

TRADE DIVERSITY AND STAGES OF DEVELOPMENT - EVIDENCE ON EU COUNTRIES

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Aleksandra Parteka[*]

Abstract

The paper presents the dynamics of trade diversity with respect to stages of development in the European context. The analysis focuses on EU27 countries observed across the years 1988-2010 and compared to a sample of 136 international economies at all levels of income per capita. We use product level statistics (six digit HS0) and confront export and import patterns of *absolute* diversification/concentration. The results show that in line with 'stages of diversification' approach (Imbs and Wacziarg, 2003), EU27 countries are characterized by high degree of trade diversity (on average, EU27 countries export 78% and import 90% of goods effectively exported and imported at the world level) and within the analyzed period most of them registered a reconcentration of trade structures. Obtained estimation results confirm positive relationship between trade diversity and economic development levels (conditional mainly upon the size of the country) with a possibility of reconcentration at higher stages of development (observable in nonparametric estimates).

Keywords: diversification, concentration, trade, economic development

JEL: F14, O11, O52

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1. Introduction

Following recent interest in the relationship between the diversity of economic activity and stages of economic development (Cadot et al., 2011a; Imbs and Wacziarg, 2003), main purpose of this paper is to present related empirical evidence concerning EU countries. In particular, we aim at locating European economies within the so-called 'diversification curve' (revealed in international panel data setting) which approximates the link between trade diversity measures and income per capita levels.

The process of economic development (the movement along stages of development) is marked by a process of a structural transformation in which countries: *(i)* change the set of produced (and traded) goods *(ii)* change the typology of goods, typically moving towards more demanding products. Here we focus on the first aspect, analyzing quantitative changes in the composition of trade baskets, occurring as countries move towards higher levels of income per capita.[1] It has been found that the effects of trade (in particular export) diversification on economic growth can be nonlinear, with developing countries gaining most from diversification and higher income countries benefiting from major specialization (Hesse, 2009). Consequently, we expect that EU countries, being mainly high-income ones, should already have highly diversified trade structures and could actually gain from their deconcentration.

The analysis focuses on a group of EU27 countries, observed across the years 1988-2010 and compared to a sample of 136 international economies at all levels of development. We use very detailed product level statistics (six digit HS0, almost 5000 product lines) to calculate synthetic measures of traded products diversity. Importantly, the analysis is performed simultaneously for imports and exports which allows us to confront patterns of product diversification typical for both flows.

The rest of the paper is structured as follows: in Section 2 we briefly summarize related literature, focusing on the evidence concerning trade diversification process in European countries. Methodology used in the present study (details on data and adopted measures of product diversity) is described in Section 3. The core of the paper is presented in Section 4 where we first compare patterns of trade diversification in EU27 sample with respect to the rest of the

[1] Trade diversification in the economic growth process can also go along with changes in the relative importance of intra-industry trade (IIT) and inter-industry trade. For instance, Brülhart (2009, p.417) shows that trade among high-income countries is characterized by the highest IIT shares on average while IIT among the low-income countries is almost non-existent. In the simplest way IIT can be seen as two-way trade of differentiated products with similar prices, but due to growing importance of trade in qualitatively differentiated products, it has been disentangled into IIT in *horizontally* differentiated (similar) products and IIT in *vertically* differentiated products (with different quality). Vertical IIT (VIIT) accounts for specialization in products of different quality within industries and can be further decomposed into '*up-market'* VIIT and '*down-market'* VIIT. Up-market VIIT takes place when unit values of export flow are greater than import unit values.

world, and subsequently estimate econometrically the 'diversification curve', locating EU countries in a comparative setting versus international trends. We use both flexible nonparametric and parametric estimation methods. Finally, the last Section 5 concludes.

2. Related literature

Recent empirical literature on the relationship between diversification of economic activity and stages of development originates mainly from the seminal contribution of Imbs and Wacziarg (2003) who were among the first to reveal nonmonontonicity in the link between diversification and income per capita levels. Using measures of concentration calculated with sector level employment and export data, they revealed a specific hump shaped pattern of diversification in the process of economic growth. Poor countries tend to deconcentrate their economic structures (introducing more varieties) but at some point in the development process, economies tend to re-concentrate: such a pattern is illustrated by a U-shaped 'diversification curve', with a turning point revealed by Imbs and Wacziarg to occur around $9,000 (1985 PPP). Such a 'diversification curve' was obtained by linking income per capita levels (plotted on horizontal axis) and the index of production concentration (on the vertical axis). U-shape of the curve results from the use of an inverse measure of diversification (based on inequality/concentration index), consequently the decreasing part of the U-curve corresponds to decreasing concentration (increasing diversification) of economic activity along the development process, while the upward rising part of the U-curve illustrates the re-concentration track.

Since then many studies deviated from Imbs and Wacziarg (2003) contribution, introducing methodological or conceptual modifications in the original approach (see Cadot et al., 2012 for an excellent literature review). U-shaped path of diversification followed by respecialization/reconcentration was confirmed by Koren and Tenreyro (2007), using different production data. Other authors focused on the diversity visible in trade structures: Klinger and Lederman (2011) found a U-shaped pattern of diversification of exports with a turning point at $22,500 (2000 PPP). Cadot et al. (2011a) reached a similar conclusion (turning point at $25,000, 2005 PPP) and moved a step further: in particular, they examined what forces can drive the upward rising part of the curve. Using the decomposition properties of the Theil index (employed as an inverse measure of product diversity) they explore intensive and extensive margins of trade[2]. The decreased concentration of exported products typical for lower income

[2] The distinction between the two margins became popular after the paper by Hummels and Klenow (2005). Roughly speaking, the extensive margin concerns changes in the number of active product lines while intensive margin of trade refers to the variation in trade values for already traded goods.

countries results from a rise in the number of exported products (activity at extensive margin), intensive margin dominates around the turning point and afterwards the extensive one dominates again: rich countries close export lines quicker than they open the new ones which explains the reconcentration track.

Slightly different stream of research proposed another view on stages of diversification, where its degree for each country is assessed with respect to the rest of the sample through the use of so-called relative measures of diversification (Bickenbach et al., 2010; de Benedictis et al., 2009). In such a setting the relative diversification track dominates in the economic development process (countries' economic structures become more and more dissimilar with respect to the typical benchmark) and no robust tendency towards respecialization occurs.[3]

Export studies dominate the literature on trade diversification, while evidence on imports' diversity and its relationship with economic development, performed in a panel data setting, is much more scarce. Most of the import related studies focused on country-specific effects of a rise in imported inputs variety on productivity and welfare (see Cadot et al., 2012, Section 5 for an overview). Different aspect of import diversity – the geographical one - was examined for more countries by Cadot et al. (2011b): they analyze geographical concentration of OECD imports across origin countries (i.e. diversity of suppliers) and find that that reconcentration of imports after the year 2000 was caused by rising importance of China as a supplier.

As far as the specific case of EU countries is concerned, the evidence on stages of trade diversification is rather limited, especially if we seek for studies performed with highly disaggregated trade data. Parteka (2009) presents patterns of evolving economic activity concentration with respect to income per capita levels of 25 European countries (revealing U-shaped pattern similar to what Imbs and Wacziarg, 2003 found in an international sample of countries) but the focus here is on employment and not on trade. Funke and Ruhwedel (2005) calculate relative export variety measure based on Feenstra (1994) index, confirming the role of export variety fostering economic growth of 14 East European transition economies (1993-2000). Along these lines, Misztal (2011) argues that export diversification was a positive determinant of economic growth in 27 EU countries in the later period (1995-2009). To the best of our knowledge, EU-focused import-export studies on stages of diversification are missing.

[3] See Parteka (2010) for a comparison between the results obtained with absolute and relative diversification measures calculated with employment and export sector level statistics.

