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Ville Kaitila

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JANE JA AATOS
ERKON SÄÄTIÖ

Ville Kaitila[1] (ETLA)

Specialisation and/or Convergence: Structure of European Exports and Production

Abstract: We analyse the degree of EU countries' specialisation in their exports and manufacturing value added using the Herfindahl-Hirschmann index and the degree of structural similarity using the similarity index developed by Finger and Kreinin (1979). We also analyse the convergence of GDP growth rates over time and compare it with export similarity. At the industry level (HS2), EU15 countries' exports became more specialised before the introduction of the euro and less specialised thereafter. However, exports have become more specialised at the product level (HS6) during the euro years. Manufacturing value added (21 sectors) has become more specialised both before and after 1999. The results for the ten ex-transition countries' exports are different reflecting their economic transformation. Also the post-2008 period with economic distress creates special cases. Export structures became more similar before 2008. However, manufacturing value added similarity decreased. GDP growth rates have been more uniform after the introduction of the euro than in 1992–1999. We find that similarity in export structures is positively associated with the degree of GDP growth rate correlation vis-à-vis the Euro Area average. There are a half a dozen outliers that differ in their GDP growth developments, among them the Euro Area members Greece, Malta and Slovakia.

Key words: Exports, manufacturing, specialisation, similarity, GDP growth

JEL codes: F14, F15, F44

Tiivistelmä: Tässä tutkimuksessa analysoidaan EU-maiden viennin ja tehdasteollisuuden arvonlisäyksen erikoistumisen astetta Herfindahl-Hirschmann-indeksillä sekä rakenteellista samankaltaisuutta Fingerin ja Kreininin (1979) similariteetti-indeksillä. Analysoimme lisäksi maiden bkt:n kasvuvauhtien lähentymistä euroalueen keskimääräiseen ja vertaamme kehitystä viennin samankaltaisuuteen. Toimialatasolla (HS2) EU15-maat erikoistuivat viennissään enenevässä määrin ennen euron käyttöönottoa vuonna 1999, minkä jälkeen erikoistuminen on vähentynyt. Maiden vienti on kuitenkin erikoistunut euroaikanakin, kun käytetään tarkempaa HS6-tuotetasoa. Tehdasteollisuuden (21 toimialaa) arvonlisäyksellä tarkasteltuna tuotanto on erikoistunut sekä ennen euron käyttöönottoa että sen jälkeen. Entisten siirtymätalousmaiden osalta vientitulokset ovat erilaisia, mikä kuvastaa niiden talouksien transformaatiota. Lisäksi vuoden 2008 jälkeinen talouskriisi luo tuloksiin erikoistapauksia. Vientirakenteet yhtäläistyivät ennen vuotta 2008. Sen sijaan tehdasteollisuuden arvonlisäyksen samankaltaisuus väheni. Maiden bruttokansantuotteiden kasvuvahti on ollut euroaikana keskenään samankaltaisempaa kuin vuosina 1992–1999. Vientirakenteen samankaltaisuus korreloi positiivisesti sen kanssa, kuinka samankaltainen bkt:n kasvuvauhti on suhteessa euroalueen keskiarvoon. Puolentusinaa maata kuitenkin poikkeaa enemmänkin bkt:n kasvun yleiskehityksestä, niiden joukossa euroalueelta Kreikka, Malta ja Slovakia.

Avainsanat: Vienti, teollisuus, erikoistuminen, samankaltaisuus, bkt:n kasvu

JEL-koodit: F14, F15, F44

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1 Introduction

How has deeper economic integration and especially the introduction of the single currency affected the structure and similarity of EU countries' exports and production? If these structures have become *less specialised*, i.e. more diversified, so that the economies now depend on a larger number of products than before, the countries are better protected against sector-specific adverse shocks. In the meantime, if the structures have become *more similar* across the member countries the risk of asymmetric shocks has declined and we may expect the common monetary policy in the Euro Area to fit the member countries better than when the euro was first introduced.[2]

Specialisation can be a sign of successful business activity and high productivity in a specified, even a very narrow product line. This is more pertinent for a small open economy than for a large, more closed economy. Such specialisation will also probably translate into less structural similarity with the aggregate in the EU or the Euro Area. As such this can be a positive development for the specialising country, but from the point of view of our study it creates a heightened risk of asymmetric shocks especially in the Euro Area.

On the basis of new trade theory and new economic geography literature we may expect integration to lead to an increase in specialisation. The difficult interplay between increasing specialisation and the need for some degree of similarity under a single currency is also discussed by for example Marques (2008) in the spirit of Mundell (1961), and Middelfart, Overman and Venables (2003).

We analyse how the structure of EU countries' exports (gross value) and production (value added) have developed from the 1980s to 2012 as data allow. We will split this time period first in two with the introduction of the single currency in 1999 as a divider. We will also review the latter time period in two phases with the start of the Great Recession in 2008 as a fault line. Furthermore, we will see how member countries' GDP growth rates have converged towards the Euro Area average and reflect this on the similarity of export structures. As a caveat it should be noted that the analysis does not measure the competitiveness of the countries' production and exports.

We find that at the industry level (HS2), EU15 countries' exports became more specialised before the introduction of the euro and less specialised thereafter. On the other hand, exports have become slightly more specialised at the product level (HS6) during the euro years. Manufacturing value added (21 sectors) has become more specialised both before and after 1999. There are three technical factors that affect these mutually somewhat differing results. First, the number of sectors in value added data is 21 and the number of products in exports is 97 with HS2 and 7,396 with HS6. Second, the country groups are not quite the same because we have fewer countries with manufacturing data than export data. Third, trade is measured as gross value while production is value added.

The results for the ten ex-transition countries are partly different from the EU15 countries reflecting their economic transformation. We find that after 1999, the ex-transition countries' exports have become more specialised at the industry level (HS2) but less specialised at the product level (HS6), i.e. the opposite from the EU15 countries' development. On the other hand, manufacturing has become more specialised also in the ex-transition countries. The post-2008 period with economic distress creates some special cases in our results.

Export structures became more similar before 2008. On the other hand, manufacturing value added similarity decreased. GDP growth rates have been more uniform after the introduction of the euro than in 1992–1999. We find that similarity in export structures is positively associated with the degree of GDP growth rate correlation vis-à-vis the Euro Area average. There are a half a dozen

[2] The monetary policy of the European Central Bank is primarily responsible for price stability, and supporting GDP growth is only a secondary target.

outliers that differ in their GDP growth developments, among them the Euro Area members Greece, Malta and Slovakia.

In Section 2 we will present a short literature review and discuss our methodology. In Section 3 we will use the Herfindahl-Hirschmann index to analyse the level of specialisation, and then the similarity index in Section 4 to analyse structural similarity. In Section 5, we will compare the degree of specialisation and similarity in 2012. In Section 6 we will analyse the changes in the indices for country groups. Section 7 reviews annual GDP growth rates and compares them with export similarity. Section 8 concludes with a summary.

2 Review of theory and our methodology

Centrifugal forces tend to push activities away from the centre and centripetal or agglomerative forces tend to draw them towards the centre. Firms are attracted by the pool of human resources, other firms, and purchasing power found in the centre. On the other hand, increased traffic congestion and higher land prices make more distant locations more attractive. These and other factors will affect different industries to a different degree.

According to 'new trade theory' (Krugman, 1979 and 1980; etc.) and 'new economic geography' models (Krugman, 1991; Krugman and Venables, 1995; Venables, 1996; etc.[3]), increasing returns to scale, monopolistic competition as modelled by Dixit and Stiglitz (1977) and vertical linkages drive trade patterns. With intermediate trade costs (iceberg transport costs modelled by Samuelson, 1954), industries with scale economies and a high proportion of intermediate inputs in final production become geographically concentrated in the centre with the larger markets. Upstream firms that produce intermediate products will tend to relocate close to their customers, i.e. downstream firms that produce final products for consumers. Also labour will tend to move to the centre thus increasing the relative market size of the centre and attracting even more firms there. According to Niepmann and Felbermayr's (2010) results using data for 20 OECD countries and 26 three-digit industries in 1980–1999, market size and geographical centrality have indeed become more important for the distribution of industrial production.

With low-enough trade costs this development will be reversed as the periphery regains some of its lost competitiveness. There is thus an inverted U-shaped relationship between trade costs and concentration. Lowering trade costs will first lead to increased concentration and then to a dispersion of production. For example digitalisation will lower trade costs in some industries. If trade costs could go to zero, location would no longer matter. Trade cost should be thought to include not just pecuniary costs, but also for example cultural and linguistic barriers.

Ekholm and Forslid (2001) introduced multi-region firms in Krugman's (1991) core-periphery model. They found that horizontal multi-region firms decrease agglomeration forces. The effect is positively related to the degree of multi-plant economies of scale. Forslid and Wooton (2003) accordingly introduced comparative advantage. If there is a pattern of comparative advantage, integration may lead to international specialisation of production. This too is a counterforce to agglomeration forces.

According to Baldwin and Okubo's (2006) new economic geography model with heterogeneous firms, the most productive firms tend to agglomerate in the centre. However, when Forslid and Okubo (2013) further introduced scale economies in transportation, it is the firms with intermediate productivity that relocate to the centre, while especially high productivity firms but also low productivity firms remain in the periphery. Transportation costs become relatively less important

[3] For surveys and discussions see e.g. Schmutzler (1999), Fujita and Krugman (2004), Marques (2008), and Ascani, Crescenzi and Iammarino (2012).

for the large and most productive firms in the model, as they get lower freight rates because of their large shipments. Thus also different degrees of scale economies in transportation lead to different spatial sorting patterns among the sectors.

Forslid, Haaland and Midelfart Knarvik (2002) constructed a CGE model to simulate the effects of gradual economic integration on the location of industrial production. According to their results, industries with high increasing returns to scale and important intra-industry linkages show a non-linear relationship between trade liberalisation and concentration with a maximum concentration with intermediate trade costs. On the other hand, industries with lower scale economies and where initial trade costs have prevented sufficient specialisation according to comparative advantage, have become monotonously more concentrated as trade costs have fallen. Scale economies are most important in the more skill and capital-intensive manufacturing of transport equipment, chemicals, machinery and metals, and the lowest in the more traditional manufacturing of textiles, leather and foodstuffs.

Amiti (1998) looked at the same sort of questions we do in this paper. Using the Gini coefficient based on the Balassa index, she analysed whether EU countries' manufacturing production had become more specialised and whether industries had become more geographically concentrated in Europe. Amiti's analysis was largely about how concentrated some industry is across the EU countries, while we look at how concentrated countries' trade and output are across industries. Amiti predicted that EMU will lead to further geographic concentration of industries.

Middelfart-Knarvik et al. (2000) found that most EU15 countries had showed significant convergence of their industrial structure during the 1970s. This trend was reversed in the early 1980s, and substantial divergence had occurred thereafter. Their data end in 1997. Countries had become increasingly different from the average of the rest of the EU and, in bilateral comparisons, from most of their EU partners. Middelfart-Knarvik et al. further found that some industries that had initially been spatially dispersed had become more concentrated. These were mainly slow-growing and unskilled-labour intensive industries whose relative contraction had been accompanied by spatial concentration, usually in peripheral low wage economies. Significant dispersion had occurred in a number of medium and high-tech industries and in relatively-high-growth sectors, with activity typically spreading out from the central European countries. Central locations had increasingly attracted industries with a high dependency on intermediate inputs. Industries with a high degree of increasing returns to scale had tended to locate in central regions, but this effect had diminished over the period. Middelfart, Overman and Venables (2003) argue that the single currency will lead to a modest increase in specialisation.

According to Marques (2008), economic integration will lead to a concentration of economic activity in those locations that allow for a greater reduction in trade costs and greater scale economies through market access, input access, technical services and infrastructure. The empirical studies referred to in Marques (2008) use synthetic measures of localisation of industries and specialisation of countries and conclude that EU industries have become more localised and countries have become more specialised.

As discussed in Krugman (2011), the core-periphery literature predicts economic integration to induce regional specialisation. According to Niepmann and Felbermayr's (2010) results, industrial production has indeed become more concentrated as trade has been liberalised. They build on Behrens et al. (2007) which is a multi-country Dixit-Stiglitz trade model of new trade theory. Consequently, on the basis of the trade theories we would expect to find both an increase in specialisation and a decrease in similarity.

We approach the subject at a general level without analysing what industries different EU countries harbour and attract. One caveat to be noted is that the results may and are likely to hide significant structural changes with some product groups growing much faster than others in exports. However, this is not in our research interest.

To analyse the degree of specialisation and concentration we use the Herfindahl-Hirschmann index. The index has been normalised to obtain values ranging from 0 to 1 with 1 indicating maximum specialisation, i.e. only one export product or one production sector. The index value *HH* for country *j* is given by

$$HH_j^{HS} = \frac{\sqrt{\sum_{i=1}^{n}\left(\frac{x_i}{X}\right)^2} - \sqrt{1/n}}{1-\sqrt{1/n}},$$

where x_i is the value of exports or value added of product or sector i, X is total exports or value added, and n is the total number of products or sectors. As we will see below, the results depend to some extent on the level of data aggregation. Consequently, we will use trade data at two different levels, HS2 and HS6, and mark these in the superscript for HH. The data are mostly from Eurostat[4] and partly by the OECD. We only analyse trade in goods and not trade in services. For value added we will use OECD data from the STAN Database for Structural Analysis in 1980–2009. These data are only available for the 21 EU countries that are OECD members.

To analyse the degree of similarity we use the similarity index developed by Finger and Kreinin (1979). The index is given by

$$S = \sum_k min\left(\frac{x_k^a}{X^a}, \frac{x_k^b}{X^b}\right),$$

where x_k^a and x_k^b are the exports of product k from countries a and b, respectively, and X^a and X^b are the total exports of these countries. We can calculate analogously the similarity of manufacturing value added relative to the total in a group of countries. The index goes from 0 to 1 as similarity increases.[5]

We will first use the Herfindahl-Hirschmann index in Section 3 to analyse the level of specialisation, and then the similarity index in Section 4.

3 Specialisation and diversification

Exports

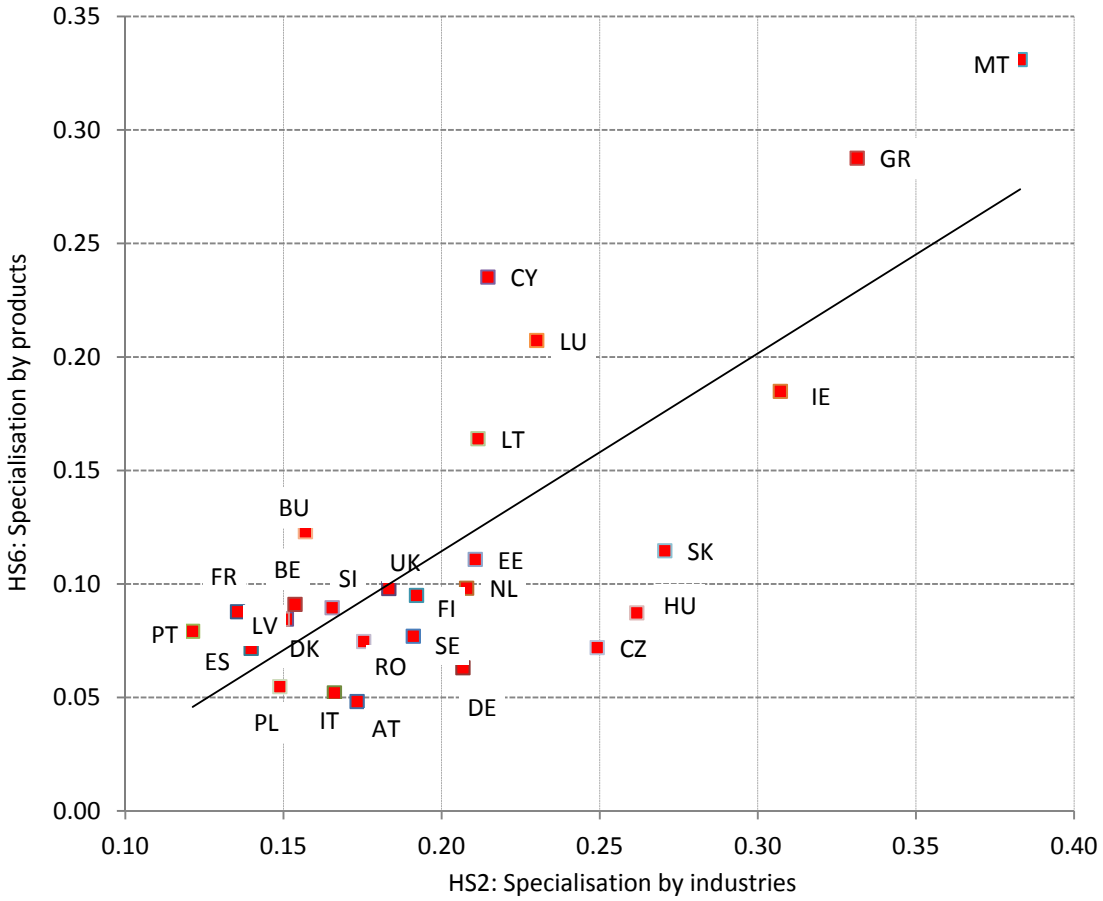
The HS2 level of aggregation with 97 export product groups can be interpreted as the industry level. In the meantime, the more disaggregated HS6 level has 7,396 product groups. One interesting question is, are there differences in terms of specialisation between these two levels. Not surprisingly, we find a general positive correlation between the two (see Figure 1). However in relative terms, Germany, the Czech Republic, Hungary and Slovakia are more specialised at the level of industries and less specialised at the level of products while the opposite is true for Cyprus, Malta, Greece, Luxembourg and Bulgaria. There are also interesting differences between such large countries as Germany and France with the latter relatively more specialised at the level of products. Among other things, these observations reflect the extent the countries are producing for the international value chains of monopolistically competitive increasing returns to scale industries.[6]

[4] We calculate the sum of extra- and intra-EU exports, which has its problems because the data are collected differently. If we compare the total export figures to data provided by the OECD or UNCTAD, there are larger differences for Luxembourg, the Netherlands and Slovenia.

[5] Similarity has also been analysed by for example Kotilainen (1996, 2006) and Kaitila (2010).

[6] For example, HS2 code 84 (nuclear reactors, boilers, machinery, etc.) includes 551 subgroups at the HS6 level, code 29 (organic chemicals) includes 412 subgroups, and code 85 (electrical, electronic equipment) includes 377 subgroups. On the other hand, five HS2 codes include less than ten product groups at the HS6 level. These numbers are without the subgroups with letters in the Eurostat HS6 code.

Figure 1 Herfindahl-Hirschmann indices at the HS2 (industry) and HS6 (product) levels in 2012



Sources: Eurostat, own calculations.

Let us now see how the national Herfindahl-Hirschmann HH^{HS2} indices have developed over time. In Figure 2, the EU countries have been divided into five graphs that contain (mostly) relatively similar countries in terms of size and/or level of development. The vertical axis has been scaled the same in all graphs to make the results more comparable. Malta is an outlier and uses the secondary axis.

The first graph shows the largest EU economies. One may expect larger countries to have relative unspecialised export structures. We find that this is indeed the case. However, there are a number of smaller countries that have index values comparable to those of the largest countries. For example Belgium and Denmark found in the second graph are at about the same level as France and Spain. At the HS2 level, Germany now has a more specialised export structure than the other five larger EU countries (or Finland and Sweden). The major changes among the largest economies are the steady increase in Dutch specialisation and the decrease in French (after 2001) and Spanish (after 1999) specialisation.

Belgium and Denmark have constantly had the least specialised export structure out of the six smaller EU15 countries shown in the second graph. Austria is found a little higher, and Sweden and Finland next. On the other hand, the export structure of Ireland is much more specialised than those of these other five countries at the HS2 level.

The major changes in the second graph are the rise in Irish specialisation mostly in the 1990s and the decline in Finnish specialisation after 2000. Finnish exports have historically been strong in forest industry products. More recently, the rise of the mobile phone industry in the late 1990s fur-

ther increased specialisation. The peak in specialisation was reached in the year 2000 after which the value of the Finnish HH^{HS2} index has declined considerably. The development was further boosted by the steep decline in mobile phone exports after the Great Recession started, but it is notable that the overall decline had been going on for a considerable period of time already before the recession started. By the year 2010, Finland had reached the level of Sweden in terms of export product specialisation at the HS2 digit level.

Among the small countries of the EU, Malta has the most specialised export structure at the HS2 level and it is shown with its own axis on the right. However, its export structure has become much less specialised after the year 2000. On the other hand, we notice that the Greek export structure has recently become much more specialised than it was before. There has been a considerable increase in the exports, matched by an increase in the imports, of mineral fuels and oils.[7] Portugal has very low specialisation in its exports.

Of the larger ex-transition countries shown in the fourth graph, Hungary's HS2 export specialisation rose to a relatively high level, but it turned down after 2010. The rise in Czech export specialisation seems to have levelled off. Specialisation is much lower in Bulgaria, Poland and Romania. Slovakia stands out as a country with a high level of specialisation and the index value has also continued to rise. On the other hand, specialisation has declined especially in Latvia.

Finally from the last graph shown in Figure 2 we see that the level of export structure specialisation for the EU aggregates (EU15, EU27 and EA17) increased between 1993 and 1998, and then declined again up to 2009 after which the development levelled off. That the structure has at the aggregate and for many individual member countries become less specialised after the introduction of the euro lowers the risk of asymmetric shocks.

The results for the Herfindahl-Hirschmann index calculations using the more disaggregated HS6 level with 7,396 product groups are shown in Figure 3. In every country except Cyprus the HS6 index value is lower than the HS2 index value. Italy has the least specialised export structure at the HS6 level among the largest EU countries, and Germany is second this respect. This differs from the HS2 level, and Germany has in relative terms more specialisation in export industries but less in export goods. Over 1999–2012, there is very little change in the curves.

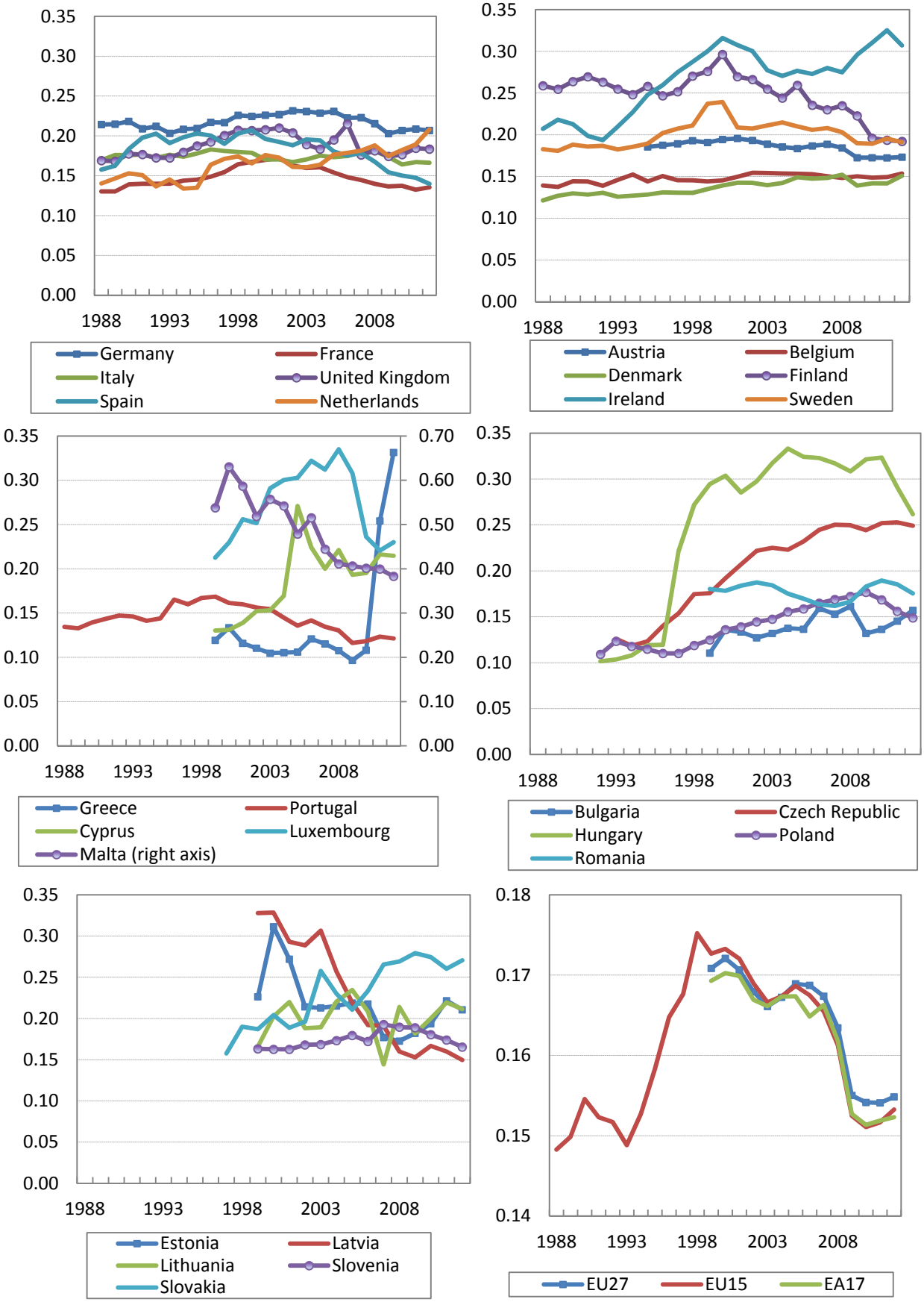
Among the smaller EU15 countries, we find that Austria has the least specialised HS6 export structure. Ireland's index value is again the highest among this group of countries and its value has also been rising. The Finnish index value has been declining after 2005. It is now at the same level as in Denmark and Belgium. The third graph with miscellaneous countries again shows the rapid rise in the Greek index value in 2011–2012. The Maltese index has been declining, the Cypriot has recently been stable, and the Portuguese has remained very low. It may also be a reflection of low overall productivity in Portugal that the country has not specialised more.

The ex-transition countries show interesting differences between the HS2 and HS6 data. There has been considerable specialisation at the industry level (HS2), especially in Hungary and the Czech Republic, but this cannot be seen at the much more disaggregated HS6 product level. Among the smallest ex-transition countries we can see a considerable decrease in Latvia's export specialisation.

We did not find any trend for the EU27 aggregate. The index value varies very little between 0.049 and 0.054, and is not shown in the graphs.

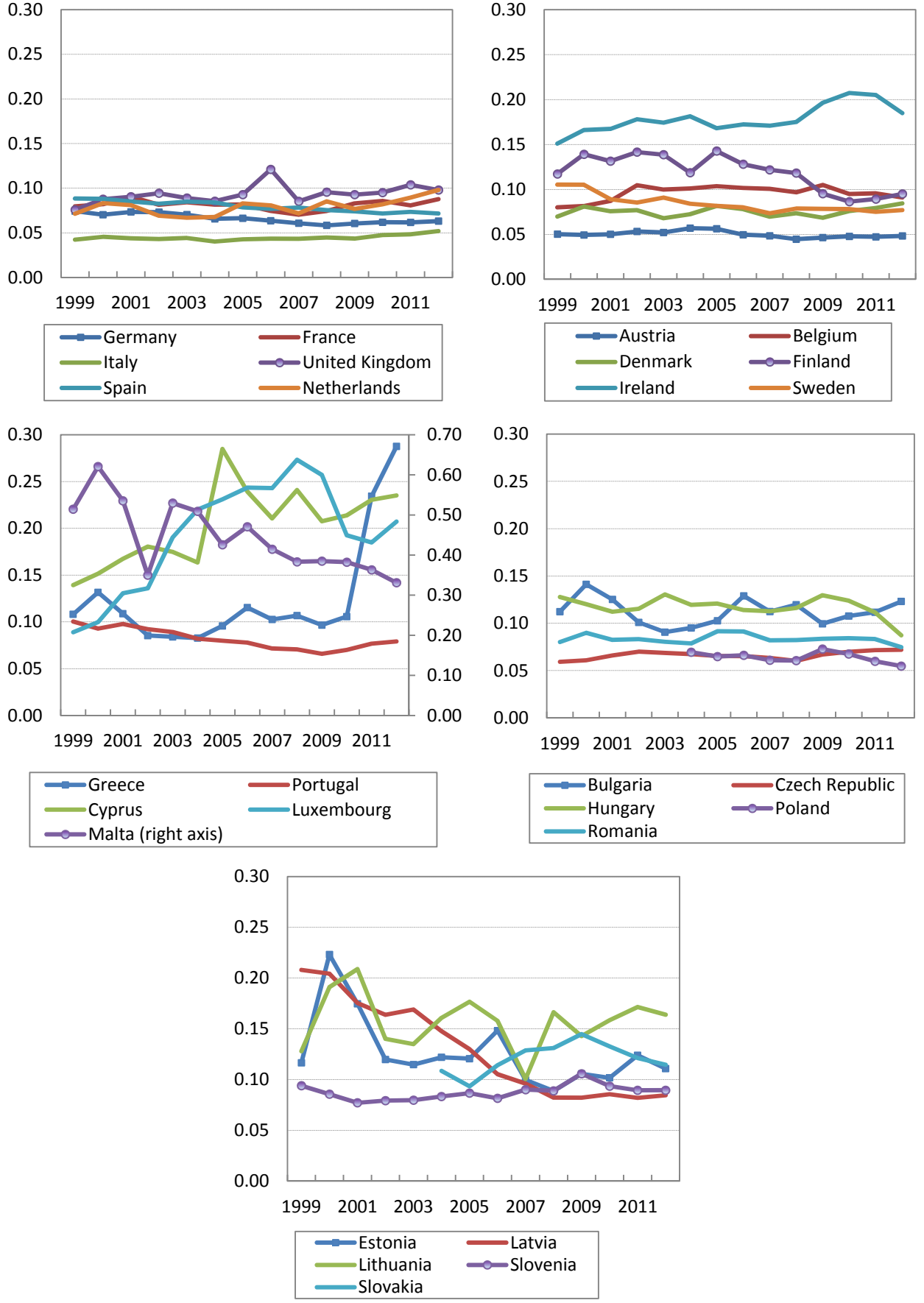
[7] The rise in the Greek HH index is due to a rise in the exports of mineral fuels and oils in 2011–2012. In 2012, some 39 per cent of Greek exports and 37 per cent of imports were HS2 code 27 Mineral fuels and oils and products thereof. In imports these products are HS4 code 2709 Petroleum oils and oils from bituminous minerals, crude, and in exports code 2710 Petroleum oils and oils from bituminous minerals, other than crude.

Figure 2 Herfindahl-Hirschmann index with HS2 data



Note: 97 product groups. Belgium includes Luxembourg in 1988–1998. EU15 is without Austria in 1988–1994.
Sources: OECD (1988–1998) and Eurostat (1999–2012), own calculations.

Figure 3 Herfindahl-Hirschmann index with HS6 data



Note: 7,396 product groups. Sources: Eurostat, own calculations.

Production

Export data are good for the analysis of specialisation in the sense that the time series are quite long and we can find a very large number of product groups. On the other hand, exports are measured in terms of their gross value, and for example arbitrage trade creates its own problems for the analysis.

As a complement to the export data analysis we use value added data in current prices. Here a problem is that Eurostat data have a lot of holes in it, and we cannot do the analysis with the number of sectors changing from year to year in different ways in different countries. Consequently, we will use OECD data from the STAN Database for Structural Analysis in 1980–2009.[8] These data are only available for the 21 EU countries that are OECD members.

The HH indices for 34 sectors covering the whole economy reveal that there has been a continuous trend of increasing specialisation.[9] The trend more or less concerns all the countries. Between 1995 and 2007, the simple unweighted average of the HH indices increased by 0.024 points to 0.212. For the 13 Euro Area countries we have data for between 1999 and 2007, the simple average increased by 0.016 points to 0.215.

Figure 4 shows the HH index using value added data in current prices for 21 manufacturing sectors (20 sectors in Ireland). The vertical axis has been scaled the same in all graphs to make them more comparable with Ireland as an outlier using the secondary axis. In many cases we can see a long-term rise in specialisation. The rise in the index values has also continued during the existence of the euro as a currency. The rise in specialisation in the largest five countries has been quite steady since at least 1980. Their 2009 index values are slightly lower than in smaller countries, as can be expected.

Austria, Sweden and Portugal have about the same level of specialisation as the largest economies. After the decline of the mobile phone industry, Finland too has been approaching this level.[10] On the other hand, Denmark, Belgium and the Netherlands have higher levels of specialisation. Greece, Luxembourg and Ireland (right axis) have much higher index values than the other countries. The rapid rise in the Greek HH index in 2008–2009 is largely due to a 6 percentage point rise in the share of food products, beverages and tobacco in total manufacturing value added.

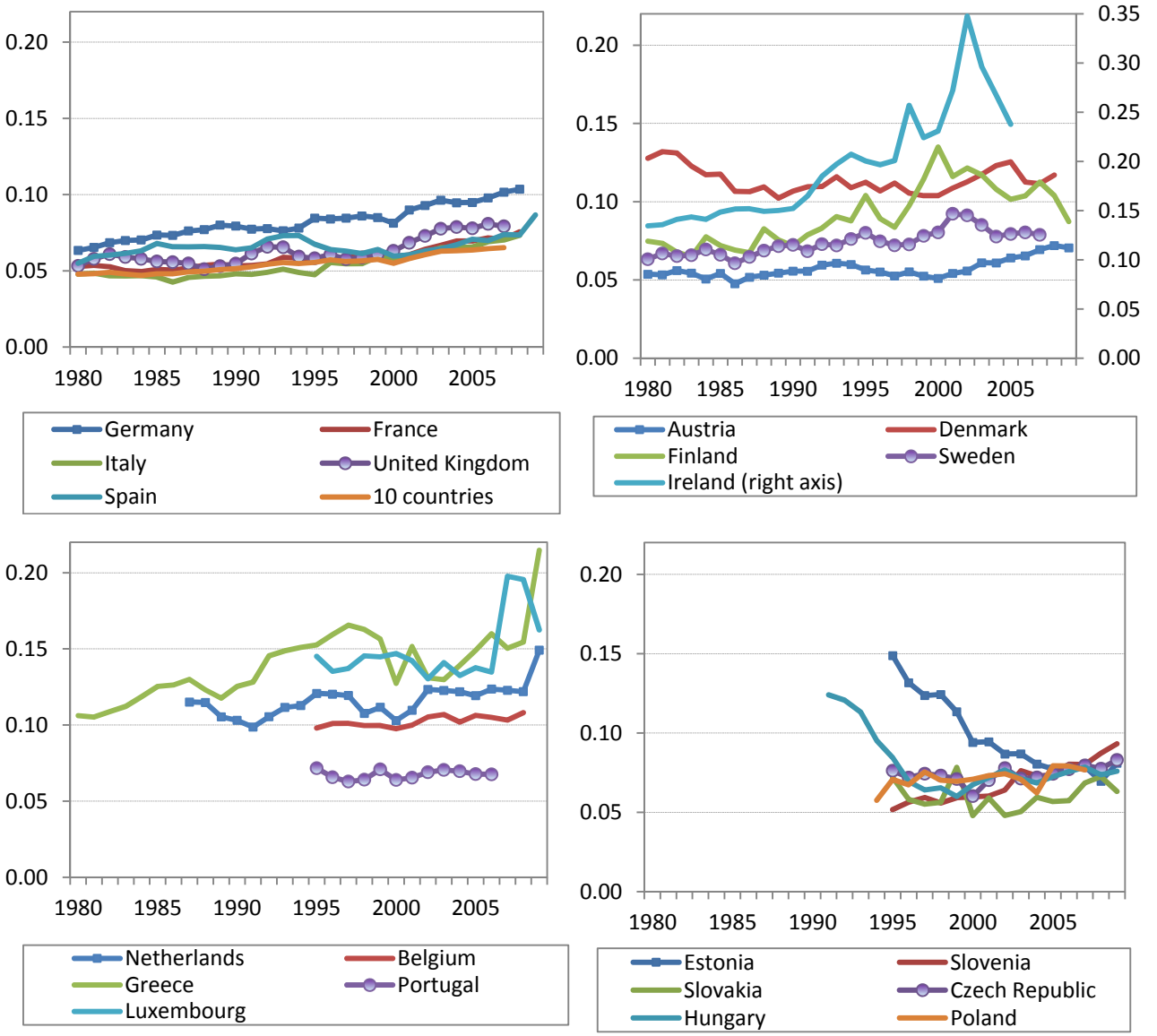
The ex-transition countries experienced a decline in specialisation during the 1990s, but the HH indices have again started to rise during the 2000s. Interestingly, however, the levels are at the same low level as in the largest five EU countries.

[8] The data are given in ISIC Rev. 3 which is the old revision. At this writing STAN has ISIC Rev. 4 data for 2010–2011 only for five EU countries.

[9] In order to save space we do not show these graphs.

[10] We can see this if we look at ISIC Rev. 4 data as Finland is one of the few countries that STAN has these data for. Most of the decline in the index value took place by 2009, but there was further slow decline in 2010–2011. By 2011 the index value for Finland had declined to its 1993 level.

Figure 4 Herfindahl-Hirschmann index of production structure for manufacturing in 1980–2009 calculated with value added



Note: 21 sectors using ISIC Rev. 3: C15T16 Food products, beverages and tobacco; C17 Textiles; C18 Wearing apparel, dressing and dyeing of fur, C19 Leather, leather products and footwear; C20 Wood and products of wood and cork; C21 Pulp, paper and paper products; C22 Printing and publishing; C23 Coke, refined petroleum products and nuclear fuel; C24 Chemicals and chemical products; C25 Rubber and plastics products; C26 Other non-metallic mineral products; C27 Basic metals; C28 Fabricated metal products, except machinery and equipment; C29 Machinery and equipment, n.e.c.; C30 Office, accounting and computing machinery; C31 Electrical machinery and apparatus, n.e.c.; C32 Radio, television and communication equipment; C33 Medical, precision and optical instruments; C34 Motor vehicles, trailers and semi-trailers; C35 Other transport equipment; C36T37 Manufacturing n.e.c. and recycling. Ireland is without sector C23. Germany is West Germany up until 1990. '10 countries' = Austria, Denmark, Finland, France, Germany, Greece, Italy, Spain, Sweden and the United Kingdom. Sources: OECD, own calculations.

4 Structural similarity

Exports

The motivation to review the development in the degree of similarity of export and production structures is that the more similar they are across countries the smaller the risk of asymmetric shocks is. Also if the structures have become more similar when integration has deepened, we may expect the common monetary policy in the Euro Area to fit the member countries better than when the euro was first introduced. However, theory predicts that the opposite has happened.

We will again first use HS2 data. The OECD provides data from 1988 onwards and we can use this to calculate the aggregate for the EU15 countries save Austria which has no data before 1995. From 1999 onwards we use Eurostat data. This gives us a longer perspective. The results are very similar to those presented below for 1999–2012 if we compare the countries' exports with the aggregate EA17 exports.

We may expect ex ante that larger countries have export and production structures that are more similar with the respective structure of the aggregate EU figures because smaller countries typically specialise more and because the larger countries also weigh in the aggregate structure more. We find that this is indeed the case.

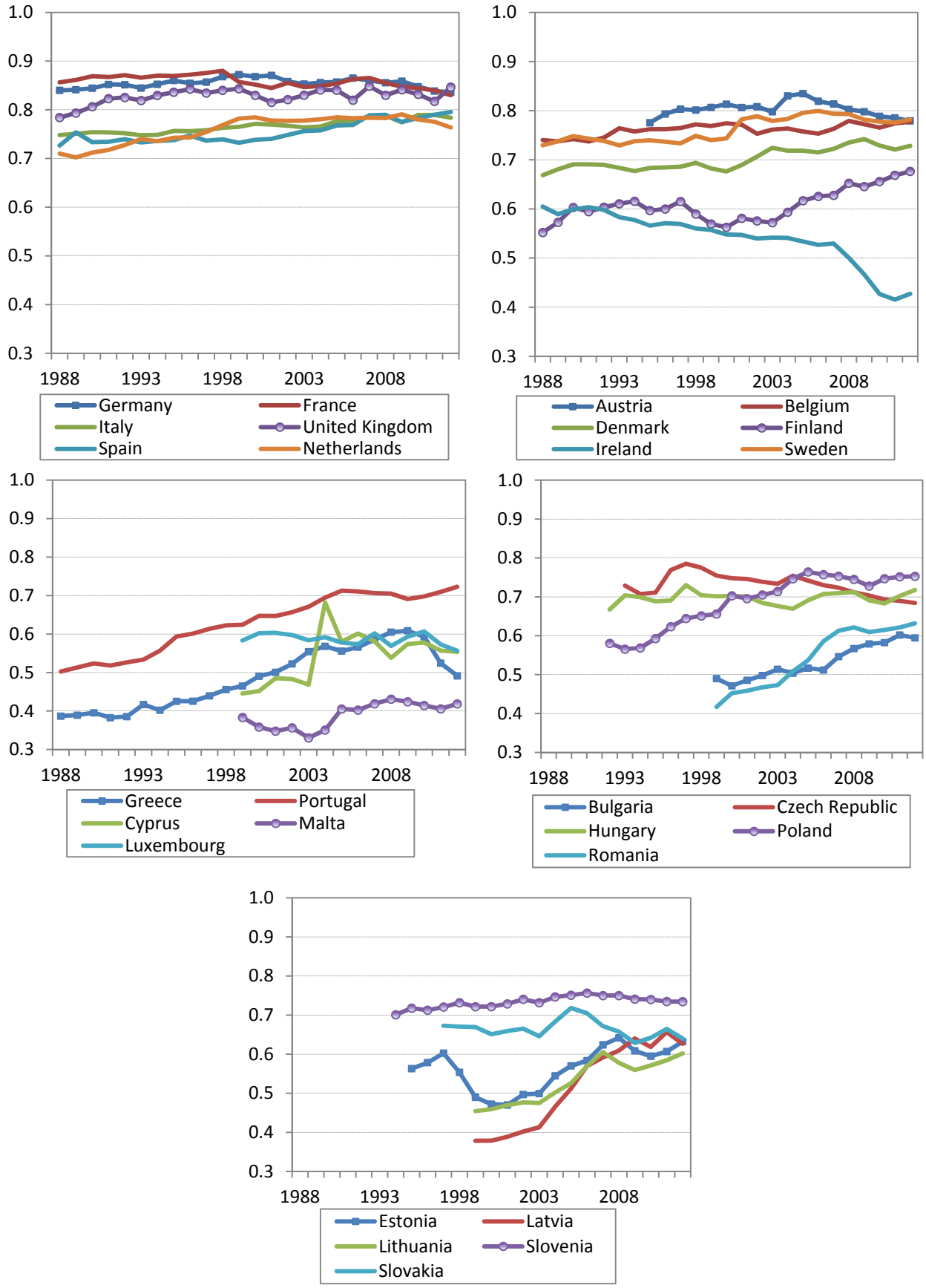
According to the results presented in Figure 5, the largest countries have remained at about the same level of similarity vis-à-vis the EU15 (less Austria). Spain, Italy and the Netherlands have been approaching the weighted average. Of the smaller EU15 countries, Ireland has been deviating from the average and has by now – together with Malta – the most dissimilar export structure. On the other hand, Finland, Denmark and Portugal have been approaching the average. Greece did so too up to the Great Recession.

Most of the ex-transition countries have been approaching the average export structure of the EU15 (less Austria) with the exception of the Czech Republic. Especially the Baltic countries, Bulgaria and Romania have been converging towards the average. The simple average for the EU27 countries in their comparison with the EU15 (less Austria) has risen by 0.044 points to 0.681 in 2012.

We did the same analysis using the more disaggregated HS6 data provided by the Eurostat for 1999–2010 (see Figure 6). We find that Germany has the most similar export structure with the aggregate EA17, followed by France, and then Italy, the UK and Spain – all large countries. The next group consists of Belgium, Sweden and Austria. Of the non-ex-transition countries, the most dissimilar export structures are those of Malta, Cyprus Ireland, Luxembourg and Greece. All ex-transition countries have more similar export structures vis-à-vis the EA17 aggregate than these five countries or Finland.

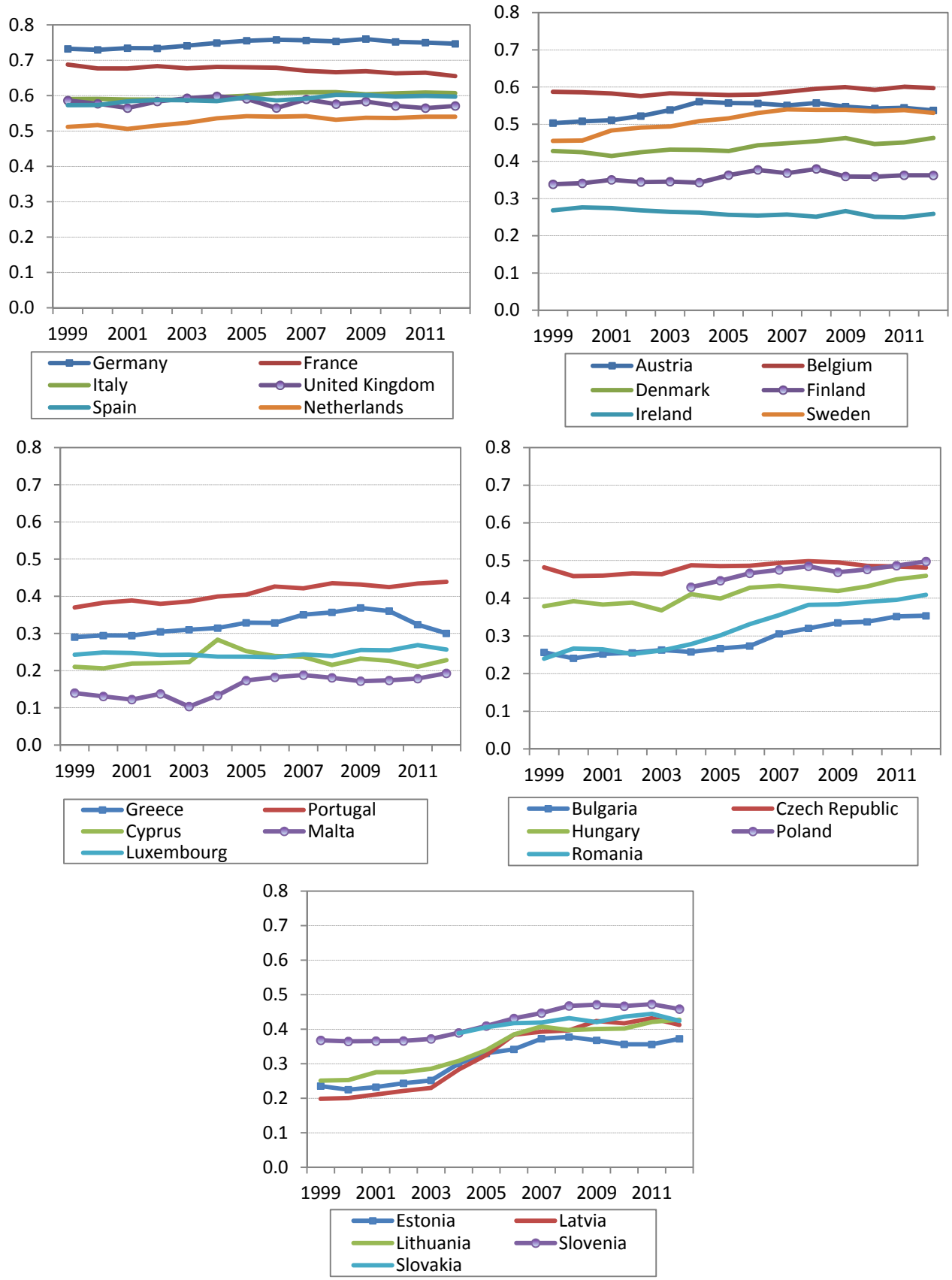
Looking at the developments, we find some decline in similarity for the UK, France and Ireland. In all other cases, similarity vis-à-vis the EU27 aggregate has increased. For the Baltic countries, Bulgaria and Romania we again witness a dramatic increase in similarity. They remain below the average but have by now moved much closer to it. The development seems to have levelled off in the Baltic countries, but the Balkan countries have continued to move upwards. Overall, the ex-transition countries' export structure similarity converged quite rapidly up until about 2008, after which the development has been less uniform and more moderate. Of the EU15 countries, we find that the export structures of especially Portugal and Sweden, but also Austria and Denmark, have become more similar vis-à-vis the EA17 aggregate.

Figure 5 Similarity of export structure vis-à-vis the EU15 (less Austria) at the HS2 level of aggregation



Sources: Eurostat, own calculations.

Figure 6 Similarity of export structure vis-à-vis the EA17 countries at the HS6 level of aggregation



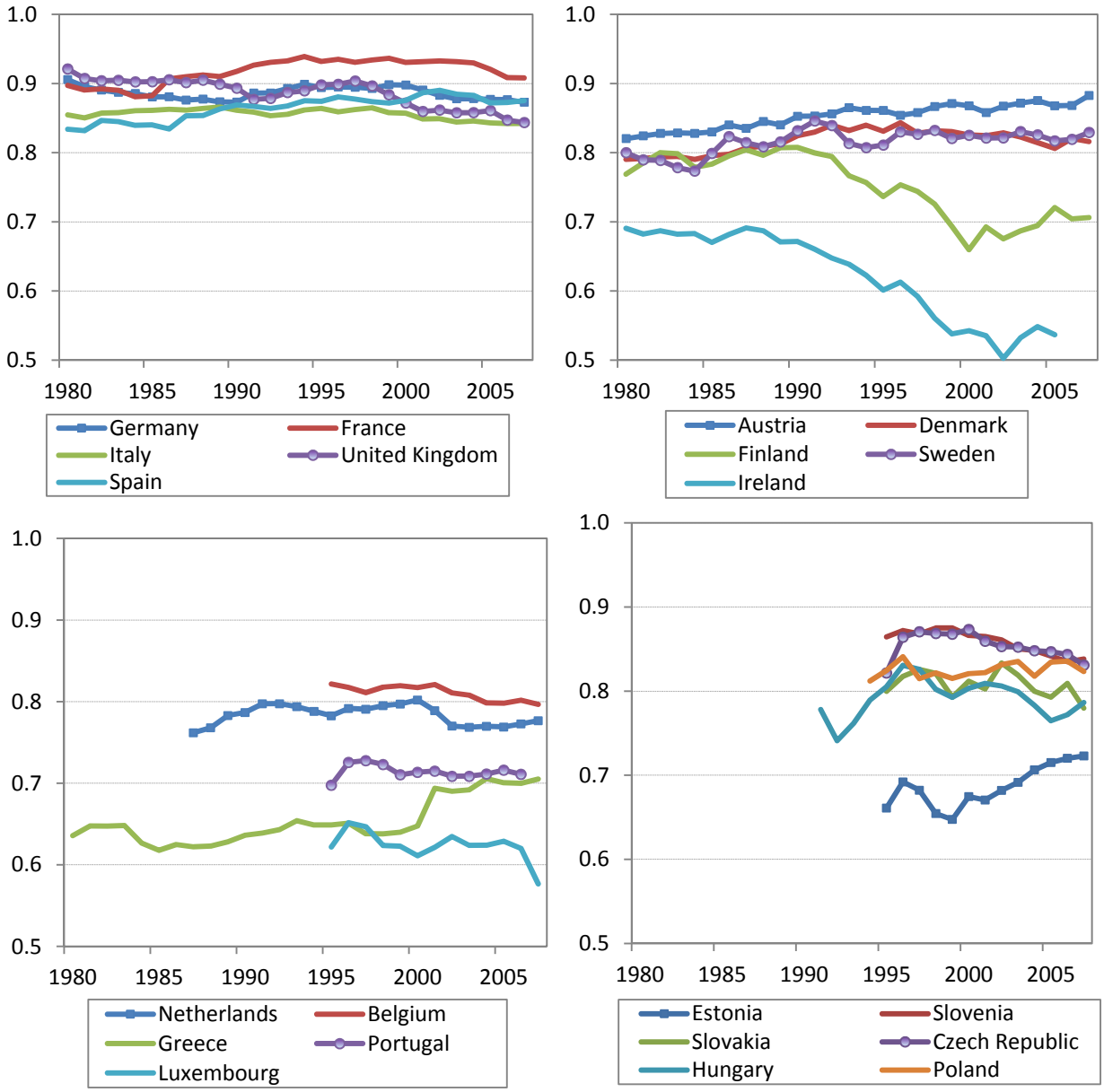
Sources: Eurostat, own calculations.

Production

To analyse the similarity of manufacturing value added we compare the countries with the summed production structure of ten countries, namely Austria, Denmark, Finland, France, Germany, Greece, