through a permanent change from a process of variety creation and market selection inside them. Hence, changes between and within industries are two closely related aspects of structural change that in addition do not take place in an isolated way in specific countries. The focus of world production shifts in permanence as companies from new countries replace companies from old ones as leaders in the production of certain types of goods. As a consequence also the trade patterns change, and they are therefore particularly apt to capture the changes driving structural change within and across countries.

Indeed, prior research shows that the variety of traded products has steadily increased in the past decades. Broda - Weinstein (2004, 2006), for instance, point out that in the US between 1972 and 2001 imported variety rose by 212 percent. More than half of this change was due to an increase in the number of countries exporting any product to the US and the other half of it was due to a rise in the number of products exported to the US, indicating that across sectors the variety of products has increased. These increments in traded varieties seem also to have an impact on economic performance. They show for the U.S. that U.S. welfare has increased by 3% due to this development. Similarly, using Funke - Ruhwedel (2001) present empirical evidence that relative product variety and relative income per capita across countries are strongly correlated. Economic theory suggests that the permanent increase in the product variety in an economy positively correlates with increases in per capita income and labour productivity growth (e.g. Romer 1990, Jones 1998), as this augments the stock of knowledge available to innovators in an economy.

The increase in variety of products and selection mechanisms induce changes in the composition of the productive structures of economies that affect also the product mix countries export. Hausmann - Hwang - Rodrik (2007) have shown that the composition of the mix of goods a country produces, and exports and its rate of economic growth are linked. 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, and that for a country specialising in some products will lead to higher growth than specialising in others. Whether a country will be able to stop producing products with low implicit productivity and move into higher valued goods will depend on the extent its firms are able to obtain minimum productivity thresholds such that production is viable. Hence, the process of variety generation and selection induce a horizontal differentiation. This leads to changes in the composition of the bundles of products a country produces and exports and leads to differential growth both across economies and across sectors within these economies.

Next to horizontal differentiation structural upgrading within sectors is an important driver of differential growth. One way to examine this process in the absence of a full sample of firm-level data is to investigate the development of export quality. Linder (1961) has observed that product quality is an important determinant of the direction of trade. In his view, the interplay between domestic demand and industry plays an important role in the development of comparative advantage; commodities that are in high demand at home induce also a specialisation of the domestic industries in these goods. For this reason, high-income countries will develop a comparative advantage in the production of high-quality goods, because these goods are in demand in their domestic markets. The converse reasoning holds for low-income countries. For this reason there will be an overlap of production and consumption patterns among countries with similar income per capita levels and because of this overlap they are also likely to trade more intensely amongst each other.

Hallak (2006, 2010) has examined this relationship and has found that for product categories where per capita income should be correlated with quality supply and quality demand a country's higher-quality exports are disproportionately directed to higher-income countries. This echoes also results by Debaere (2005) who has shown analysing bilateral trading relationships that countries with similar GDP levels also trade larger fractions of their income. Evenett - Keller (2002) provide evidence that this is related to the share of intra-industry trade between any pair of trading countries. Similarity in income levels explains the intensity of bilateral trade relationships better the more intensely they trade inside industries. This suggests that trade between these countries is in differentiated products. Schott's (2004) results indicate that large part of this differentiation is vertical, i.e. it takes place in product quality. Sutton - Trefler (2016), finally, show that vertical differentiation is not only a phenomenon of relevance for high-income countries. Their results underscore that climbing the quality ladder is very important for countries catching up, whereas the horizontal differentiation of productive structures through the development of new products becomes more important for countries that are on top of the quality ladder.

Starting with the seminal contribution of Imbs – Wacziarg (2003), who have shown that the industrial diversification follows a hump-shaped pattern across income levels with diversification increasing as countries grow richer but then specialise again at very high income levels, researchers have also started to examine the relationship between diversification and exports. Cadot et al (2011, 2013) establish a similar pattern in exports arguing that countries apparently travel through diversification cones where countries due to hysteresis fail to shut down export lines in which they no longer have a comparative advantage and therefore inflate their export portfolio artificially until these export lines are no longer economically viable and are eventually shut down.

A number of contributions have stressed the importance of existing capabilities in the process diversification. On set of contributions has shown that the likelihood of diversification is higher for those products and technologies that are related to countries' existing exports and technological competencies (e.g. Hausmann – Klinger 2007; Hausmann et al 2007; Hidalgo et al 2007). Others have studied the underlying micro-economic processes and argued that local search and discovery is an important cause of path dependence in exports (Hausmann

– Rodrik 2003; Petralia et al 2017;) and a source of sub-optimal levels of diversification for long term growth. Others again have in turn studies ways to overcome path dependence showing broader technological search is likely to dampen path dependencies (cf. Reinstaller – Reschenhofer 2019), whereas the attraction of foreign direct investment is not so well suited (cf. Lectard – Rougier 2018).

Building on Klimek et al (2012), who have studied structural change in global trade as a process of creative destruction, this paper tries to link the dynamics of variety creation and destruction in exports to the development of the manufacturing share across countries and therefore to the findings of Imbs-Wacziarg (2003). The results suggest that while there is an inverse-U-shaped relationship with income per capita levels across countries of manufacturing shares, a specialisation of countries in product lines with a high likelihood of displacing other exports and a high propensity to induce a clustering in the uptake of exports in related product lines is positively associated with manufacturing shares. Controlling for income levels more complex export portfolios are weakly associated with smaller manufacturing shares. These effects are mitigated when these parameters combine at the extreme ends of their values range.

2 Data, methods and indicators

2.1 Data

The analysis presented in this paper 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 lines classified using the Harmonized System at the 6-digit level. It covers the years 1995 till 2018 using the HS1992 product classification. 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.[1] In total the database contains more than 1.75 billion trade records for specific commodities 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 regularly updated and reconciles inconsistencies present in the COMTRADE database related to 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

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

conversion of other units into ton units using mirror flows reported in tons by a country and in another unit by the other trading partner. This implies that unit values can be examined for a larger number of commodities.

The time window provided by the release using the HS1992 classification ranging from 1995 to 2018 is long enough to capture substantial changes in productive structures and ensure that all major economies are covered consistently. In the present analysis 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 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 or to account for free ports have been dropped. Values at the product level have been transformed to represent constant values by dividing them with chained Fisher product level unit value indices with base year 2000.

All non-trade related indicators used in some descriptive exercises and in the regression analysis at the end of the paper were obtained from the World Bank.

2.2 Methods and indicators

The appearance and disappearance of products or product classes or changes in the composition of the product basket a sector exports have been examined using a methodology proposed by Klimek - Hausmann - Thurner (2012). These authors have examined the simultaneous appearance of product classes in trade as well as the appearance of some product classes followed by the delayed disappearance of other product classes within and across countries.

The analysis of co-appearance events consists of the identification of product classes which countries start exporting at the same point in time. This happens through a pair-wise comparison of all product classes in a country. The identified co-appearance events are then counted. On the basis of this count it is possible to construct a co-appearance index for each product class that measures the number of co-appearance events in which it participates across countries over the period of observation (in our case twenty-three years).

The aim of the present analysis is to identify products that permanently appear in or disappear from an export basket of a country. At the level of HS-6-digit product lines it is frequent to observe single years or short time periods where an export active product line in a country is not exported. It can also be observed that exports in a specific product line are singular events. For this reason we have used kernel smoothing to fill these gaps for all HS-6-digit product-country time series, i.e. we computed the conditional expected value for the zero-observations given the values observed before and after them. A product was deemed to disappear or appear if after the smoothing we obtained consistent export activity or consistent export inactivity. After the smoothing appearance and disappearance events were classified as follows:

Appearance: $A(i)_{c,t} = 1 \cdots$ if $v_{c,t-1} \leq 1\ Mio.USD$ and $v_{c,t} > Mio.USD$; $A(i)_{c,t} = 0 \cdots$ otherwise.

Disappearance: $D(i)_{c,t} = 1 \cdots$ if $v_{c,t-1} > 1\ Mio.USD$ and $v_{c,t} \leq 1\ Mio.USD$; $D(i)_{c,t} = 0 \cdots$ otherwise,

where *t* defines a specific point in time and *c* a specific country, $v_{c,t-1}$is the value of exports a country has in any product class *i*. The product index *i,j* runs from 1 to *n*, where n corresponds to the number of product classes in the analysis. Hence, the count of co-appearances between any pair of product classes *i* and *j* is given by

$$PA_{i,j} = \sum_{t}\sum_{c} A(i)_{c,t}A(j)_{c,t} \quad \text{for each } i,j = 1..n \ \ (1),$$

whereas the count of displacements over period $\mathcal{t}$ after the appearance of a product class *i* is given by

$$PAD_{i,j}^{(\mathcal{t})} = \sum_{t}\sum_{c}\sum_{t'=t+1}^{t+\mathcal{t}} A(i)_{c,t}D(j)_{c,t'} \quad \text{for each } i,j = 1..n \qquad (2).$$

The period $\mathcal{t}$ was set to 3 such that all displacements of a product class *j* three years after the appearance of product class *i* have been taken into account.

The co-appearance index AI follows then from equation (1) if on the one hand we control for the fact that products with a high number of appearances are likely to have also a higher number of co-appearances, and if on the other hand the resulting factor is normalised to lie in the interval [0,1].

$$AI_i = \frac{1}{\mathcal{N}}\sum_{j}\frac{PA_{i,j}}{\max[PA_i, PA_j]} \quad \text{for each } j = 1..n \ \ (3),$$

where $PA_{i,j} = \sum_t \sum_c A(i,j)_{c,t}$ is the number of appearances of each product class *i* and *j* across countries *c* and over all observation periods *t*, and $\mathcal{N}$ is the normalisation factor rescaling the sum to the established range. This index is normalised to lie in the *range between 0 and 1*. Product classes that participate more often in the co-appearance of other product classes score higher. This index captures therefore the presence of temporal clustering in the appearance of products.

This index is closely related to indicators used in product space analysis (e.g. Hausmann - Klinger, 2007; Hidalgo et al., 2007; Reinstaller et al., 2012). Product space analysis views products as being more or less strongly related on the basis of shared underlying capabilities needed to produce them. While these capabilities can't be observed they are revealed through co-export patterns of countries: when countries tend to be strong exporters (i.e. they export with revealed comparative advantage) in any pair of products then these products are assumed to share specific factors of production and capabilities. 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. Two product classes are then closely related in product space 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. If now a country has developed specific capabilities and can draw on specific types of factors of production, then we should expect that countries starts exporting not just in one product class, but simultaneously also in other product classes, that draw on similar the same or similar factors of production. Hence, co-appearance is a manifestation of the relatedness in product space.

Another index of interest for the analysis of structural change is the displacement index. It measures the disappearance of some product class within some specified time window after the appearance of another product class in a country. Analogously to the co-appearance index it measures the number of such displacement events for each product class in which it participates across countries over the observation period. It is defined as

$$DI_i = \frac{1}{\mathcal{N}} \sum_j \left[PAD_{i,j}^{(t)} - PAD_{j,i}^{(t)}\right] \text{ for each } j = 1..n \qquad (4).$$

Clearly, if the sum in equation (4) is negative, then product class i is on average displaced more often by appearances of the other product classes j during the period t. $\mathcal{N}$ is a normalisation factor rescaling the indicator in such a way that it lies in the *range between -1 and 1*.

A positive indicator value instead means that *i* displaces on average more often any other product class *j* than *j* replaces *i* after its appearance. A negative indicator value indicates that a product class is relatively more often displaced by other product classes rather than displacing them itself. Whereas a positive value indicates that a product class displaces more often other product classes than it is displaced itself. The underlying interpretation of this indicator range is that structural change close to the technological frontier goes into the direction of products with positive indicator values where products with negative indicator values tend to disappear. Far off the technological frontier, products with negative displacement scores represent instead an opportunity for market entry.

3 The dynamics of structural change in trade across countries: Descriptive evidence

3.1 The diversification patterns in the world economy and some underlying processes

In the introduction to this section we have argued that the perpetual creation of variety and the displacement of old product classes through new product classes is a principal driver of structural change and long-run economic growth. Figure 1 provides some first empirical evidence for this process. The upper panel of Figure 1 ranks countries by the number of appearances of product classes in the country over the period 1995 and 2018. It also shows the number of disappearances of product classes for each country. The lower panel instead ranks the product classes in the data set by their number of appearances across countries and displays also the number of disappearances for each product class over the same time period.

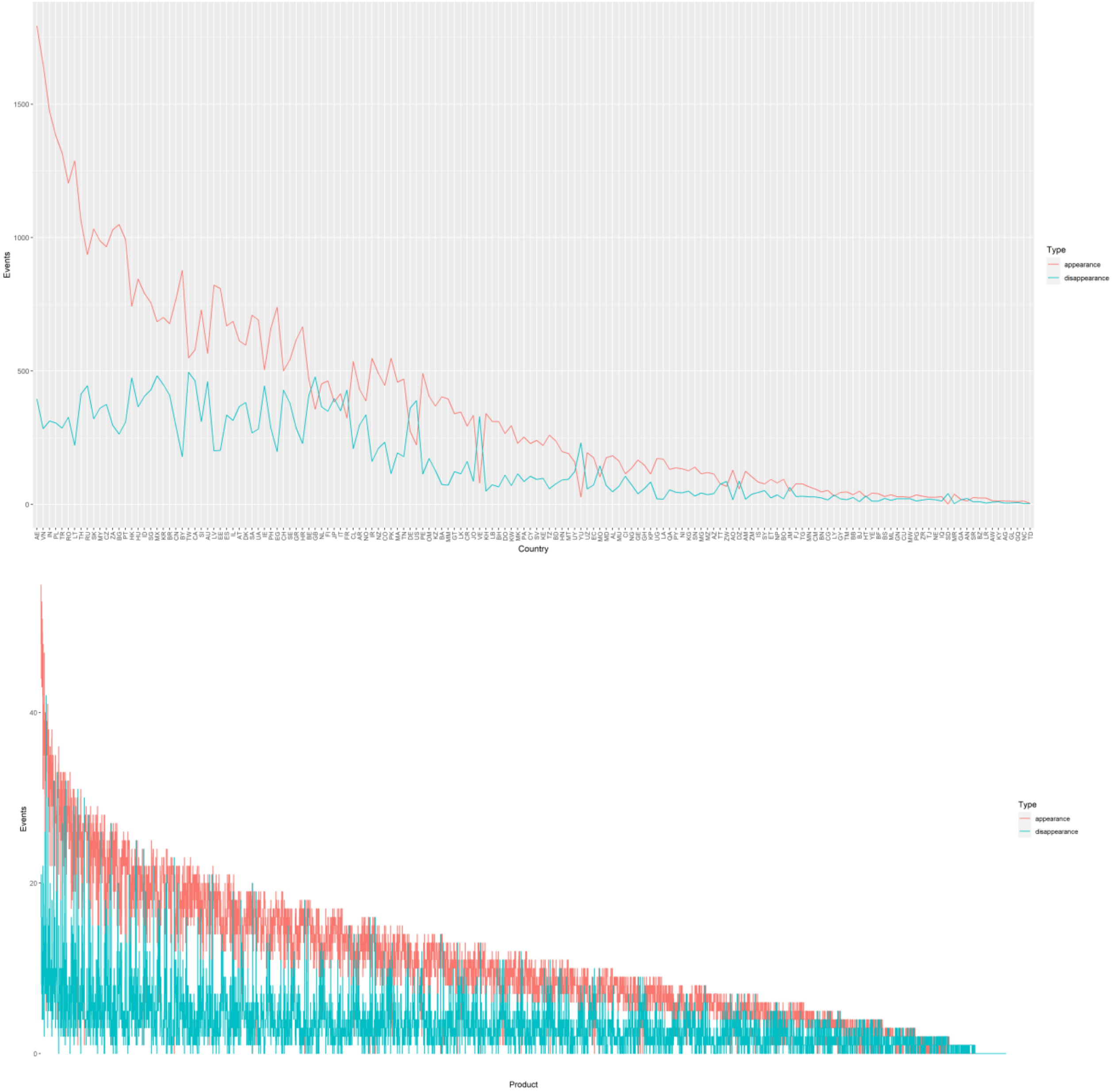
Looking at the upper panel for countries first, we see that the number of appearances and disappearance increases across countries in a non-linear fashion. Appearance and disappearance events of entire six-digit product classes happen frequently. The fifty top ranking countries have experienced between slightly less than 500 and more than 1700 appearance events over the period 1995-2018. The appearance of product classes seems also to be related to the disappearance of other product classes. The countries with the highest number of appearance events register also the highest number of disappearance events. For the fifty top ranking countries in terms of appearance events, disappearance events range between 250 and slightly less than 500, this number into the range between 0 and 250 events for the remaining countries gradually flattening out. A remarkable feature of Figure 1 is that it shows that the number of disappearances of product classes is consistently lower or at the level of product class appearances. This suggests that the variety of export baskets has been steadily increasing across most countries.

The lower panel of Figure 1 largely mirrors the image on the upper panel but shows appearance and disappearance counts at the level of the more than 5000 products across countries in our sample. The appearance counts are very high for a relatively small number of product classes, they lie then in the range between 25 and 100 events for a very small number of product classes. These product classes have also the highest number of disappearance events. A general feature is that in most cases disappearance counts are lower than appearance counts supporting the view of a general trend towards more diversified export portfolios across countries. This increase of variety of exports by countries is driven by a large number of product lines, even though events are somewhat concentrated.

Figure 2 shows how the diversity of the export basket has varied over time across countries. Clearly the number of products a country exports increase with country size and the level of industrialisation. With respect to the reference year 1997 a number of countries, most notably China, Vietnam, India, Turkey Poland have strongly increased the diversity of their export portfolio, whereas diversity of the export portfolio of the top five countries in terms of the diversity of their export portfolio USA, Germany, France, the UK and Italy has decreased. On the other hand, all other economies have increased the diversity of their export portfolios.

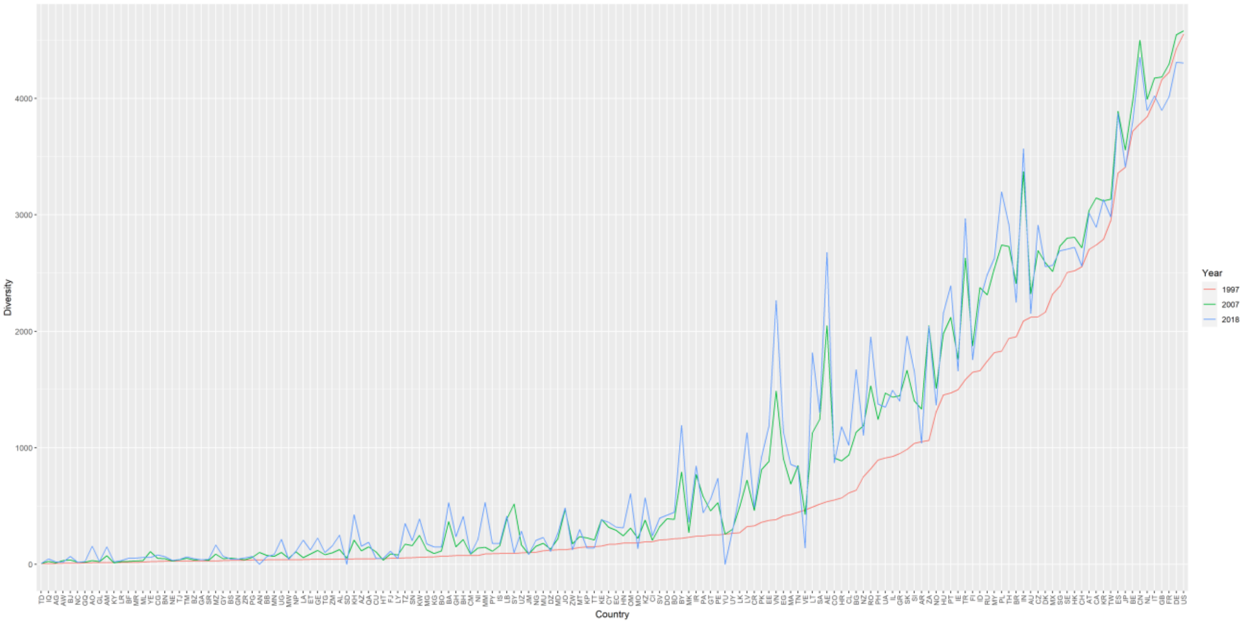
Looking at the development of appearance and disappearance events across countries over time Figure 3 shows that in the twenty years between 1998 and 2018 the development has changed qualitatively. Whereas up to the economic crisis 2008 the number of active export lines across countries has increased after that point in time the number appearance events have decreased whereas disappearance events have been rising steadily up to 2016 where from where on disappearance events are in excess of appearance events such that the number of active export lines across countries has been decreasing since 2016. This indicates that the economic crisis is likely to have exerted an influence on the dynamics of the development of the variety of exports. However, as the broken line shows, the increase or decrease of the number of active export lines is a marginal phenomenon regarding only between 1 and 4 percent of the total number of active export lines. These events are however rather unevenly distributed across countries as Figure 2 suggests.

Figure 1: Appearance and disappearance of HS-6-digit product classes across countries, total number of events between 1995-2018 over country and product rank



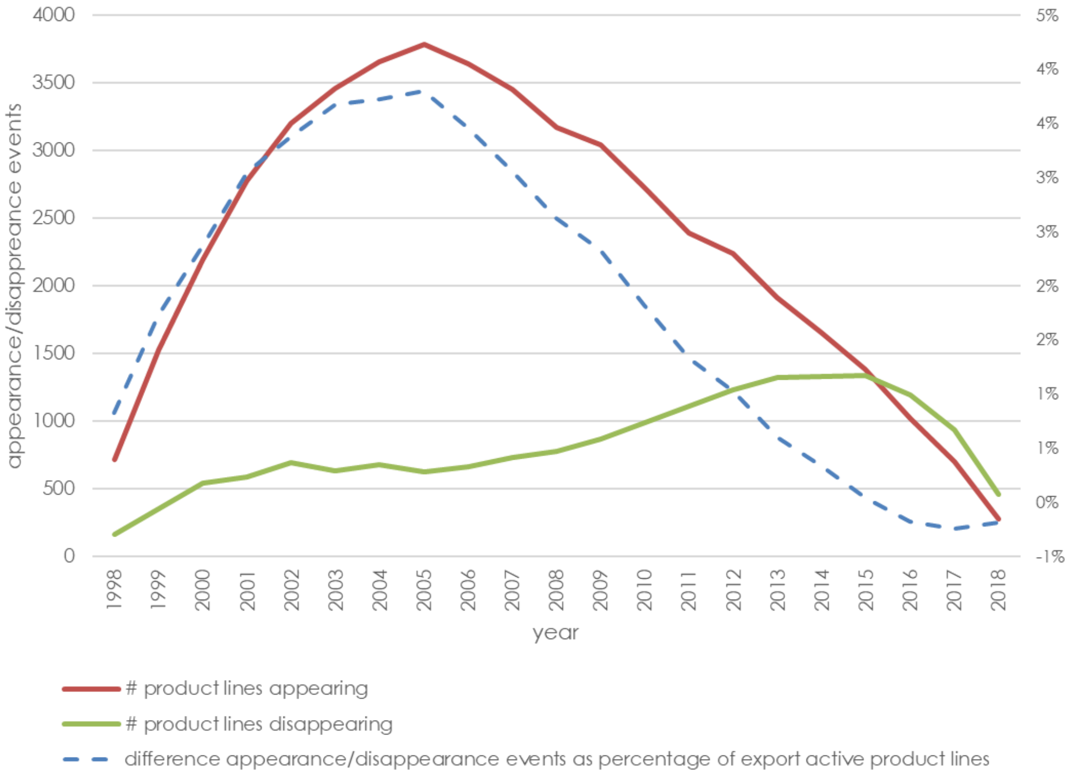
Source: Authors calculations; BACI dataset (Gaulier - Zignago, 2010);

Figure 2: The development of diversity between 1997 and 2018 across countries.



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

Figure 3: Appearance and disappearance events across countries over time.

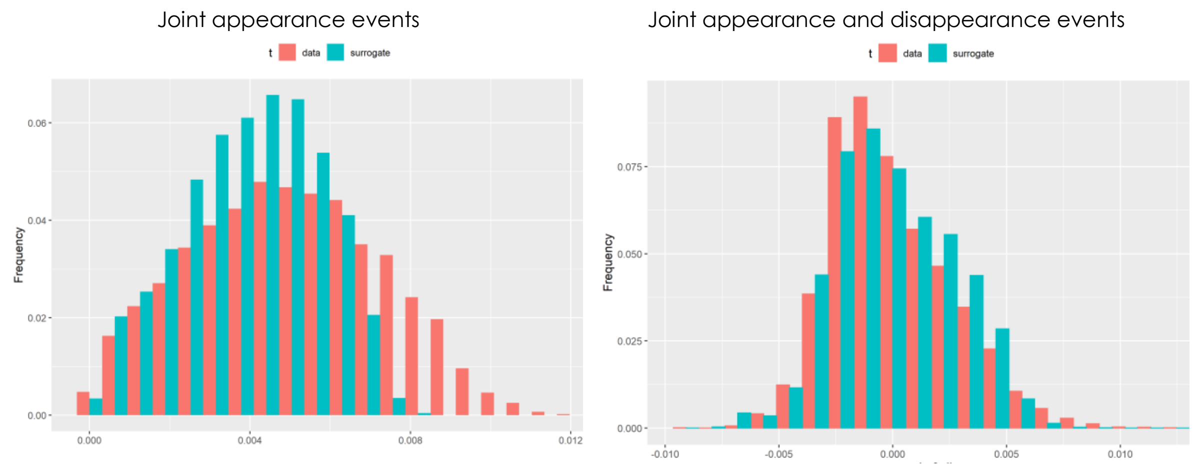


Source: Authors calculations; BACI dataset (Gaulier - Zignago, 2010);

While Figure 1 provides some first evidence for the two principal mechanisms driving structural change, one has to be aware of the inherent limitations of these simple counts. They do not consider country size and most importantly they do not take into account that appearance events in a country are likely to be interdependent. This is the case if -- as postulated by the product space literature -- countries are more likely to diversify into products that are related in terms of the factors of production and capabilities needed to produce them. On the other hand, also appearances of product classes and the disappearance of others in the export basket of a country are likely to be related. If the limited resources of economies are reallocated from sectors of lower productivity towards sectors of higher productivity, then appearance events should always also be accompanied by disappearance events. However, this reallocation process is not smooth. Factors of production cannot be easily reallocated among different uses or there are barriers to exit increasingly less profitable product lines causing a delay in the disappearance of products. For this reason appearance and disappearance events should be related but in a less systematic fashion than appearance events.

In order to verify to what extent co-appearance and appearance and disappearance events cluster in time, Figure 4 compares the realisations of the co-appearance and displacement indices described in the previous section to randomised data. The randomised data have been obtained directly from the trade data by randomly shuffling the points in time on which appearance and co-appearance events have been observed in the data. In this way the temporal sequence of appearance and disappearance events becomes random. These data are referred to as surrogate data in the figure.

Figure 4: Distribution of the conditional appearance and disappearance of HS-6-digit product classes across countries, index scores calculated for trade data and randomised data



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

The left panel of Figure 4 provides evidence that the co-appearance of product classes is temporally clustered. The figure shows the distribution of the co-appearance index scores for the trade data and the surrogate data set. The distribution of the co-appearance index scores of the trade data are clearly shifted to the right of the realisations of the randomised data set. That is, while we may observe some degree of clustering also in randomised data, trade data show more frequently a temporal clustering of co-appearance events. The right panel of Figure 4 shows instead the results for the displacement index. As expected, appearance and disappearance events cluster much less in time than the observed appearance events. The empirical distribution has slightly fatter tails and is skewed slightly more towards negative indicator values relative to the random distribution. This indicates that some clustering can also be observed for displacement events. It is however considerably weaker than for the appearance events.

In **Fehler! Ungültiger Eigenverweis auf Textmarke.** provides some evidence for structural change in trade across NACE sectors over the period 1995-2018. Looking at broad sector groups, the figure shows patterns of substitution between agricultural and forestry products (NACE 1-3) and low-tech sectors (NACE 13-15) related to textile, apparel and leather processing and production, whereas a complementarity seems to exist with food products, beverages and tobacco industries (NACE 10-12). The appearance of new export lines is also positively related to the appearance of export lines in the technologically more intense manufacturing sectors (NACE 20-22; 25-29). Inside manufacturing on the other hand, the low-tech sectors are positively related to the appearance of exports in almost all other manufacturing sectors suggesting that across *all countries and for the period of observation* these industries have been important drivers of the diversification of exports.

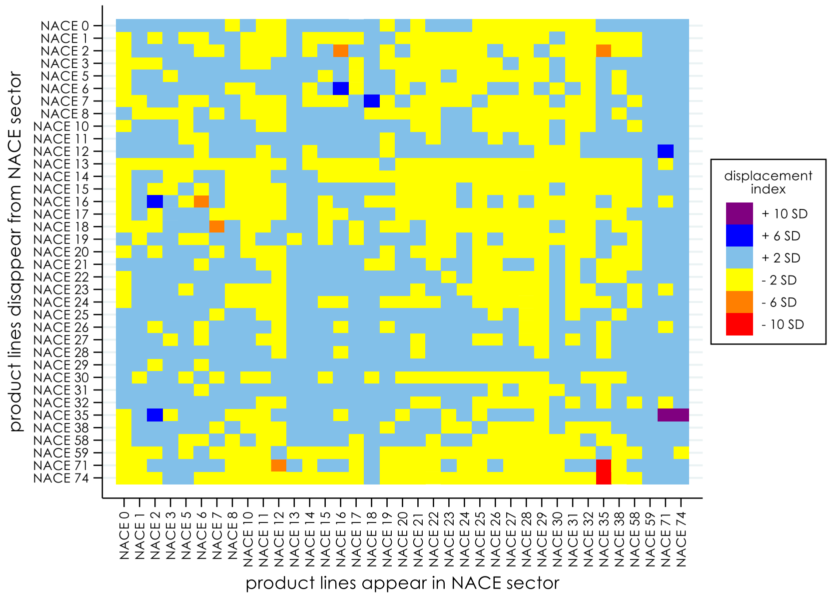
Figure 5 we examine the displacement at the product level across NACE 2-digit (rev. 2) classes in order to establish, whether there are systematic substitution patterns across broad sector classes. The displacement scores $PAD_{i,j}^{(t)}$ for product classes have been aggregated for the NACE 2-digit sectors using sector weights:

$$DI_{k,l}^{(t)} = \frac{1}{\mathcal{N}}\left[\sum_{i \epsilon S_l} \omega_i PAD_{j,i}^{(t)} - \sum_{j \epsilon S_k} \omega_j PAD_{i,j}^{(t)}\right] \text{ for each } j = 1..n \qquad (5),$$

where the weights ω_i are represent by the share in total export value of sectors *k* and *l* of products *i* and *j* in Sector S. These weights give higher importance to appearance and disappearance events that create and/or destroy more export value. Product classes appearing in the export basket of a sector are listed row wise, whereas product classes that have been displaced in a sector are listed column wise. A positive value indicates that a product class appearing in a sector displaces more often product classes in another sector than being displaced itself by products appearing in that sector (light blue to purple). Vice versa, negative values indicate that products appearing in a sector tend to be displaced more often by the appearance of other products in another sector than their appearance leads to the displacement of products in that sector (red to yellow shaded areas). The matrix is symmetric along the diagonal. The displacement index takes on very small values reflecting the difference between already small displacement frequencies. The values displayed in Figure 5 have therefore been standardised to better highlight the structure of the transition matrix.

Fehler! Ungültiger Eigenverweis auf Textmarke. provides some evidence for structural change in trade across NACE sectors over the period 1995-2018. Looking at broad sector groups, the figure shows patterns of substitution between agricultural and forestry products (NACE 1-3) and low-tech sectors (NACE 13-15) related to textile, apparel and leather processing and production, whereas a complementarity seems to exist with food products, beverages and tobacco industries (NACE 10-12). The appearance of new export lines is also positively related to the appearance of export lines in the technologically more intense manufacturing sectors (NACE 20-22; 25-29). Inside manufacturing on the other hand, the low-tech sectors are positively related to the appearance of exports in almost all other manufacturing sectors suggesting that across *all countries and for the period of observation* these industries have been important drivers of the diversification of exports.

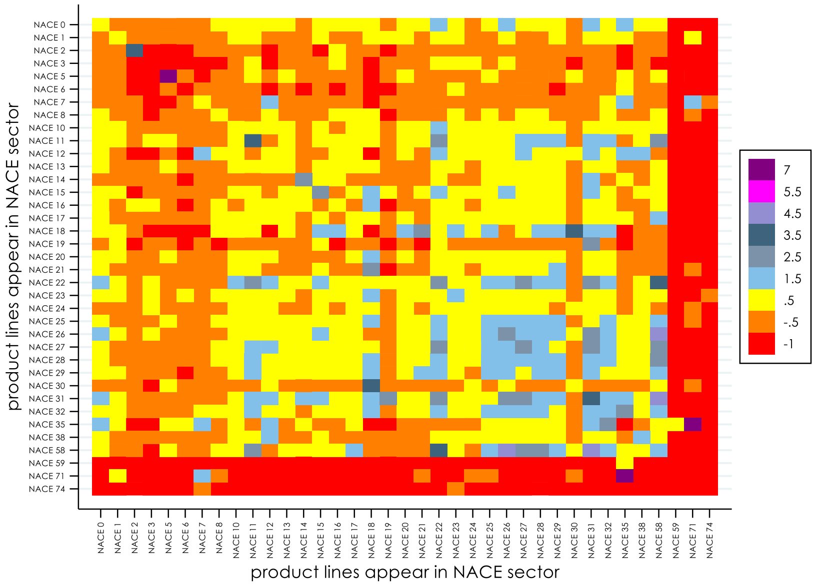
Figure 5: Transition matrix of HS6 digit product classes across NACE 2008 sectors (in global trade)



Note:Standardised values. Light blue to purple areas indicate that products introduced in sectors listed column wise, displace products in sectors listed row wise more often than being displaced by products introduced in these sectors. The reverse holds for fields in coloroud from yellow to red. Observations have been weighted by the trade share displaced products have in sector aggregates to capture the importance of the displacement for the sector. Code 0 stands for product classes that could not be allocated to any NACE sector unambiguously (NACE Rev. 2).

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

Figure 6: Clustering matrix of HS6 digit product classes across NACE 2008 sectors (in global trade)



Note: Standardised values.Negative values indicate below average co-appearance indices. Observations have been weighted by the trade share displaced products have in sector aggregates to capture the importance of the displacement for the sector. Code 0 stands for product classes that could not be allocated to any NACE sector unambiguously (NACE Rev. 2).

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

Figure 6 puts the evidence presented in **Fehler! Ungültiger Eigenverweis auf Textmarke.** provides some evidence for structural change in trade across NACE sectors over the period 1995-2018. Looking at broad sector groups, the figure shows patterns of substitution between agricultural and forestry products (NACE 1-3) and low-tech sectors (NACE 13-15) related to textile, apparel and leather processing and production, whereas a complementarity seems to exist with food products, beverages and tobacco industries (NACE 10-12). The appearance of new export lines is also positively related to the appearance of export lines in the technologically more intense manufacturing sectors (NACE 20-22; 25-29). Inside manufacturing on the other hand, the low-tech sectors are positively related to the appearance of exports in almost all other manufacturing sectors suggesting that across *all countries and for the period of observation* these industries have been important drivers of the diversification of exports.

Figure 5 into perspective. It presents the co-appearance indices as calculated from equation (3). Also these values have been standardised. The figure shows that low tech sectors export products that typically have only relatively low co-appearance indices, whereas technologically more advanced industries show a relatively high clustering in the parallel up-take of exports in product lines not only within each sector but also in other technologically intensive sectors. Considered jointly **Fehler! Ungültiger Eigenverweis auf Textmarke.** provides some evidence for structural change in trade across NACE sectors over the period 1995-2018. Looking at broad sector groups, the figure shows patterns of substitution between agricultural and forestry products (NACE 1-3) and low-tech sectors (NACE 13-15) related to textile, apparel and leather processing and production, whereas a complementarity seems to exist with food products, beverages and tobacco industries (NACE 10-12). The appearance of new export lines is also positively related to the appearance of export lines in the technologically more intense manufacturing sectors (NACE 20-22; 25-29). Inside manufacturing on the other hand, the low-tech sectors are positively related to the appearance of exports in almost all other manufacturing sectors suggesting that across *all countries and for the period of observation* these industries have been important drivers of the diversification of exports.

Figure 5 and Figure 6 therefore suggest that in technologically less intense sectors we observe for the period of observation some a lower likelihood of displacement or even a higher intertemporal co-appearance (i.e. positive displacement values) associated with lower contemporary co-occurrence events. In technologically more intense sectors we are in turn more likely to observe a "churning" effect in exports: while some products in their export baskets have a high likelihood of being driven out of the market with some delay at the same time this is associated with a higher likelihood that when they start exporting new product varieties this leads to a cascade in the uptake of exports in related export lines.

3.2 Structural change in trade and its relationship to the level of economic development of a country

This section will now examine the variation in the patterns of uptake and discontinuation of exports in specific product lines as outlined in the previous section across countries with different levels of economic development. In the literature one finds two observations regarding the development of trade diversification over time in relation to income development.

On the one hand, trade diversification has been observed to move through a hump shaped pattern (Cadot el al 2011) that is very much in line with the diversification patterns observed for industries (Imbs – Wacziarg 2003). The process of industrialisation and the entry into export markets is one starting from specific specialisations followed by a process of branching into new industrial domains where low-income countries have a comparative advantage due to lower factor costs. This goes along with increasing diversification up to some income level. After that a refocusing of industrial activities and exports on a more limited set of products can be observed. Trade diversification therefore follows a hump-shaped pattern over per capita income levels.

On the other hand, there is now a large body of evidence suggesting that industrial branching is a process in which economies engage into the uptake of new industrial and export activities that are related to existing capabilities. This process is a key characteristic of structural change at industry and regional levels as well (cf. Frenken et al., 2007; Neffke et al., 2011). As countries develop, they move therefore from more peripheral parts of what is referred to as the global product space (Hidalgo et al., 2007) into more central, more closely interlinked parts through a process of diversification in which existing and new technical knowledge and knowledge about products and markets (cf. Arthur, 2009; Bresnahan, 2012) are recombined.

In order to develop a better understanding of the co-appearance and displacement processes analysed in this section, we first characterise the variation of productive structures across countries with different levels of economic development by means of two product space indicators. Product space analysis conceives of globally traded products either i) as a bipartite network linking successful exporters to products (see Hidalgo - Hausmann, 2009) or ii) as a network of products that are related through a common knowledge base (see Hidalgo – (Hidalgo et al., 2007).[2] The analysis of these networks reveals unobserved information on the capabilities of countries, the characteristics of products and the structure of the economies.

One summary indicator that comes out of the analysis of the network linking products to successful exporters is the product complexity score. It is constructed using information on how many countries produce a specific product and on how diversified these countries are. For this reason it 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) needed to produce products in a specific product class. Various contributions have shown that the process of economic upgrading and structural change is closely related to the adoption of more complex products across countries (cf. Reinstaller et al., 2012).

A second indicator considered here is the product density.[3] This indicator exploits the fact that products are related to one another through common knowledge bases and similar factors of production. It is a measure for the factor substitutability across products and can be broadly interpreted as capturing comparative advantages obtained from Marshallian externalities between the products a country exports. It is normalised between a minimum of zero and a maximum of one. This indicator is a strong predictor for the type of products in which it will develop a comparative advantage, and it is also a *measure for the specialisation of the productive structures of a country* if it is averaged over all products in the product basket of a country (see also Reinstaller – Reschenhofer 2019).

In order to uncover some structure in the large number of observations in our data the figures in this and the next section show fractional polynomials fitted to the country-product data pooled over all countries and years in the sample. To reduce the number of observations for the sake of easier handling product indicators are presented as weighted averages aggregated to the HS-4-digit level using export shares of each HS-6-digit product line within a HS-4-digit level product class at the country level as weights.

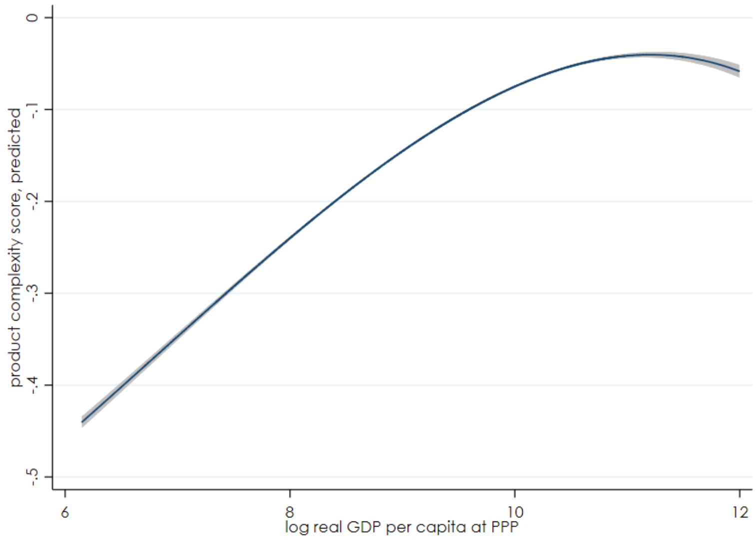
Figure 7 shows the predicted product complexity scores across countries between 1995 and 2018 over per log real per capita income levels at purchasing power parities. As has been outlined in the introduction prior research has shown that economic development implies a perpetual adjustment of productive structures towards more complex products. This is also evident from this figure as the average product complexity increases with the income level across countries. However, at the top level the predicted average starts to level out. This is a first indication that for high-income countries it becomes increasingly difficult to upgrade the productive structures in manufacturing towards more complex and unique products, as competitors learn, catch up and competition increases.

[2] Following Klimek et al (2012) the complexity score of any product can be obtained by defining a bipartite Matrix $M(c,i)$ of products and countries where each cell $m(c,i) = 1$ if a country c exports product i with comparative advantage, and $m(c,i) = 0$ otherwise. The product complexity score is then then obtained from the eigenvector associated with the second largest eigenvalue of Matrix $\widetilde{M}(i,j) = M^T M \,/ k_{c,0} k_{i,o}$ with $k_{c,0} = \sum_i M(c,i)$ and $k_{i,0} = \sum_c M(c,i)$. This is a generalisation of the method presented in Hidalgo – Hausmann (2009) and is applied here.

[3] See Hidalgo et al (2007) for details in the calculation of the density indicator.

In interpreting this evidence it has to be kept in mind that product complexity scores capture largely horizontal differentiation. On top of the technological frontier it becomes harder to produce exclusively specific product classes. This last aspect has to do that with the fact that the complexity score captures also the exclusivity of a product class in terms of the number of countries producing it. As competing countries catch up and enter into an increasing number of product classes complexity scores are harder to improve and should therefore start dropping over time.[4]

Figure 7: Product complexity aggregated to 4-digit product classes over the period 1995-2018 across income levels, predicted values on the basis of fitted fractional polynomials with 95% confidence interval.



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

Figure 8 shows the specialisation of the productive structures of the economies in terms of the average relatedness of the products a country exports. In the core of the product space the network of interrelated exports is very dense and consists mostly of products from industries with intermediate to high technological intensity (see Figure 13 in the appendix). Indeed, most exports of the industrialised countries are located in this part of the network. Therefore, as countries industrialise and move into the core of the product space, this indicator should increase. This is shown in the left panel of Figure 8. The specialisation in related products increases with the level of per capita income. Keeping in mind the facts presented in Figure 7 this implies that an increase in related specialisation goes along with a restructuring of the economy towards more complex products whose production requires a broader knowledge base.

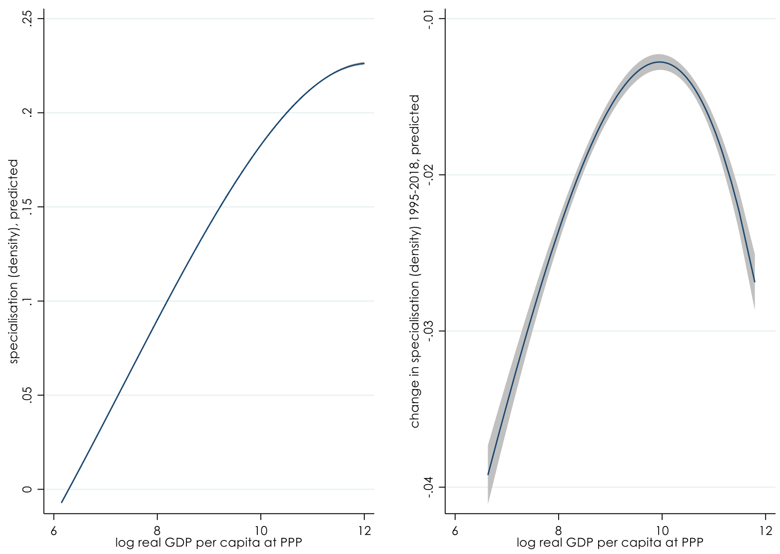
The right panel of Figure 8 presents again the predicted changes in the product density across countries with different levels of per capita income. Countries increase their related

[4] This problem may also be related to inherent limitations deriving from the use of older releases of the HS-product classification for trade data in the analysis. While the use of older releases ensures that the analyst has sufficiently long time series to study long term developments it also the capability to identify trade in novel product classes which are explicitly considered only in more recent releases of the product classification, and are imputed to existing product classes in the trade data based on older releases of the classification.

specialisation quickly up to a GDP per capita level corresponding to about 3000USD per capita (log 8). At an income level corresponding to about 22000USD per capita (log 10) the process stops and starts reversing with the product lines countries export becoming more unrelated. It should be noted, that product density has decreased across all countries and per capita income levels, but less so at income around 22000 USD.

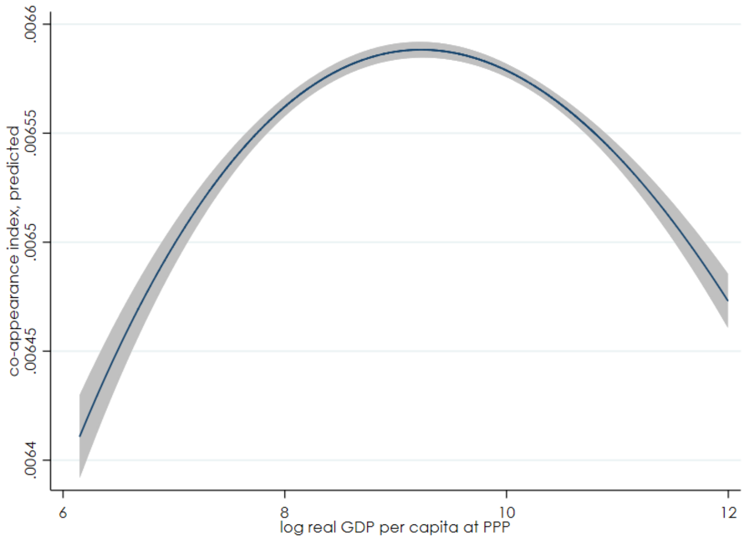
This evidence seems to indicate that economic development and restructuring through related diversification and specialisation as captured by the product space indicators reach a limit at some point. It also indicates that generally the variety of exports has increased in product varieties that are generally farther off the key specialisation of the exporting countries. We will explore this now further using the co-appearance and displacement indices. Looking at the data one has to keep in mind however, that the results refer to averages from data that show a considerable variation across countries and products.

Figure 8: Specialisation of productive structures and changes over the period 1995-2010 across income levels, predicted values on the basis of fitted fractional polynomials with 95% confidence interval.



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

Figure 9: Co-appearance indices across income levels, predicted values on the basis of fitted fractional polynomials with 95% confidence interval.

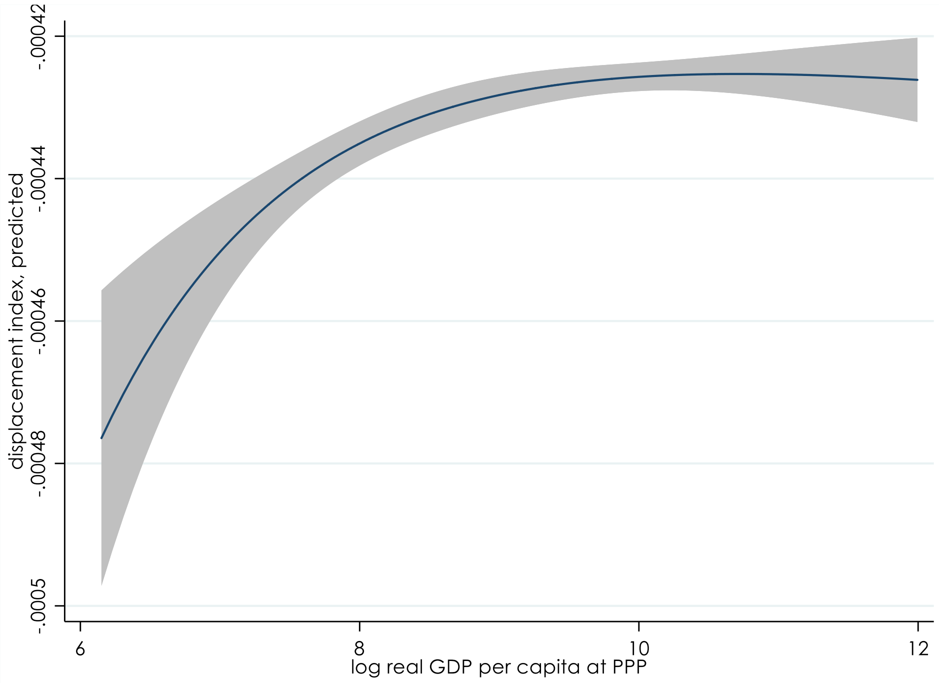


Source: Authors' calculations; BACI dataset (Gaulier - Zignago, 2010);

Figure 9 and Figure 10 illustrate the variation of the co-appearance and displacement indices across per capita income levels. The predicted co-appearance index in Figure 9 follows an inverted U-shape over the per capita income levels with a predicted maximum at an income level corresponding to about 8000USD per capita (log 9). Up to that point the average value of the co-appearance indices increases and decreases then again for income levels above that value. This suggests that the clustering of product appearances is a phenomenon related to economic catching up processes.

This evidence hints also at the relationship with the dynamics of related specialisation observed earlier. The predicted changes in related specialisation follow a pattern similar to that of the predicted co-appearance indices. If a country simultaneously starts exporting different product classes, it is likely that these rely also on capabilities and factors of production that convey some comparative advantage in international markets. If this is the case, then the co-appearance of products leads also to an increase in the related specialisation score. While a more thorough examination of the relationship between the two indicators would be necessary, the data suggest that co-appearance events drive the dynamics of related specialisation.

Figure 10: Displacement indices across income levels, predicted values on the basis of fitted fractional polynomials with 95% confidence interval.



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

Figure 10 finally suggests that at lower levels of income products that tend to be displaced are more frequent in the structure of the export basket of countries. This flattens out for per capita income levels above about 3000 USD per capita (log 8), even though the predicted score remains negative over the entire per capita income range indicating that also for wealthier countries products that have a certain likelihood of being displaced by other products are relatively frequent also in the export basket of advanced industrial nations.

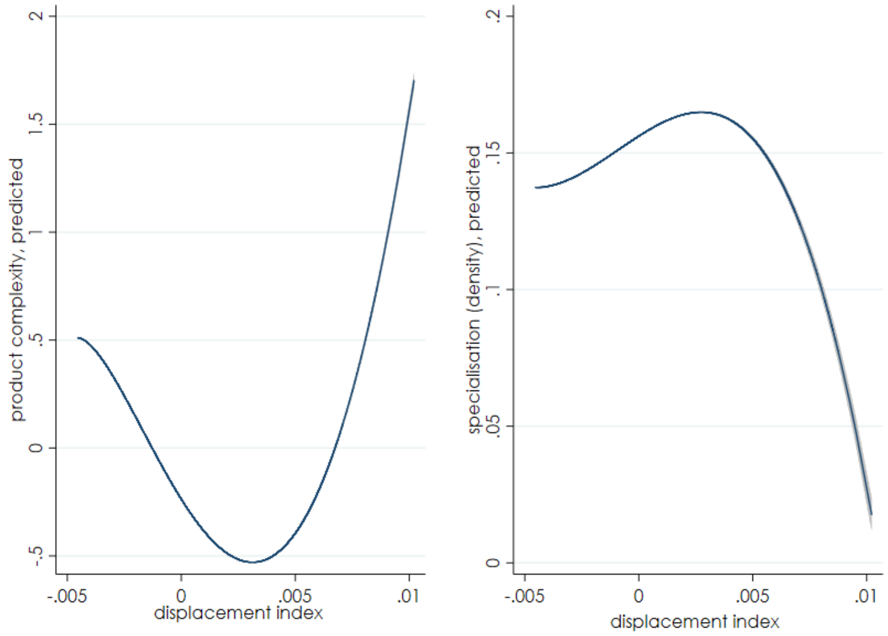
3.3 Product displacement and product characteristics

If product displacement is related to international competition, catching up and upgrading processes then we should observe systematic variations of product characteristics in terms of their complexity and relatedness to domestic export baskets. The complexity score is an indicator of horizontal product differentiation and the depth and breadth of the knowledge base underlying specific products, whereas the relatedness captures the presence of Marshallian externalities in production and therefore specialisation advantages.

The left panel of Figure 11 shows how the predicted product complexity score of product classes pooled across countries and years (left panel). Complexity scores tend to be low for bulk commodities and simple manufactured goods. To the left and the right of these commodities one finds product lines that are more strongly related to more sophisticated manufacturing products.

The fitted polynomials suggest a U-shaped relationship: the higher the likelihood products are displaced the higher are the complexity scores. The same holds on the positive side of the range of the displacement index reflecting the likelihood to replace other products. For large positive displacement scores all these indicators reach very high values (in the prediction) suggesting that product that have a high likelihood of displacing other products while being rare (see distribution in right panel of Figure 4) are more complex than products with displacement scores below 0.005.

Figure 11: Product complexity and product density over the range of the displacement index, predicted values on the basis of fitted fractional polynomials with 95% confidence interval



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

The left panel of Figure 11 finally indicates that the likelihood of products replacing other products increases the degree of relatedness of the products to existing capabilities of the exporting countries, whereas displacement is more likely for products that are weakly embedded in the local system of production. The exception in this case are products with the highest likelihood of replacing other products. These seem to be only weakly related to existing specialisations indicating that unrelated diversification may be at work to generate unique and complex products.

4 The development of the manufacturing share across countries over time and structural change in trade

How do these broad patterns of development of exports related to industrial development? As merchandise trade is tightly linked to the output of the primary and the secondary sector, the development patterns observed for the composition of the export portfolio of countries should be equally closely linked to the development of the manufacturing sector, or more precisely its contribution to the value added generated in a country. This is suggested by Cadot et al (2011) by referring to the evidence on industrial development presented by Imbs -- Wacziarg (2003).

The diversification of the export portfolio captured by the co-appearance and displacement index of the products each country export should go along with an increase of the manufacturing share of a country. A high co-appearance index as measured by the export share weighted indicator average of the exported products should contribute to increase the manufacturing share of a country. We should expect that an observed clustering in the uptake of related export lines should contribute to the growth of the industrial sector and therefore its contribution to value added generation in the country should increase. On the other hand, we should expect that a negative displacement index as measured by the export share weighted indicator average of the exported products should contribute to limit or reduce the manufacturing share of a country. If there is a high number of products the country exports that have a high likelihood of being displaced this should dampen the expansion of the manufacturing sector.

To explore these conjectures we pursue the following regression strategy. We focus on the manufacturing share in total value added of a country as principal dependent variable and test the following equation:

$$ln\_MS_{i,t} = ln\_MS_{i,t-1} + ln\_GDP\_PC_{i,t-1} + ln\_GDP\_PC^2_{i,t-1} + lt\_Complexity_{i,t-1} + ln\_Co - appearance_{i,t-1} + lt\_Displacement_{i,t-1} + crisis\_dummy_{2008/2009=1} + u_{i,t} \quad (6)$$

where i identifies 176 countries included in the regression analysis and t = 1995, …, 2018 stands for the year-observations included in the panel. Note that in order to capture and control for the empirical regularity that the manufacturing share follows an inverted U-shaped relationship with income per capita we include both the log GDP and its squared term in the regression expecting that log GDP pe capita is positively and its squared term is negatively related to the manufacturing share. We also include a lagged dependent variable in order to control for the high persistency of the development of the manufacturing share over time. We also control for the potential effect the economic crisis of 2008-2009 might have had on manufacturing shares.

Table 1 presents the descriptive statistics of the variables included in the analysis (prior to taking logs and log transformed as used in the regressions). As we take logs of all variables to avoid issues of heteroscedasticity the complexity and the displacement index that vary between negative and positive values around a zero mean have been rescaled using the sign preserving John – Draper transformation (prefix lt_ in equation 1). Observations in the sample with manufacturing shares larger than 100 percent have been dropped. The panel is strongly balanced.

Table 1 Descriptive statistics for the indicators used in the regression analysis on the relationship between the manufacturing share and export diversification

Variable		Mean	Std. Dev.	Min	Max	Observations
Share of manufacturing VA in GDP	overall	12.63727	9.369404	0	89.52807	N = 3956
(World Bank)	between		8.423143	.811104	53.18304	n = 182
	within		4.451796	-40.66243	48.7325	T = 21.7363
GDP per capita at constant prices and at purchasing power parities (USD)	overall	17860.33	19492.92	469.1356	161938.7	N = 4136
(World Bank)	between		19213.58	835.5657	96329.82	n = 176
	within		4697.959	-25969.13	86957.91	T = 23.5
Complexity country	overall	-.04137	.9998797	-2.648313	2.631839	N = 4608
(own calculation)	between		.9416146	-1.937893	2.467911	n = 192
	within		.3428524	-1.644521	1.882821	T = 24
Co-appearance Index	overall	.0038318	.0009377	.0011426	.0066598	N = 4608
(own calculation)	between		.0008507	.0017256	.0053566	n = 192
	within		.0003989	.0011977	.0066733	T = 24
Displacement Index	overall	-.0001116	.0007363	-.0031098	.0048504	N = 4608
(own calculation)	between		.0006275	-.001853	.0019285	n = 192
	within		.0003878	-.0020024	.0046841	T = 24
Log transformed variables						
Log Share of manufacturing VA in GDP	overall	2.303431	.7758986	-2.140216	5.257487	N= 3955
	between		.7523177	-.3309706	4.296676	n=182
	within		.278426	-.3025262	4.325637	T= 21.7308
Log GDP per capita at constant prices and at purchasing power parities (USD	overall	9.168954	1.200029	6.150892	11.99497	N= 4136
	between		1.183371	6.727084	11.47485	n= 176
	within		.228342	6.785251	10.06763	T=23.5
Log transformed complexity country	overall	-.030245	.6296383	-1.294265	1.289739	N=4608
	between		.5931031	-1.064997	1.243255	n=192
	within		.2154744	-.9697232	1.248846	T=24
Log transformed co-appearance Index	overall	-5.59972	.2789605	-6.774406	-5.011666	N=4608
	between		.2563465	-6.421504	-5.229602	n=192
	within		.1115057	-6.476784	-4.9936	T=24
Log transformed displacement Index	overall	-.0001116	.0007358	-.003105	.0048386	N=4608
	between		.0006271	-.001851	.0019266	n=192
	within		.0003874	-.0020007	.0046729	T=24

Source: Authors' calculations.

We begin our analysis with pooled ordinary least squares (pooled OLS – 1 in Table 2) estimates as these regressions are straightforward and transparent. A drawback of pooled OLS is that there are many country-specific time invariant components associated with the outcome variable such that the error terms are not iid. To take into account for the shortcoming of the pooled OLS estimation we perform a fixed effects regression (FE – 2 in Table 2).The included lagged dependent variable biases also both the pooled OLS and FE. For this reason we finally present the results of a standard and a corrected version of least squares dummy variable (LSDV 3 and 4 in Table 2) regressions, which is an appropriate estimator for panels with long time series but also a large number of cross-sectional units.

Table 2: Explorative Regression Analysis on the relationship between the manufacturing share and export diversification

	1	2	3	4
	Pooled OLS	FE	LSDV	LSDVC
	b/se	b/se	b/se	b/se
Log manufacturing share (t-1)	0.98***	0.79***	0.79***	0.87***
	0.00	0.01	0.01	0.01
Log GDP per capita (t-1)	0.06*	0.32***	0.33***	0.29**
	0.03	0.11	0.11	0.130
Log GDP per capita (t-1), squared	-0.07*	-0.02***	-0.02***	-0.02**
	0.00	0.01	0.01	0.01
Complexity exports (t-1)	-0.00***	-0.02	-0.02	-0.02+
	0.03	0.01	0.14	0.01
Displacement index exports (t-1)	-5.05	23.32**	23.08**	19.53**
	5.41	9.44	9.44	9.14
Co-appearance index exports (t-1)	0.00	0.07**	0.07*	0.06*
	0.01	0.03	0.03	0.03
Economic crisis 2008-2009	-0.013+	-0.02*	-0.02**	-0.02*
	0.01	0.01	0.01	0.01
R^2	.95	.69	.95	.95
N	3657	3657	3633	3633

*Note: + p<0.15, * p<0.10, ** p<0.05, *** p<0.01*

Source: Authors' calculations.

The results show that the log GDP per capita indicators show consistently the same inverse U-shaped relationship with statistically significant coefficients across the different estimations. The dummy variable capturing the impact of the economic crisis 2008-2009 on the manufacturing share across countries shows also the expected negative and statistically significant sign.

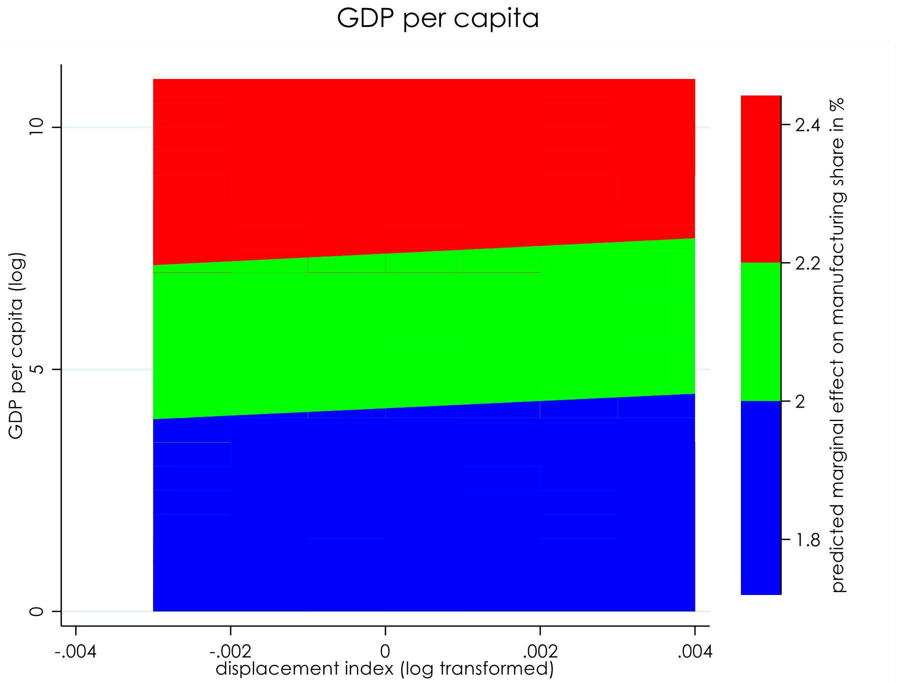
In the FE and dynamic panel setting both the displacement and the co-appearance index show the expected sign and are also statistically significant even though the significance of the estimated coefficients for the co-appearance index is just at the 10% level. The results therefore suggest that the observed clustering in the appearance of product lines in the export basket of countries is positively related to the manufacturing share of countries. This "mushrooming" indicates that chances to export come in clusters and that these have a positive impact on the manufacturing share. The manufacturing share is also positively related to the displacement index: For any given level of per capita income a higher the share of exported products that tend to displace other products (positive indicator values) rather than being displaced themselves is also associated with a higher the manufacturing share. The complexity of exports of the countries in our sample, finally, is negatively correlated with manufacturing shares even though the statistical significance of the estimated coefficients are low for the LSDVC estimation. Generally, the literature holds that the complexity of a country is positively correlated with industrial development and per capita income (cf. Hidalgo- Hausman 2009). Hence, once one controls for income levels, the effect of complexity on the manufacturing share changes. Our results suggest that countries exporting on average more advanced products tend also to have slightly lower manufacturing shares.

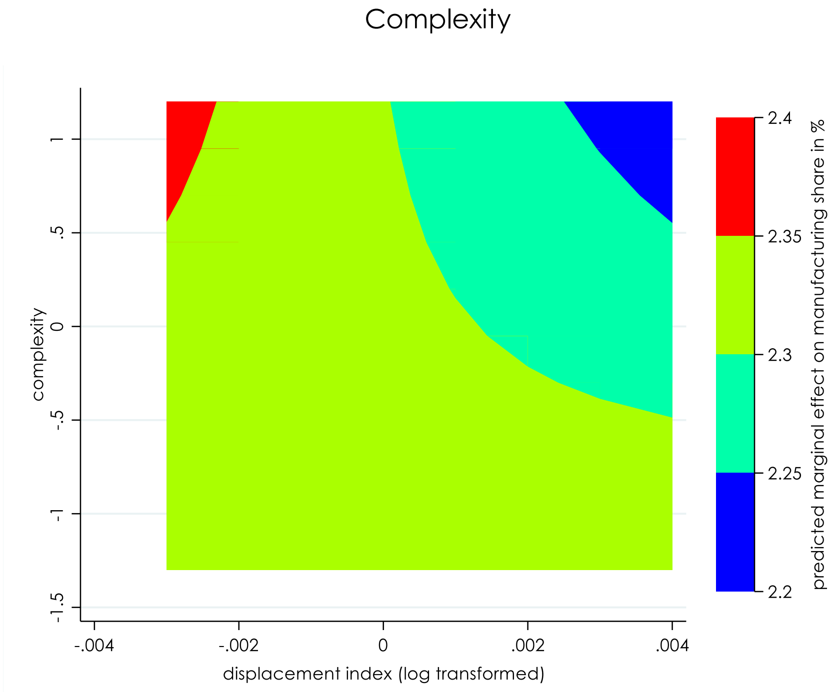
To examine how the effect of the displacement index differs across income levels the upper plot in Figure 12 shows the estimated interaction effects between these two indicators over their entire value range. For any given level of income the displacement index has only a relatively limited impact on the manufacturing share but is positively related with the manufacturing share. It is also apparent that income per capita levels have a far more important effect on the observed manufacturing share. For any given level of the aggregated displacement index manufacturing shares increases significantly for higher income levels.

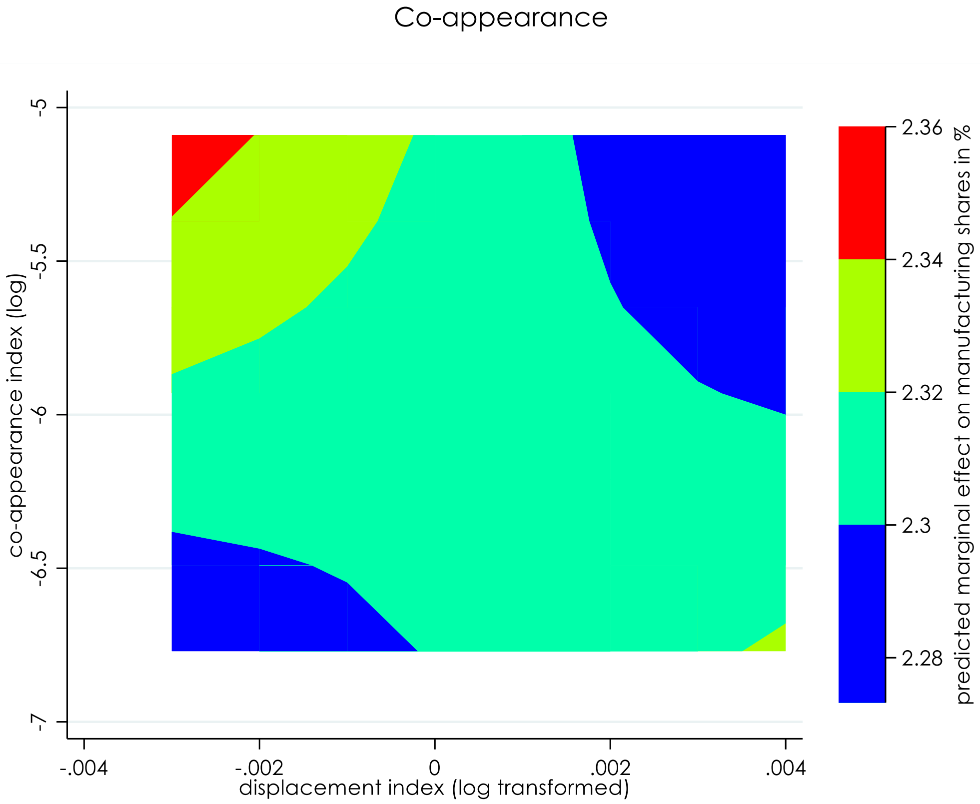
The second panel in Figure 12 studies again the interaction effect of the complexity score and the displacement index. Interestingly, for low to intermediate ranges of the displacement index the manufacturing share (between -.002 and about .001 for the log transformed displacement index) complexity seems make little difference on the associated manufacturing share. Complexity plays however a role on the more extreme parts of the distribution of the displacement index: for very low values of the displacement index (capturing a high likelihood of own exports being displacement) high complexity is also associated with higher manufacturing shares (at a given income level), whereas for higher values of the displacement index (capturing a higher likelihood of own exports displacing exports) and higher complexity values associated manufacturing shares are lower. Hence at any given income level countries specialising in exports with high complexity and high likelihood of displacement have higher manufacturing shares, whereas countries specialising in exports with intermediate to high complexity and a higher likelihood of displacing exports have lower manufacturing shares.

The last panel of Figure 12, finally, shows the joint effect of the displacement and co-appearance indices on the manufacturing export share. While the effects are relatively small the figure shows that manufacturing shares are highest when a high likelihood of displacement of a country's exports is associated with a high likelihood of uptake of exports in new product lines. Manufacturing shares are therefore associated with a "churning" effect on export markets: while some products tend to be driven out of the export portfolio of specific industries (and countries) the uptake of exports of new varieties of product lines induces clustered entry into related product lines. However, the overall effect on manufacturing shares is very small if compared to other constellations.

Figure 12: Analysis of the interaction effects between the displacement index and GDP per capita, the complexity of the economy, and the co-appearance index.







Source: Authors' calculations.

In high income countries these export portfolios are also characterised by higher complexity. Products with such characteristics are to be found in technologically more sophisticated and mostly discrete manufacturing industries.[5]

5 Conclusions

The paper has examined the process of creation of variety and the sorting of exported product lines across countries and sectors.

The descriptive results show a continuous increase in the variety of exported products across countries. With respect to the reference year 1997 a number of countries like China, Vietnam, India, Turkey or Poland have strongly increased the diversity of their export portfolio whereas the diversity of the five most diversified countries – the USA, Germany, France, the UK and Italy -- has decreased. The process of variety creation and destruction has however undergone a significant qualitative change in the years since the economic crisis 2008-2009 relative to the period before. Whereas up to the economic crisis the number of active export lines has increased across countries after that point in time appearance of new product lines in the

[5] As Figure 16 and Figure 17 in combination with Figure 14 in the appendix show higher income countries try to export more sophisticated products in these industries than competitors from lower income countries. However, over time (Figure 16 for 1995; Figure 17 for 2018) this seems to become increasingly difficult.

export portfolios across all countries have decreased whereas disappearance events have been rising steadily.

A closer look at the patterns of displacement and clustering in the entry into new product lines at the sector level for the period of observation the data show for technologically less intense sectors a low likelihood of displacement associated with lower contemporary co-occurrence events. In technologically more intense sectors one observes in turn a "churning" effect in exports: while for some products in these sectors have a high likelihood of being driven out of the export portfolio of a country at the same time there is a higher likelihood that when they start exporting new product varieties this leads to a cascade in the uptake of exports in related export lines. This suggests that in the past twenty years industries with low technological intensity have been an important driver of industrialisation and globalisation of countries with comparative advantages in the production of related products, technology intensive industries have been exposed to strong international competition but at the same time these sectors present also more economic opportunity.

The analysis of the characteristics of the exported product lines across income levels confirms earlier findings that wealthier countries generally export more complex products and that the relatedness of the products they export declines, suggesting that unrelated diversification plays an important role in the development of exports of these countries.

The clustering in the uptake of export lines follows an inverted-U-shaped pattern: the exports of low- and high-income countries show lower clustering, whereas the exports of medium income countries show a high clustering, suggesting that these countries diversify into many product lines in parallel and thereby considerably increase the variety of their export baskets. The high likelihood of own exports being displaced falls monotonically with increasing per capita income levels, suggesting that wealthier countries export products that are more difficult to displace, even though on average they export more products with a high likelihood of displacement than products with a high likelihood of displacing other products.

An econometric analysis of the relationship of the observed dynamics of displacement and clustered entry into new product lines in trade and the development of the manufacturing share across countries over time shows that generally, the manufacturing share shows an inverse -U-relationship with per capita income. However, the results in relation to the dynamics of structural change in trade show that at any given level of per capita income high likelihood of displacement of product lines from the export basket of a countries is associated with smaller manufacturing shares. A clustering in the appearance of product lines in the export basket of countries is positively related to the manufacturing share of countries. Finally, countries exporting on average more complex products tend also to have slightly lower manufacturing shares ceteris paribus.

An interaction analysis shows however, that if a high likelihood of own exports being displaced by other exports is observed with both a higher complexity of exports and a higher clustering in the appearance of product lines manufacturing shares tend to be higher than for combinations at the opposite end of the values range. However, the differences are very small.

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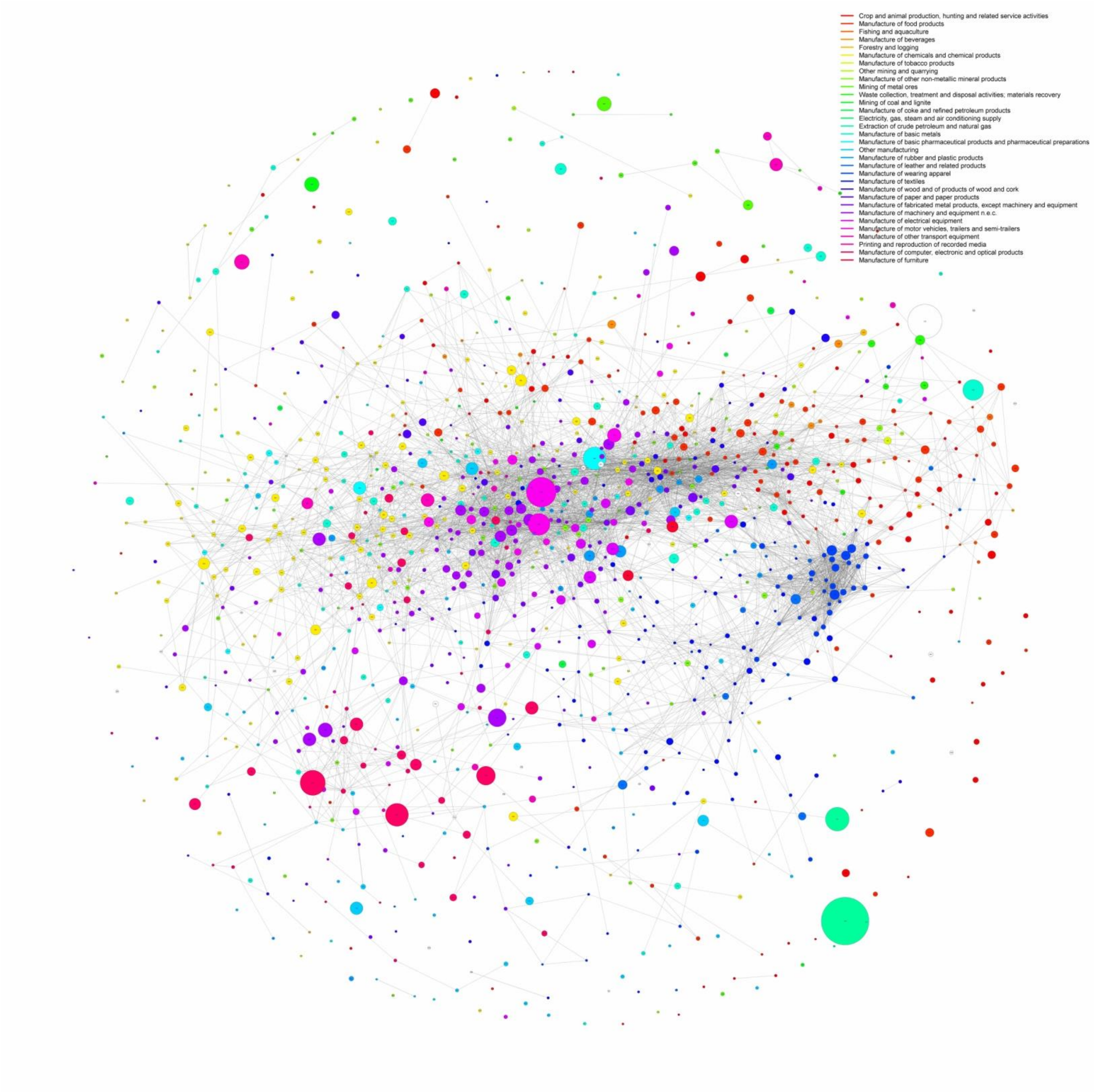
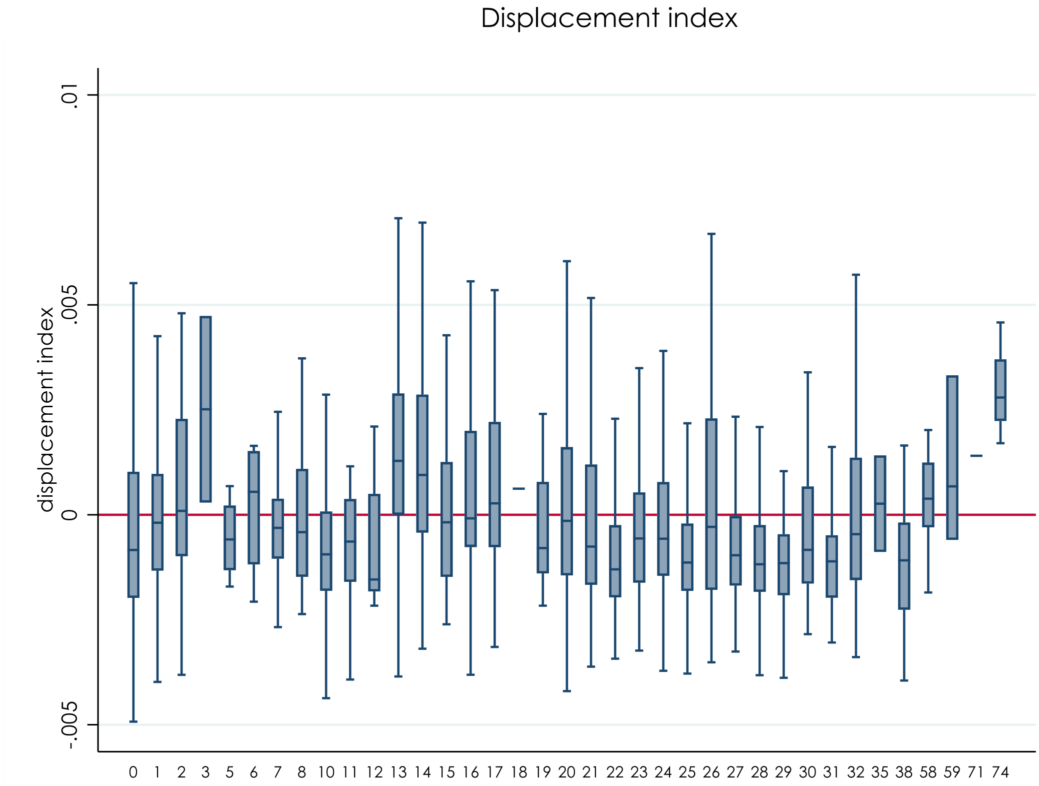
Appendix:

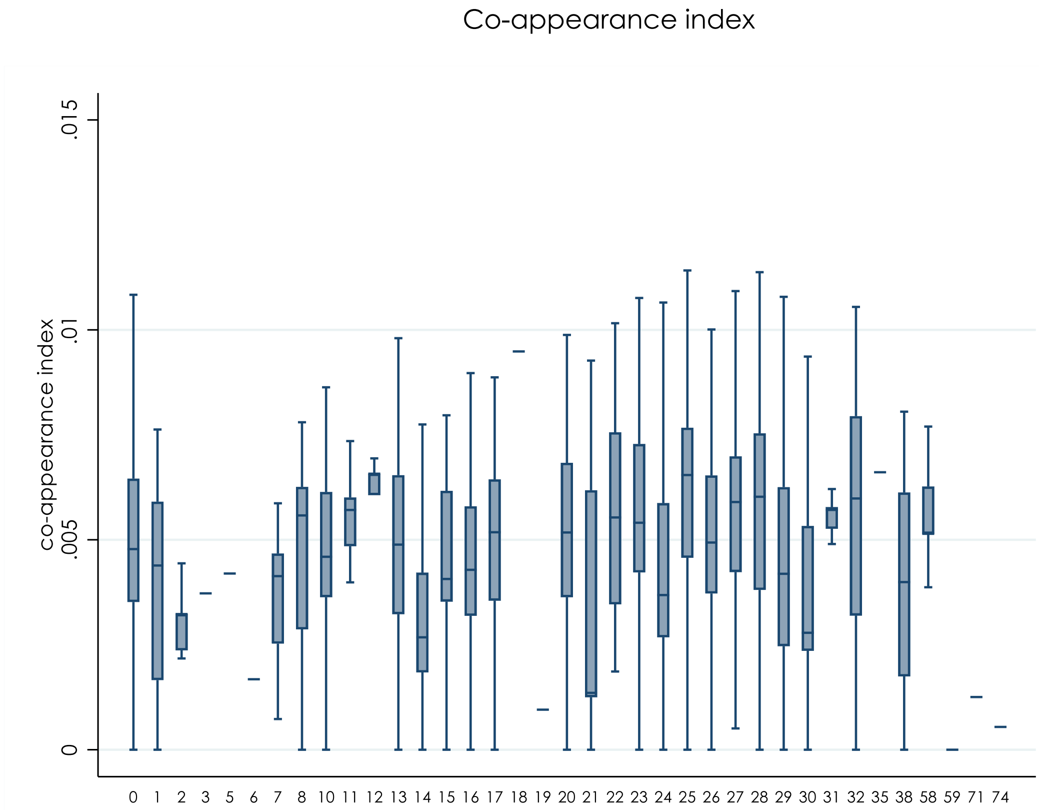
Figure 13: The product space by NACE 2-digit manufacturing industries.



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

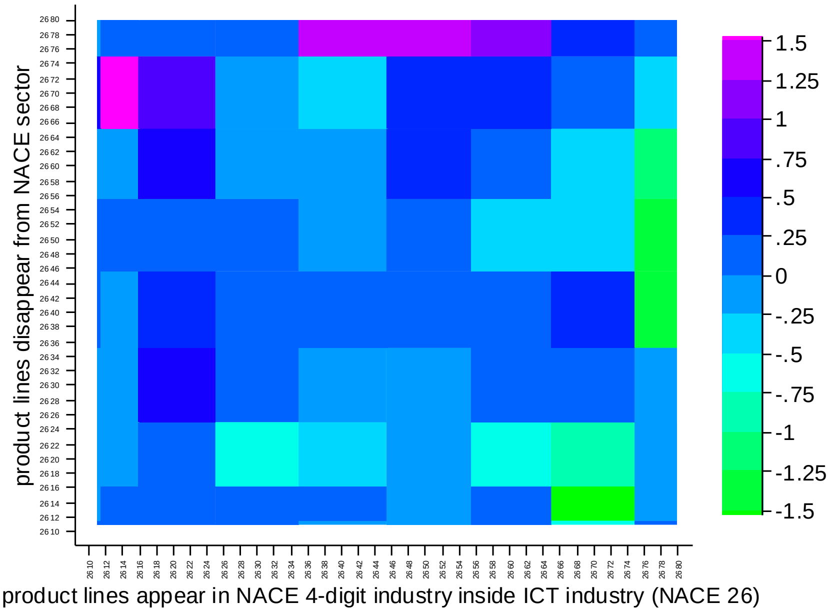
Figure 14: Boxplots for the displacement and co-appearance index over NACE 2-digit sectors.





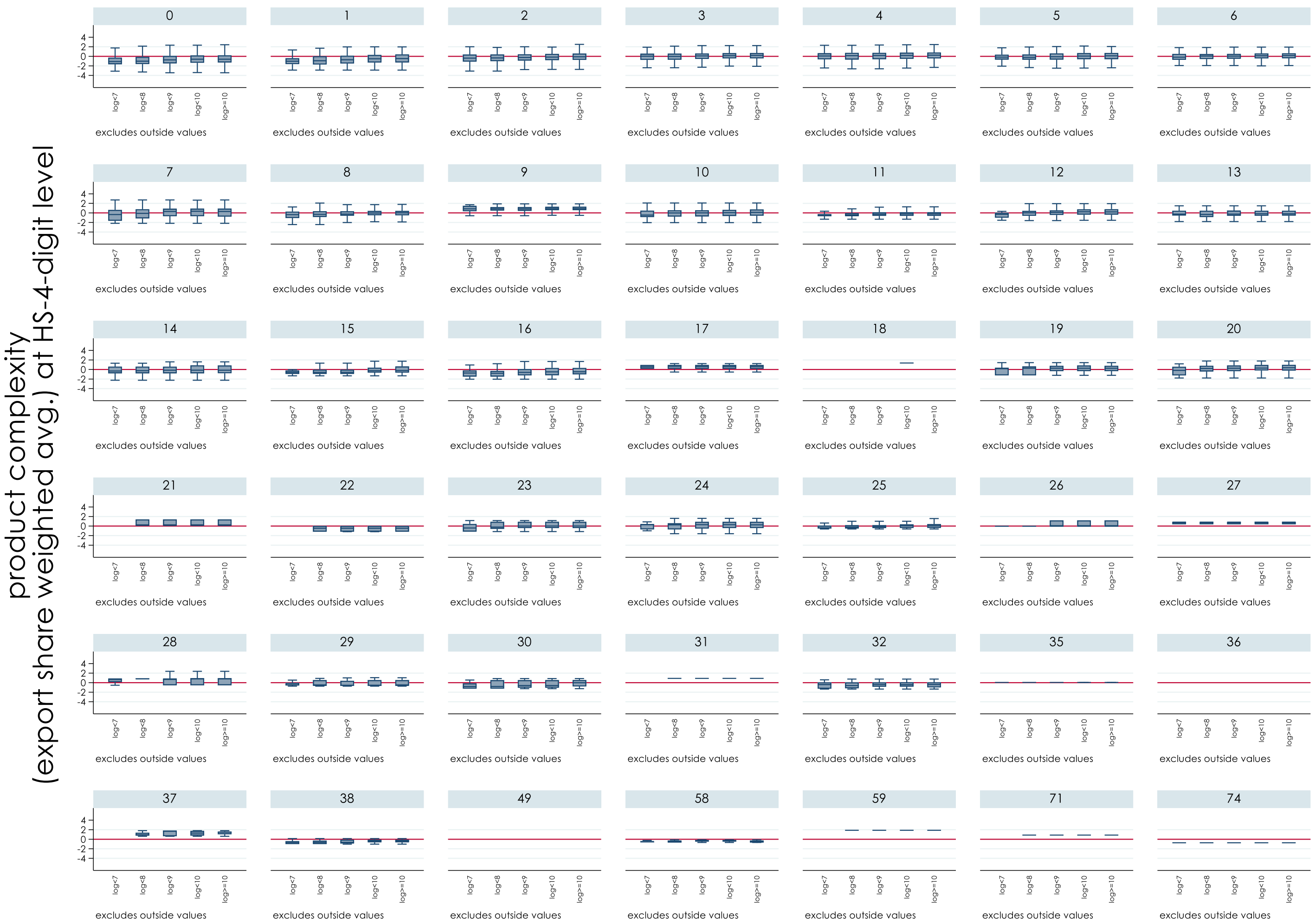
Source: Authors' calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 15: Heatmap for the displacement between the NACE-4-digit industries inside the ICT industry (NACE 26).



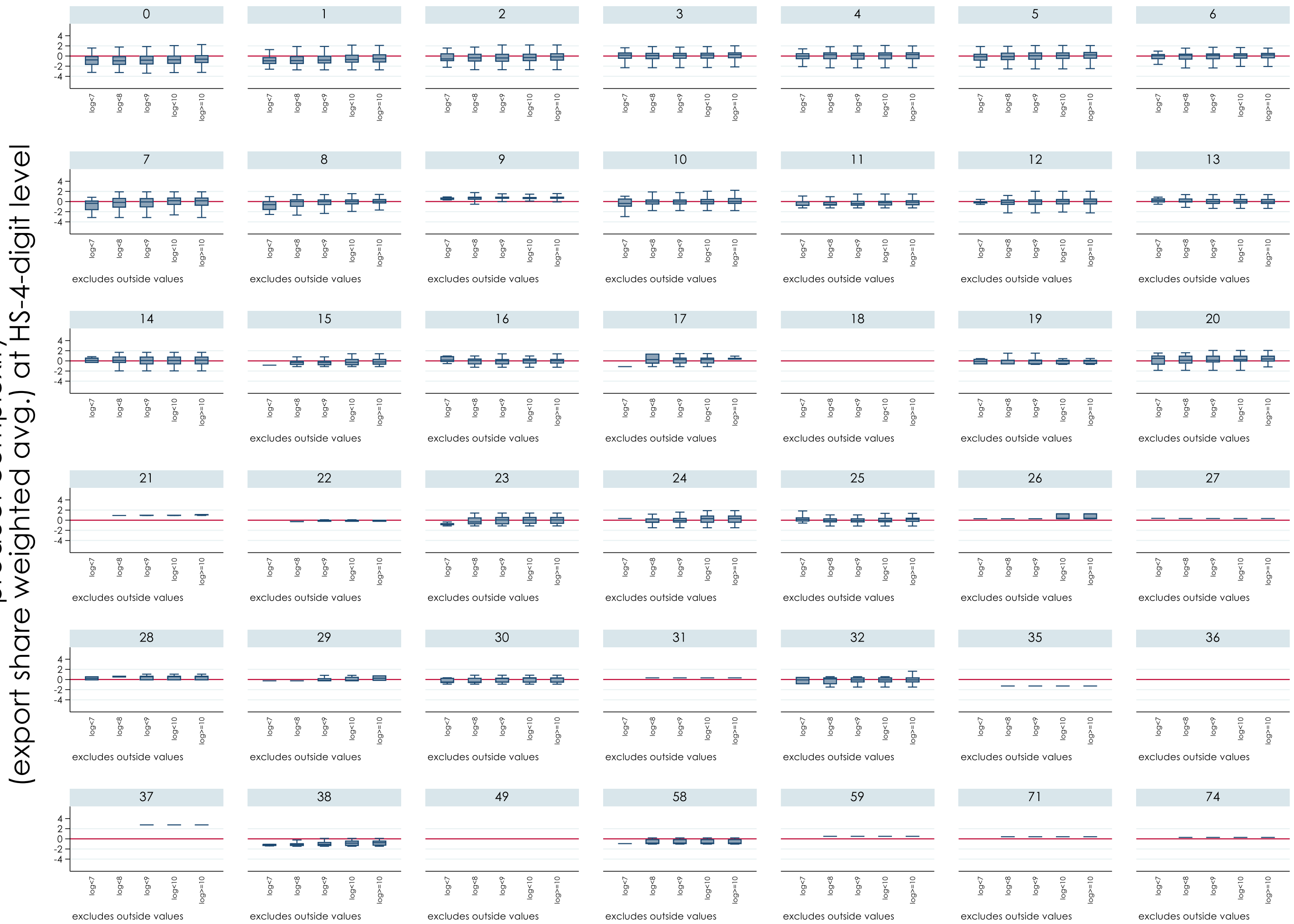
Source: Authors' calculations; BACI dataset (Gaulier - Zignago, 2010)

Figure 16: Product complexity for NACE-2-digit industries across income levels in 1995.



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

Figure 17: Product complexity for NACE-2-digit industries across income levels in 2018.



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