3. Measurement

3.1. Data

Trade statistics on imports and exports used in our study come from UNComtrade and have been downloaded using World Integrated Trade Solutions software[4]. We use direct statistics for imports and mirrored data for exports (imports are usually recorded with more accuracy than exports because imports generally generate tariff revenues while exports don't). Mirroring implies using information from the partner, so that in order to obtain value of exports from A to B we use data on imports from A reported by B. We are interested in tracing product diversification patterns in the course of time, so we use as disaggregated data for a long period of time as possible: we rely on HS0[5] 6-digit division[6]. We use automatic conversion tables from WITS to obtain concordance between various revisions of the HS system. After necessary clearing of the rough data (eliminating 'silent lines' - never traded goods etc.) we are left with the set of 4963 product lines (all commodities – list of chapters corresponding to broad product categories is reported in Table A1 in the Appendix). With these statistics for each country and year we calculate synthetic measures of product diversity (defined in Section 3.2) and then match them with income per capita data and additional country level statistics. GDP per capita (in PPP, 2005 int.USD), population (in 1000) and GDP (in PPP, 2005 int.USD) statistics come from World Bank's World Development Indicators (release 2011).

As for the country composition and time span, throughout the whole analysis we will compare European Union countries (EU27) to the 'Rest of the World' (RoW) sample, composed of 136 extra-EU economies observed across the years 1988-2010. The two datasets are unbalanced (due to data availability) and are summarized in Table A2 in the Appendix. EU27 countries, along with their average income per capita levels and years covered by the analysis, are listed in Table A3 in the Appendix. In order to distinguish between economies at different stages of development we use the classification of the World Bank which clusters countries into five groups according to their income per capita (LI- low income, LMI - lower middle income, UMI - upper middle income, HI- high income: OECD and non-OECD members). As it can be seen in

[4] https://wits.worldbank.org/WITS

[5] HS stands for the Harmonized System. It is an international nomenclature for the classification of products which allows participating countries to classify traded goods on a common basis for customs purposes. HS0 corresponds to first launch of the system (1988/1992). Disaggregation deeper than 6-digit are not harmonized across countries so cannot be used in cross-country studies.

[6] "The six digits can be broken down into three parts. The first two digits (HS-2) identify the chapter the goods are classified in, e.g. 09 = Coffee, Tea, Maté and Spices. The next two digits (HS-4) identify groupings within that chapter, e.g. 09.02 = Tea, whether or not flavoured. The next two digits (HS-6) are even more specific, e.g. 09.02.10 Green tea (not fermented)..." (information from UNComtrade Knowledgebase http://unstats.un.org/unsd/tradekb/Knowledgebase/Harmonized-Commodity-Description-and-Coding-Systems-HS).

Table A3, all but four (namely: Bulgaria, Lithuania, Latvia and Romania) EU27 countries belong to high income (HI) group, mainly HI-OECD, except Cyprus and Malta which are not OECD members.

In Table 1 we show key statistics concerning our EU27 sample (486 country-year observations) and the remaining sample of 136 countries (1419 country-year observations). In line with the existing evidence on diversification drivers (Cadot et al., 2012; Parteka and Tamberi, 2011), we consider: income per capita levels, country size (measured terms of GDP and population) and petrol abundance as factors potentially influencing the degree of trade diversification. In order to place EU27 sample in a comparative setting, we also report all of these statistics for the aforementioned five country groups, classified according to their stages of development. In general, on average EU 27 countries are richer (in terms of GDP per capita), smaller in terms of population (the difference in GDP is much less pronounced) and less abundant in petrol than the remaining RoW sample.

Table 1. Key statistics (potential determinants of trade diversification) on EU and non-EU countries (RoW) in the sample

Countries group:		no of obs. **(1)**	GDPpc [PPP, const.2005 int.USD] **(2)**	Population [1000] **(3)**	GDP [10^9 const.2005 int.USD] (4)	Share of fuel exports [%] **(5)**
EU27		**1419**	**23050.5**	**18635.08**	470	**4.7**
RoW (136)		486	11291.3	58617.35	460	16.1
Countries (EU27 + 136 non-EU) divided by income group*	low income	178	922.521	25302.02	24	3.2
	low-middle income	333	2971.01	80446.18	170	14.4
	upper middle income	609	8173.75	67029.41	380	17.2
	high income non OECD	195	26384.5	3716.91	92	28.8
	high income OECD	590	27031.4	32986.63	990	6.3

Note: average values across country-year observations (1988-2010) *country groups according to the World Bank's (2011) classification. RoW – Rest of the World
Source: own elaboration based on GDP per capita, GDP, population and share of fuel exports (as % of all merchandise exports) from World Bank's World Development Indicators (2011).

3.2. Measures of imported and exported products' diversification

As the simplest measure of product diversity we consider the number of active product lines with non-zero export (import) value, respectively for export (import) diversification measures. We denote them as $Nactive_{it}^{exp}$ and $Nactive_{it}^{imp}$ where *i* refers to country and *t* to time period. Additionally, we express the number of exported/imported products with respect to the number of products effectively being exported (imported) at the world level at time *t*, obtaining $RelNactive_{it}^{exp}$ and $RelNactive_{it}^{imp}$.

The process of product diversification at the extensive margin could be visible through the increase in the number of traded goods. Hence, to quantify this issue we count the number of

new product lines appearing in country's export (import) portfolio. However, given that many trade relations are extremely vulnerable and tend to disappear very quickly (it has been documented by Besedes and Prusa, 2006), instead of a mere change in $Nactive_{it}^{exp}$ and $Nactive_{it}^{imp}$ we calculate the number of new product lines which are added to export (import) basket and, importantly, manage to survive. In order to do so, we adopt two alternative definitions. First, in line with Besedes and Prusa (2006) for each country and time period we define new product as such which was not exported (imported) by this country in the prior year but started to be exported (imported) at time *t* and is still exported (imported) in the following year (*t+1*). This definition is based on one-year cutoff and three-year moving window to define the spell. The second definition (based on Cadot et al., 2011a) is more restrictive and uses five-year moving window and two-year cutoff. Consequently, we count the number of new product lines using the two alternative definitions: $Nnew(1)_{it}^{exp}$, $Nnew(1)_{it}^{imp}$ and $Nnew(2)_{it}^{exp}$, $Nnew(2)_{it}^{imp}$.

Finally, we rely on Theil measure of product concentration which serves as an inverse measure of product diversification (calculated as in Cadot et al., 2011a and based on Theil, 1972):

$$Theil^{\exp}{}_{it} = \frac{1}{n}\sum_{k=1}^{n}\left(\frac{x_{ikt}}{\overline{x_{it}}}\cdot \ln\frac{x_{ikt}}{\overline{x_{it}}}\right) \qquad (1)$$

where *i* refers to countries, $k = 1,\ldots,n$ to products, *x* stands for exports' value while $\overline{x_{it}} = \frac{\sum_{k=1}^{n} x_{ikt}}{n}$ is the average (across products) export value of country *i*. Similarly, in case of imports, the index is obtained as:

$$Theil^{imp}{}_{it} = \frac{1}{n}\sum_{k=1}^{n}\left(\frac{m_{ikt}}{\overline{m_{it}}}\cdot \ln\frac{m_{ikt}}{\overline{m_{it}}}\right) \qquad (2)$$

with *m* referring to imports value. The computation of Theil index involves the use of natural logarithm, so in cases in which the argument of ln resulted to be equal to zero (due to the presence of zero trade flow – products not present in country's trade portfolio), we substituted it with a very small number (10^{-10}), which allowed us to compute correctly the index affecting only negligibly its value. The lower bound of Theil indices is 0 (and corresponds to maximum product diversity within the analysed set of product lines) while the upper limit is equal to $ln(n)$, signalling maximum product concentration (minimum diversity) of trade portfolio.

Summary statistics of import and export product diversifiction measures, separately for EU27 and RoW samples, are reported in Table 4A in the Appendix.

4.Stages of import and export diversification

4.1. Prima facie evidence – EU27 versus RoW sample

In Table 2 and Table 3 we report the comparison between measures of imported and exported products diversity typical for EU27 countries in our sample and for other countries. First of all, it is clear that EU27 have well diversified baskets of traded goods: on average they export 3816 and import 4378 commodities (out of 4963 products theoretically present in our HS0 set). These values correspond to 78% and 90% of goods effectively exported and imported at the world level (column 2). For comparison, countries from RoW sample, composed of 136 extra EU27 economies, import 77% and export only 47% of all goods that are imported (exported) in the world. As it can be seen, product heterogeneity varies greatly across development levels – the difference is especially pronounced in case of export portfolio (Table 2) with low income countries covering only 21% of potential export basket and 83% for high income OECD countries. Note that high income non OECD countries do not have very heterogeneous exports, mainly due to the fact that they are often small (in terms of population) and petrol abundant countries (see Table 1), thus relying on exports of petrol products.

Similar pattern of varying export and import heterogeneity across various stages of development is confirmed when we compare average values of Theil index (column 3 of Table 2 and Table 3). Its low value for EU27 (2.75 in case of exports and 2.17 in case of imports) indicates high degree of product heterogeneity and low product concentration.

As far as the process of diversification visible through the introduction (and survival) of new product lines is concerned, EU27 countries already having well diversified baskets of exported and imported products, every year add less new lines than countries from RoW sample (columns 4 and 5 of Table 2 and Table 3).

Table 2. Measures of *exported* products diversity – EU27 versus other countries

Countries group:		No of active export product lines (max=4963) (1)	Relative number of active export product lines (2)	Theil index (exports) (53	No of new export lines (1) (4)	No of new export lines (2) (5)
EU27		**3816**	**0.78**	**2.750**	**162**	**64**
RoW (136)		2299	0.47	4.700	189	69
Countries (EU27 + 136 non-EU) divided by income group*	low income	1014	0.21	5.718	155	49
	low-middle income	1662	0.35	5.003	198	71
	upper middle income	2528	0.52	4.438	222	84
	high income non OECD	2291	0.47	4.932	208	86
	high income OECD	4063	0.83	2.821	131	49

Note: average values across country-year observations (1988-2010) *country groups according to the World Bank's (2011) classification
Source: own elaboration based on trade data from UNComtrade

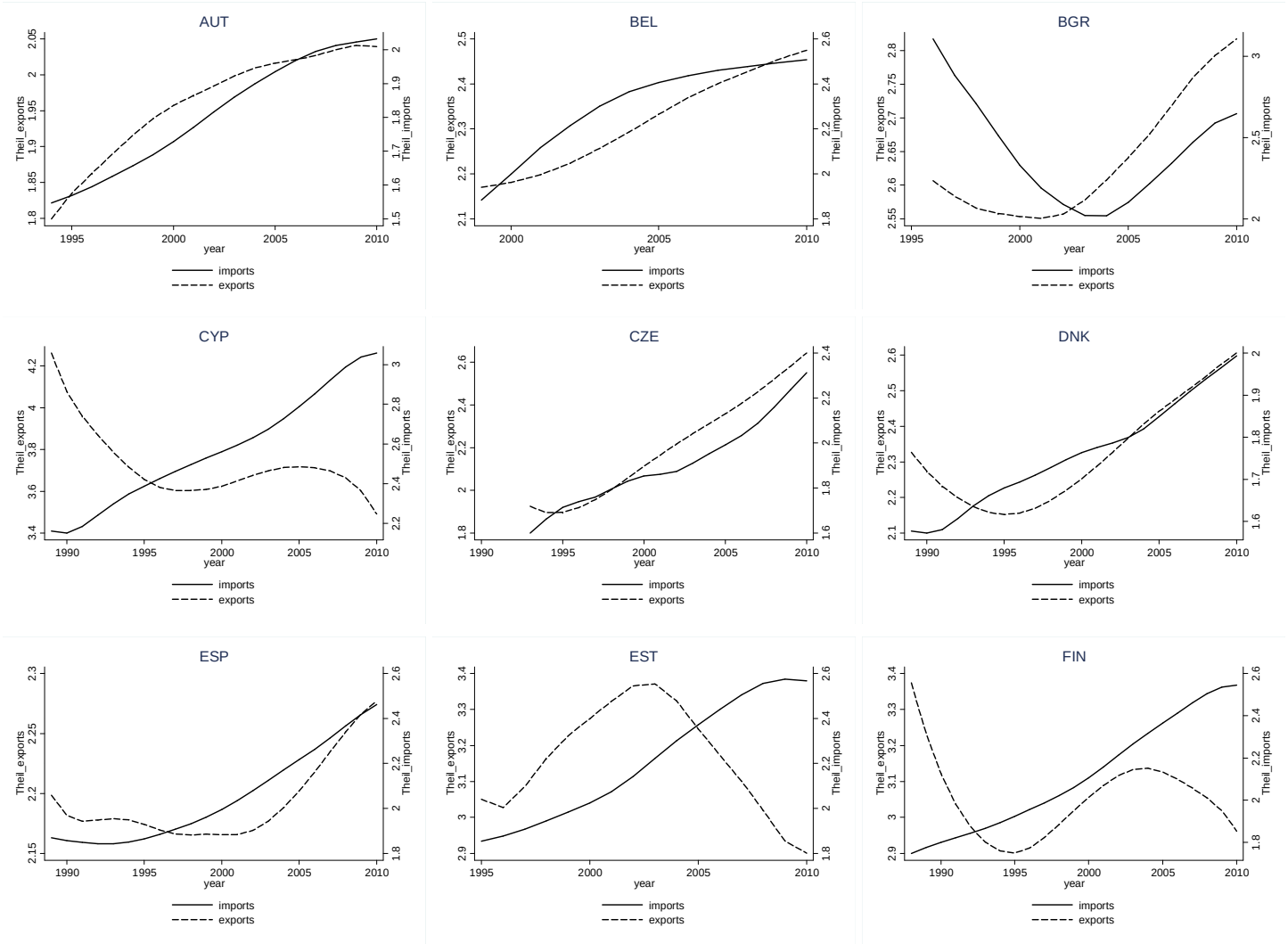
Table 3. Measures of *imported* products diversity – EU27 versus other countries

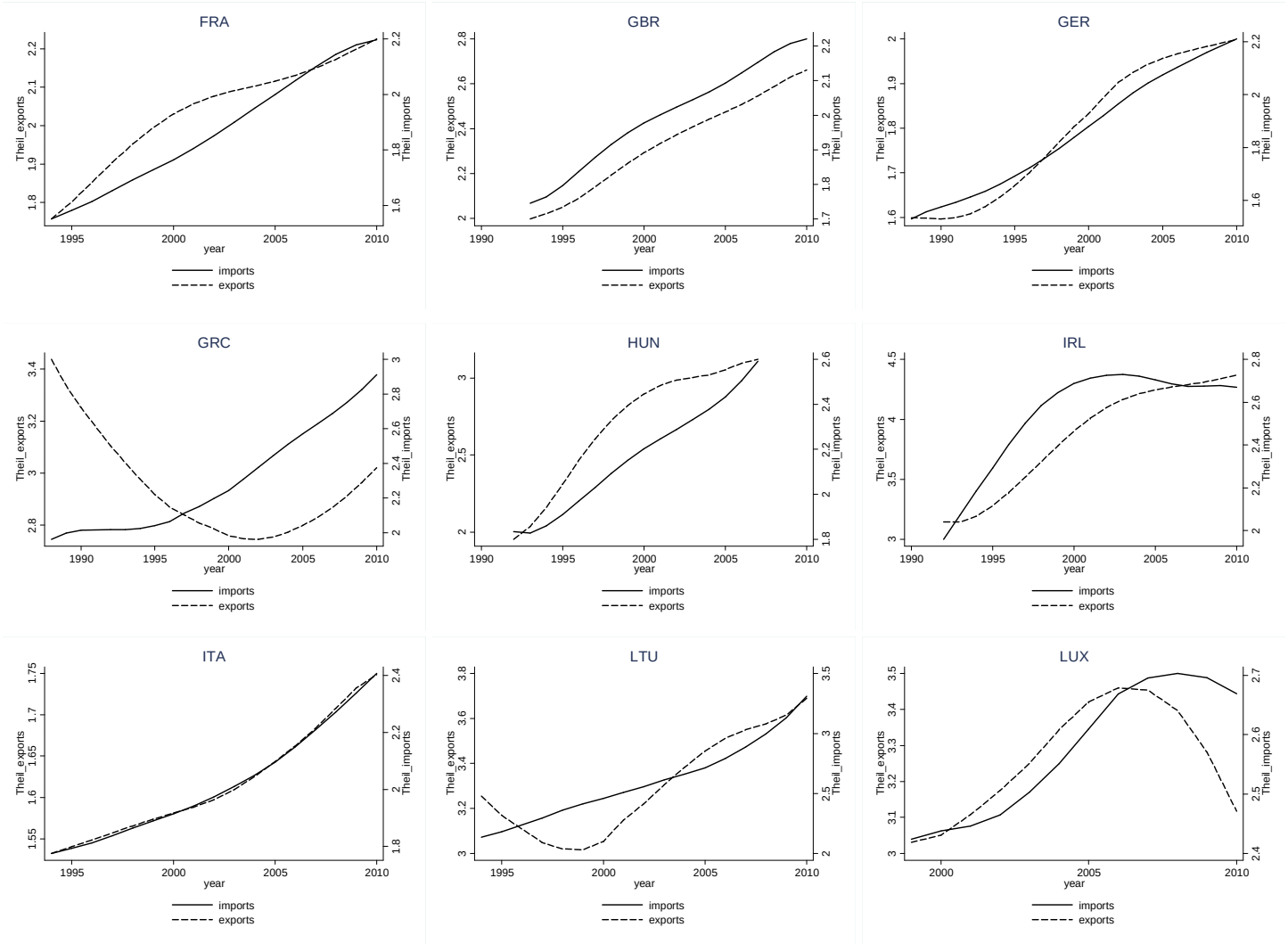
Countries group:		No of active import product lines (max=4963) (1)	Relative number of active import product lines (2)	Theil index (imports) (3)	No of new import lines (1) (4)	No of new import lines (2) (5)
EU27		**4378**	**0.90**	**2.170**	**63**	**30**
RoW (136)		3760	0.77	2.700	99	38
Countries (EU27 + non-EU) divided by income group*	low income	3063	0.63	3.261	154	47
	low-middle income	3476	0.71	2.943	127	50
	upper middle income	3931	0.80	2.470	99	39
	high income non OECD	3746	0.77	2.865	99	38
	high income OECD	4467	0.91	2.156	49	23

Note: average values across country-year observations (1988-2010) *country groups according to the World Bank's (2011) classification
Source: own elaboration based on trade data from UNComtrade

4.2 Country specific trends (EU27)

In order to provide the evidence on trade diversity evolution in single EU countries from our sample, in Figure 1 we show plots of synthetic measure of export ($Theil^{exp}$) and import ($Theil^{imp}$) concentration against time. There is some heterogeneity across countries, but several common observations can be done. First of all, most of the countries from the EU27 sample, being already well developed ones (and classified as high income countries – see Table 3A in the Appendix) registered an increase in both import and export measure of product concentration, which corresponds to the respecialization track. This is in line with Cadot et al. (2011a) pattern of trade reconcentration at higher stages of economic development. Such a pattern, common for imports and exports, concerns such European countries as: AUT, BEL, CZE, FRA, GBR, GER, HUN, IRL, ITA, LTU, LUX (till 2007), NLD, SVK, SVN and SWE. On the other extreme, we find less developed countries such as BGR or ROM (classified as upper-middle income countries). Romania followed a clear path of trade diversification (drop in $Theil^{exp}$ and $Theil^{imp}$) while Bulgaria was characterized by a U-shaped pattern of diversification followed by reconcentration of exports and imports in the recent years. Hence, trends in trade diversity seem to be linked to stages of development. We will address this issue in the next section, where we examine econometrically the link between import/export diversity indices and income per capita.


AUT
BEL
BGR
CYP
CZE
DNK
ESP
EST
FIN
Theil_exports
Theil_imports
year
imports
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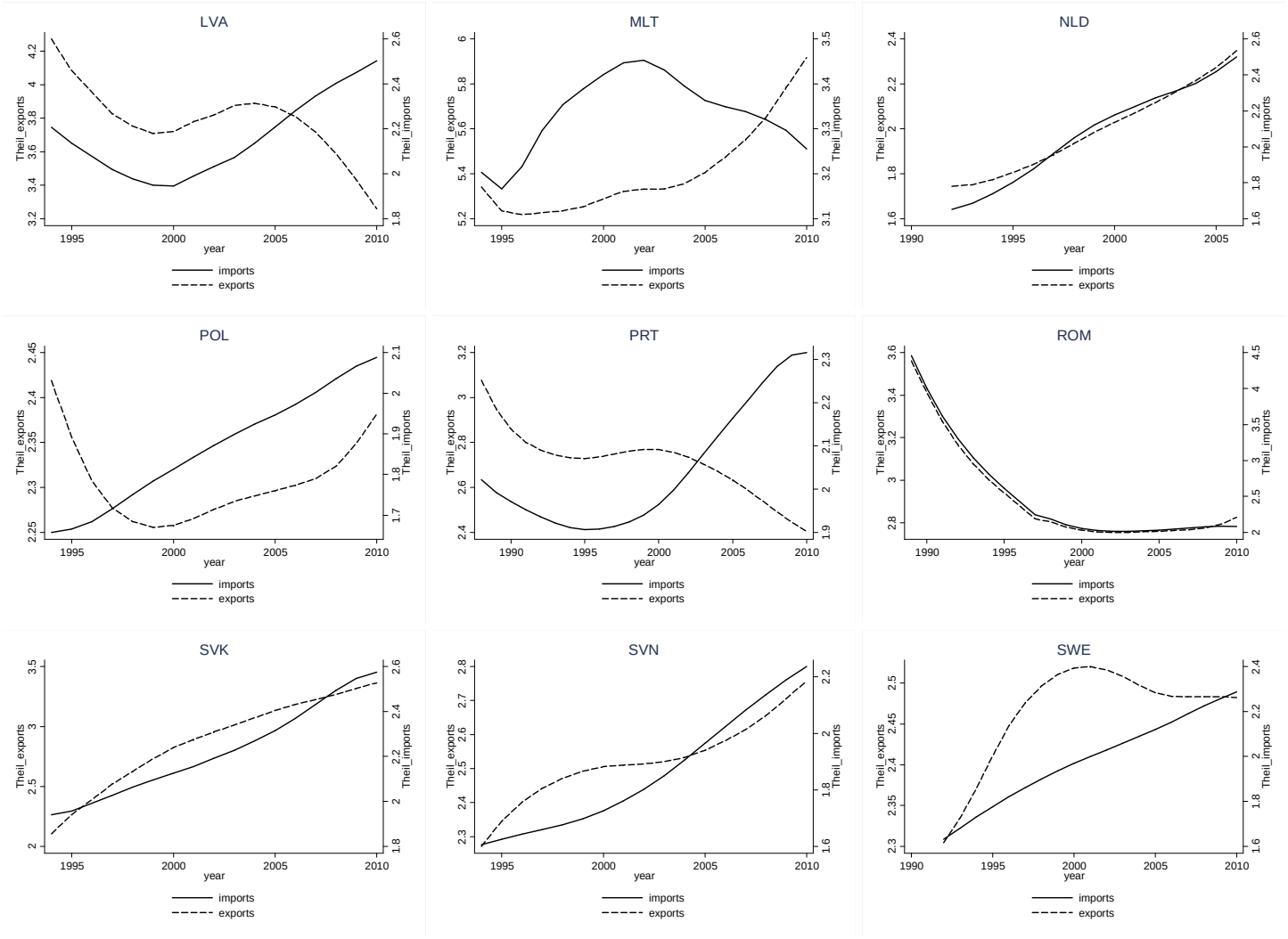


Figure 1. Evolution of import and export diversity in EU27 countries
Source: own elaboration based on trade data from UNComtrade (HS0, 4963 product lines)

4.3 Estimation results

As stated in Section 2, recent empirical literature on diversification dynamics focused on the nonlinear relationship between measures of product concentration and economic development levels. Hence, in order to check the existence (or not) of such a relationship in our sample of EU27 countries, in the first step we perform nonparametric estimation in the form of the lowess curve (Cleveland, 1979) which can be described by the following equation:

$$Y^{\exp}{}_{it} = f(GDPpc_{it}) \quad (3)$$

where $Y^{exp}=\{Nactive^{exp}, Theil^{exp}\}$denotes one of the synthetic measures of exported products diversity defined in eq. 1 and eq.2 , *i* refers to countries and *t* to time period. *GDPpc* is a proxy of the development level (income per capita in real terms) and *f(.)* is a flexible function estimated through the use of the lowess smoother and represented graphically. Similarly, the equation for imports takes on the following form:

$$Y^{imp}{}_{it} = f(GDPpc_{it}) \quad (4)$$

where $Y^{imp}=\{Nactive^{imp}, Theil^{imp}\}$ denotes one of our synthetic measures of imported products diversity.

Graphical representation of nonparametric curve for exports is shown in Figure 2, while Figure 3 presents evidence for imports. We compare the pattern typical for the EU27 sample (upper plot) with that emerging from RoW sample (lower plot).

Focusing first on exports (Figure 2) and concerning the EU27 sample, we observe a rise in the number of exported product lines ($Nactive_{it}^{exp}$) up to income per capita level of approximately $30,000 (PPP,2005) followed by a subsequent drop in $Nactive_{it}^{exp}$ which marks the reconcentration track. Theil index, measuring product concentration, mirrors the plot obtained with the number of active lines and thus follows a U-shaped path. Comparing EU27 to the rest of the word (RoW) sample, we note that in the latter case the pattern of progressing export diversification is dominating (constant increase in $Nactive_{it}^{exp}$ as income per capita grows, only a slight increase in $Theil^{exp}$ at higher stages of development). This is in line with the predictions based on Cadot et al. (2011a) hump-shaped evidence on export diversity evolution because EU27 sample is composed of more developed countries than RoW sample (compare average income per capita levels reported in Table 1: $23050.5, PPP 2005 in case of EU27 and $11291.3, PPP 2005 in case of RoW).

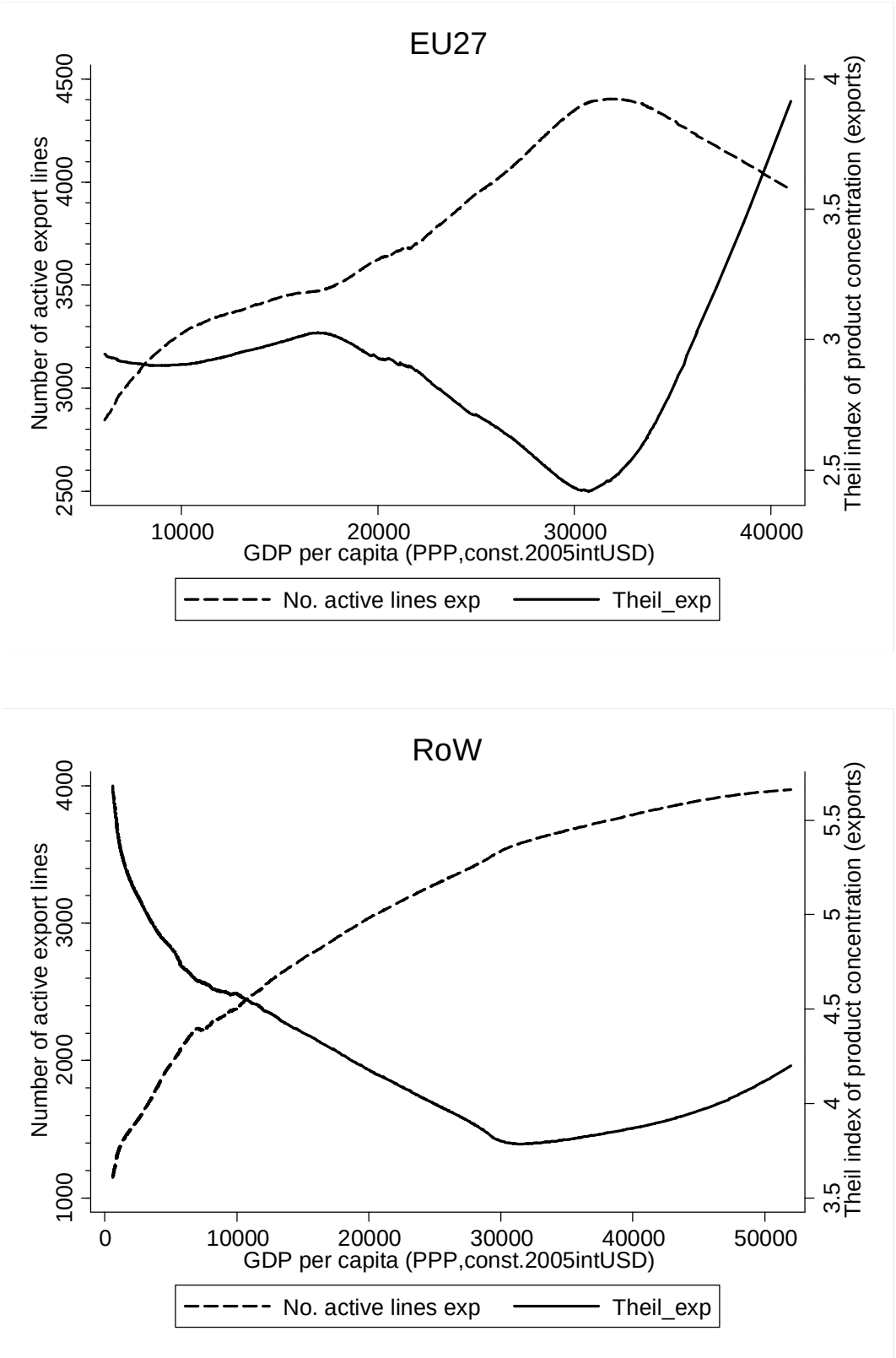
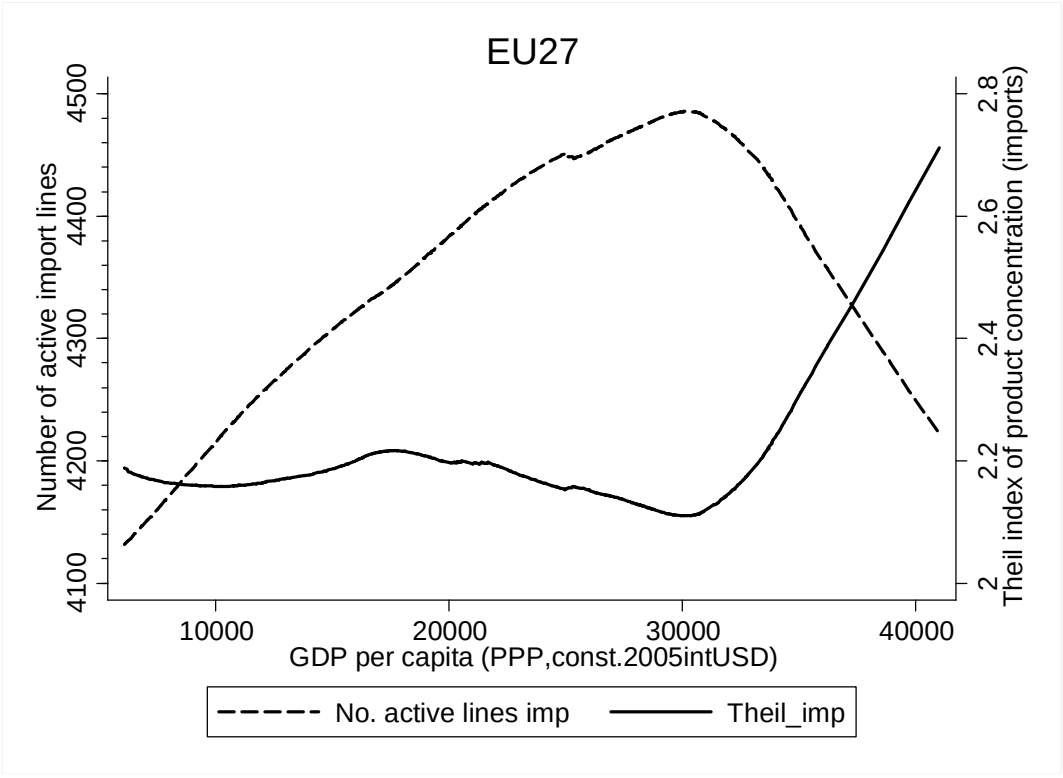


Figure 2. Measures of product diversity versus level of economic development, nonparametric plots (EU27 and RoW), exports

Source: own elaboration based on trade data from UNComtrade(HS0, 4963 product lines) and GDP per capita from World Bank's World Development Indicators (2011).

Note: RoW – Rest of the World (136 countries); nonparametric plot obtained with lowess - span=0.8, sample without outliers defined as observations below 1st or above 99th percentile



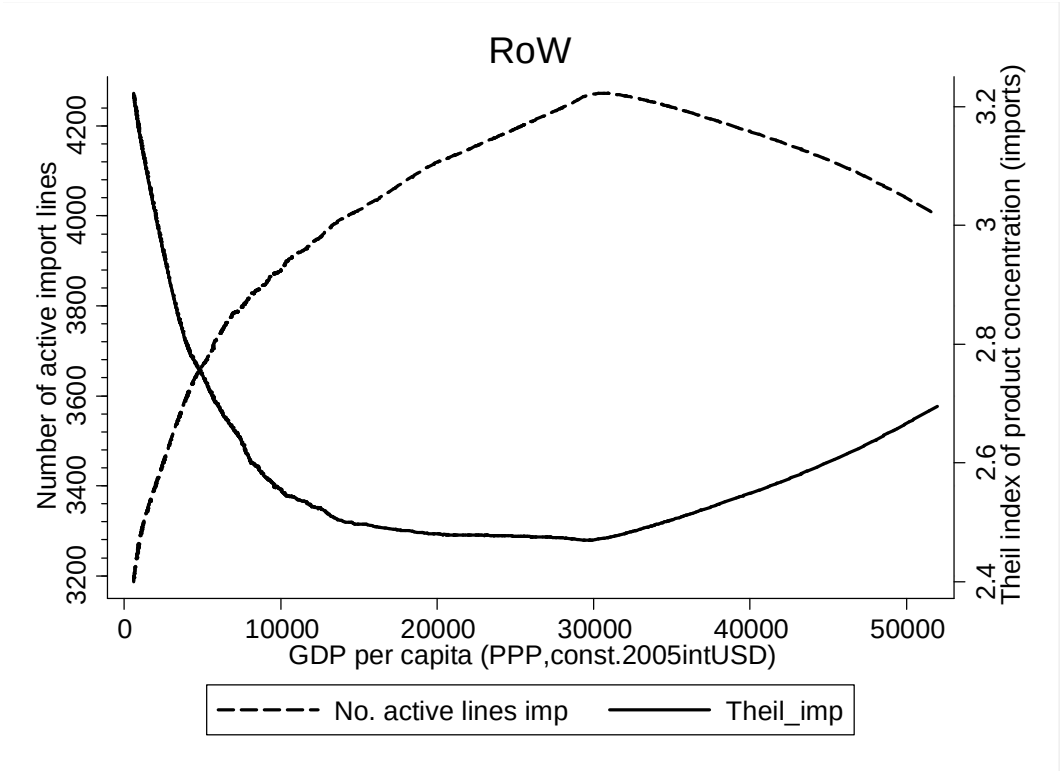


Figure 3. Measures of product diversity versus level of economic development, nonparametric plots (EU27 and RoW), imports

Source: own elaboration based on trade data from UNComtrade(HS0, 4963 product lines) and GDP per capita from World Bank's World Development Indicators (2011).

Note: RoW – Rest of the World (136 countries); nonparametric plot obtained with lowess - span=0.8, sample without outliers defined as observations below 1st or above 99th percentile

In case of trends typical for the import structures (Figure 3), the pattern is very similar, with increasing import diversity in EU27 sample up to income per capita levels of $30,000 (PPP, 2005) and observable reconcentration afterwards. On average less developed RoW sample is characterized by strong import diversification path at initial stages of economic development.

However, unconditional lowess estimation does not take into account other factors which influence diversification opportunities. Consequently, we should correct eq. (3) and (4) for the inclusion of additional right hand side variables and assess their statistical significance. In the following step, in order to check the pattern revealed through nonparametric estimation, we estimate parametrically the following models:

$$Y^{\exp}_{it} = \alpha + \beta_1(GDPpc_{it}) + \beta_2(GDPpc_{it})^2 + \beta_3 GDP_{it} + \beta_4 Fuel_{it} + D_t + \nu_{it} \quad (5)$$

$\forall\ Y^{exp} = \{Nactive^{exp}, Theil^{exp}\}$

and

$$Y^{imp}_{it} = \alpha + \beta_1(GDPpc_{it}) + \beta_2(GDPpc_{it})^2 + \beta_3 GDP_{it} + \beta_4 Fuel_{it} + D_t + \nu_{it} \quad (6)$$

$\forall\ Y^{imp} = \{Nactive^{imp}, Theil^{imp}\}$

In alternative specifications real income per capita enters linearly or in a quadratic form (to correct for eventual non-linearity in diversification-income relationship and check its importance once other factors are taken into account). Additionally, following empirical literature on the determinants of trade diversification (Cadot et al, 2011b; Parteka and Tamberi, 2011) we consider the importance of such country specific characteristic as: country size (*GDP*) and petrol abundance (*Fuel* – as percentage of total merchandise exports). All models include time dummies (in order to account for common business cycle effects).[7]

As far as export diversity is concerned (results reported in Table 4 and Table 5), when considering the number of exported products, it results to be positively and significantly related to income per capita levels (columns 1, 2 and 3 of Table 4). Coefficients associated with *GDPpc* in models employing Theil index of export concentration are negative (column 1,2 and 3 of Table 5) which is correct, given that it is an inverse measure of product diversification. Quadratic formulation results to be not significant. Country size and petrol abundance are among positive determinants of export diversity in EU27 sample. Results concerning imports' diversification and its relation to stages of development (reported in Table 6 and Table 7) are similar: the number of imported products is positively related to income per capita levels (negative coefficient is obtained when Theil index of import concentration is used as dependent variable). Model with the number of imported products as dependent variable (Table 6) performs better in terms of

[7] We do not adopt FE estimation with country dummies as it would wipe out most of the variability across countries which is captured for instance by the inclusion of size variable.

variables' significance and goodness of fit. All in all, the crucial conclusion holds: also within EU27 sample the diversity of exported and imported products is increasing in income per capita.

Table 4. Estimation results – exports (dependent variable: number of active lines), EU27 sample

	Dependent variable: No of active export product lines					
	(1)	(2)	(3)	(4)	(5)	(6)
(GDPpc) ^{2}				-7.30E-08 [-0.14]	-1.74E-07 [-0.37]	-5.20E-07 [-1.23]
GDPpc [PPP, const.2005 int.USD]	5.501e-02*** [19.45]	4.020e-02*** [13.45]	4.509e-02*** [14.19]	5.810e-02*** [2.59]	4.757e-02** [2.23]	6.752e-02*** [3.56]
GDP [PPP, const.2005 int.USD]		4.571e-10*** [9.58]	4.539e-10*** [9.79]		4.571e-10*** [9.58]	4.534e-10*** [9.85]
Fuel exports [%total merchandise exports]			2.541e+01*** [3.13]			2.736e+01*** [3.72]
No of observations	460	458	458	460	458	458
adj R2	0.33	0.42	0.44	0.33	0.42	0.44
Time fixed effects	yes	yes	yes	yes	yes	yes

Note. *, ** and *** denote significance at 10%, 5% and 1% level, respectively. Least Squares estimates, sample without outliers defined as observations below 1st or above 99th percentile. Robust t-statistics in parenthesis under coefficients.
Source: own elaboration based on trade data from UNComtrade (HS0, 4963 product lines); GDP per capita, GDP and fuel exports from WB WDI (2011).

Table 5. Estimation results – exports (dependent variable: Theil index), EU27 sample

	Dependent variable: Theil index of export concentration					
	(1)	(2)	(3)	(4)	(5)	(6)
(GDPpc) ^{2}				-4.56E-10 [-0.62]	-3.13E-10 [-0.50]	4.81E-11 [0.08]
GDPpc [PPP, const.2005 int.USD]	-2.671e-05*** [-6.48]	-8.828e-06** [-2.01]	-1.446e-05*** [-3.31]	-7.41E-06 [-0.25]	4.44E-06 [0.18]	-1.65E-05 [-0.68]
GDP [PPP, const.2005 int.USD]		-5.637e-13*** [-11.48]	-5.543e-13*** [-11.67]		-5.636e-13*** [-11.33]	-5.543e-13*** [-11.68]
Fuel exports [%total merchandise exports]			-2.964e-02*** [-3.15]			-2.981e-02*** [-3.13]
No of observations	455	453	453	455	453	453
adj R2	0.1	0.26	0.28	0.1	0.26	0.28
Time fixed effects	yes	yes	yes	yes	yes	yes

Note. *, ** and *** denote significance at 10%, 5% and 1% level, respectively. Least Squares estimates, sample without outliers defined as observations below 1st or above 99th percentile. Robust t-statistics in parenthesis under coefficients.
Source: own elaboration based on trade data from UNComtrade, 2011 (HS0, 4963 product lines); GDP per capita, GDP and fuel exports from WB WDI (2011).

Table 6. Estimation results – imports (dependent variable: number of active lines), EU27 sample

	Dependent variable: No of active import product lines					
	(1)	(2)	(3)	(4)	(5)	(6)
(GDPpc) ^{2}				-4.324e-07*** [-2.70]	-4.529e-07*** [-2.94]	-5.345e-07*** [-3.66]
GDPpc [PPP, const.2005 int.USD]	1.672e-02*** [12.68]	1.282e-02*** [8.38]	1.384e-02*** [8.67]	3.507e-02*** [4.86]	3.207e-02*** [4.41]	3.687e-02*** [5.35]
GDP [PPP, const.2005 int.USD]		1.147e-10*** [7.91]	1.138e-10*** [7.94]		1.137e-10*** [8.00]	1.124e-10*** [8.06]
Fuel exports [%total merchandise exports]			5.671e+00** [2.42]			7.427e+00*** [3.42]
No of observations	462	460	460	462	460	460
adj R2	0.49	0.53	0.53	0.49	0.53	0.54
Time fixed effects	yes	yes	yes	yes	yes	yes

Note. *, ** and *** denote significance at 10%, 5% and 1% level, respectively. Least Squares estimates, sample without outliers defined as observations below 1st or above 99th percentile. Robust t-statistics in parenthesis under coefficients.
Source: own elaboration based on trade data from UNComtrade, 2011 (HS0, 4963 product lines); GDP per capita, GDP and fuel exports from WB WDI (2011).

Table 7. Estimation results – imports (dependent variable: Theil index), EU27 sample

	Dependent variable: Theil index of import concentration					
	(1)	(2)	(3)	(4)	(5)	(6)
(GDPpc) ^{2}				-1.15E-10 [-0.34]	-1.07E-10 [-0.33]	-1.81E-10 [-0.58]
GDPpc [PPP, const.2005 int.USD]	-8.143e-06*** [-3.82]	-1.83E-06 [-0.76]	-7.35E-07 [-0.31]	-3.28E-06 [-0.22]	2.74E-06 [0.19]	7.07E-06 [0.51]
GDP [PPP, const.2005 int.USD]		-1.735e-13*** [-8.26]	-1.739e-13*** [-8.17]		-1.738e-13*** [-8.14]	-1.745e-13*** [-8.06]
Fuel exports [%total merchandise exports]			6.10E-03 [1.24]			6.69E-03 [1.45]
No of observations	459	457	457	459	457	457
adj R2	0.2	0.26	0.26	0.2	0.26	0.26
Time fixed effects	yes	yes	yes	yes	yes	yes

Note. *, ** and *** denote significance at 10%, 5% and 1% level, respectively. Least Squares estimates, sample without outliers defined as observations below 1st or above 99th percentile. Robust t-statistics in parenthesis under coefficients.
Source: own elaboration based on trade data from UNComtrade, 2011 (HS0, 4963 product lines); GDP per capita, GDP and fuel exports from WB WDI (2011).

4.4 Extensions and robustness checks[8]

First of all, we checked if changes in the level of disaggregation of trade data used for the calculation of diversity indices could influence the results. In order to do so, we recalculated, for the same set of countries and years, Theil indices of product concentration defined in eq. (1) and eq. (2) with more aggregated data: we used statistics classified according to SITC rev.3, 4-digit nomenclature (712 lines). Indices obtained with HS0 6-digit product level data (~5000 products,

[8] All the results referring to this section are obtainable upon request from the author. They are not presented here due to space limits.

used in the main analysis) and those calculated with SITC 4-digit data are highly correlated. For the whole sample (1905 obs.) *corr(Theil^{exp}_HS0, Theil^{exp}_SITC)* =0.93; *corr(Theil^{imp}_HS0, Theil^{imp}_SITC)* =0.89 while in the sample of EU countries only *corr(Theil^{exp}_HS0, Theil^{exp}_SITC)* =0.87; *corr(Theil^{imp}_HS0, Theil^{imp}_SITC)* =0.94. Consequently, the results (e.g. the lowess curves plotted in Figure 2 and Figure 3) obtained with less disaggregated data are very similar to the benchmark ones.

Secondly, we considered modifications in the estimated empirical model. We included the degree of trade openness (*OPEN*) as additional explanatory variable, potentially influencing diversification possibilities. Then, we considered a change in the estimation method (applying instrumental variables estimator), treating income per capita as potentially endogenous and instrumented with its own lag. Finally, we substituted *GDP*, as a measure of country size, with population (*POP*); the two variables are highly correlated: *corr(GDP, POP)*=0.93. In all of the cases, the main result (negative relationship between synthetic measures of traded product diversity and the level of economic development) remains robust.

5. Summary of the findings and conclusions

Following recent interest in diversification-economic development relationship, this paper presents related empirical evidence concerning EU countries. Our analysis focuses on EU27 economies observed across the years 1988-2010 and compared to an international sample of 136 economies at all levels of income per capita. Through the use of very detailed product level statistics (circa 5,000 goods) on both export and import flows, we are able to trace changes in trade diversification visible at deeper than sector or industry level of detail.

The results presented in this paper suggest a few observations. First of all, in line with 'stages of diversification' approach (Imbs and Wacziarg, 2003) and existing empirical literature on trade diversity and its relationship with income per capita (Cadot et al., 2011a), EU countries can be located among economies with already well diversified baskets of exported and imported products. On average, EU27 countries export 78% and import 90% of goods effectively exported and imported at the world level. However, in terms of evolution along the development path, most of the EU countries, being already well developed ones (and classified as high income countries) registered an increase in both import and export measures of product concentration in the analyzed period (reconcentration track). Less developed EU economies such as Bulgaria and Romania followed a typical diversification path, characteristic for countries at lower stages of development.

In all, evidence on EU27 fits well in a general 'diversification curve' (illustrating product diversity-development relationship) which predicts diversification followed by a reconcentration track. Using both non-parametric (lowess) and parametric estimation methods, we estimate the curve in our sample of EU27 countries. Obtained results confirm positive relationship between trade diversity and income per capita levels, with a possibility of reconcentration at higher stages of development (observable in nonparametric estimates). Further research could focus on changes in the typology of goods traded at distinct stages of development.

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Appendix

Table 1A. List of product categories present in disaggregated trade data used in the analysis

01-05 Animal & Animal Products
06-15 Vegetable Products
16-24 Foodstuffs
25-27 Mineral Products
28-38 Chemicals & Allied Industries
39-40 Plastics / Rubbers
41-43 Raw Hides, Skins, Leather, & Furs
44-49 Wood & Wood Products
50-63 Textiles
64-67 Footwear / Headgear
68-71 Stone / Glass
72-83 Metals
84-85 Machinery / Electrical
86-89 Transportation
90-97 Miscellaneous
98-99 Service

Note: numbers correspond to HS 2-digit code.
Source: UNComtrade

Table 2A. Summary statistics of country-year panels: EU27 and 'RoW- Rest of the World' sample

		EU27 countries	RoW (Rest of the world)
Total number of country-year obs.		486	1419
Time span		1988-2010	1988-2010
Number of countries		27	136
Number of year obs. per country	Mean	18	10
	Min	12	1
	Max	23	23
Number of country obs. per year	Mean	21	61
	Min	4	7
	Max	27	103

Source: own elaboration

Table 3A. List of European countries (EU27) covered by the analysis

Country code	Country Name	Income group*	GDP per capita [PPP, const.2005 int.USD]**	Years covered by the analysis	
				First	Last
AUT	Austria	HI-OECD	31864.6	1994	2010
BEL	Belgium	HI-OECD	31735.3	1999	2010
BGR	Bulgaria	UMI	8857.79	1996	2010
CYP	Cyprus	HI-nonOECD	21986.6	1989	2010
CZE	CzechRepublic	HI-OECD	18435.4	1993	2010
DEU/GER	Germany	HI-OECD	29069.6	1988	2010
DNK	Denmark	HI-OECD	30139.5	1989	2010
ESP	Spain	HI-OECD	24020.7	1989	2010
EST	Estonia	HI-OECD	13504.8	1995	2010
FIN	Finland	HI-OECD	26349.9	1988	2010
FRA	France	HI-OECD	28154.1	1994	2010
GBR	UnitedKingdom	HI-OECD	29747.5	1993	2010
GRC	Greece	HI-OECD	21101.5	1988	2010
HUN	Hungary	HI-OECD	13499.7	1992	2007
IRL	Ireland	HI-OECD	30952.2	1992	2010
ITA	Italy	HI-OECD	27161.6	1994	2010
LTU	Lithuania	UMI	12000.1	1994	2010
LUX	Luxembourg	HI-OECD	66777.1	1999	2010
LVA	Latvia	UMI	10659.3	1994	2010
MLT	Malta	HI-nonOECD	19966.7	1994	2010
NLD	Netherlands	HI-OECD	31695.1	1992	2006
POL	Poland	HI-OECD	12676.2	1994	2010
PRT	Portugal	HI-OECD	19329.4	1988	2010
ROM	Romania	UMI	8257.19	1989	2010
SVK	SlovakRepublic	HI-OECD	14937.6	1994	2010
SVN	Slovenia	HI-OECD	21107.5	1994	2010
SWE	Sweden	HI-OECD	29122.1	1992	2010

Note: *country groups according to the World Bank's (2011) classification: LI- low income, LMI - lower middle income, UMI - upper middle income, HI- high income (OECD and non-OECD members)
**year average
Source: own elaboration

Table 4A. Summary statistics of import and export diversification measures – EU27 and other countries (RoW – Rest of the World)

	Export diversification measures						
	index	group	obs	mean	sd	min	max
Number of active products	$Nactive^{exp}_{it}$	EU27	472	3784	873	829	4858
Relative number of active products	$RelNactive^{exp}_{it}$	EU27	472	0.77	0.18	0.17	0.99
Number of new product lines (1year cutoff)	$Nnew(1)^{exp}_{it}$	EU27	444	155	121	2	680
Number of new product lines (2year cutoff)	$Nnew(2)^{exp}_{it}$	EU27	418	60	58	0	320
Theil index of product concentration	$Theil^{exp}_{it}$	EU27	467	2.80	0.79	1.63	5.96
	Export diversification measures						
	index	group	obs	mean	sd	min	max
Number of active products	$Nactive^{exp}_{it}$	RoW	1395	2320	1435	171	4798
Relative number of active products	$RelNactive^{exp}_{it}$	RoW	1395	0.47	0.29	0.03	0.98
Number of new product lines (1year cutoff)	$Nnew(1)^{exp}_{it}$	RoW	1302	185	127	2	765
Number of new product lines (2year cutoff)	$Nnew(2)^{exp}_{it}$	RoW	1218	65	55	0	319
Theil index of product concentration	$Theil^{exp}_{it}$	RoW	1400	4.66	1.44	1.85	7.84
	Import diversification measures						
	index	group	obs	mean	sd	min	max
Number of active products	$Nactive^{imp}_{it}$	EU27	474	4383	317	2435	4867
Relative number of active products	$RelNactive^{imp}_{it}$	EU27	474	0.90	0.06	0.50	0.99
Number of new product lines (1year cutoff)	$Nnew(1)^{imp}_{it}$	EU27	424	60	51	0	307
Number of new product lines (2year cutoff)	$Nnew(2)^{imp}_{it}$	EU27	398	27	32	0	204
Theil index of product concentration	$Theil^{imp}_{it}$	EU27	471	2.18	0.41	1.60	4.07
	Import diversification measures						
	index	group	obs	mean	sd	min	max
Number of active products	$Nactive^{imp}_{it}$	RoW	1393	3788	721	1257	4868
Relative number of active products	$RelNactive^{imp}_{it}$	RoW	1393	0.77	0.15	0.26	0.99
Number of new product lines (1year cutoff)	$Nnew(1)^{imp}_{it}$	RoW	1038	95	78	0	340
Number of new product lines (2year cutoff)	$Nnew(2)^{imp}_{it}$	RoW	969	34	43	0	214
Theil index of product concentration	$Theil^{imp}_{it}$	RoW	1396	2.69	0.53	1.62	4.15

Note: Sample without outliers defined as observations below 1st or above 99th percentile.
Source: own elaboration

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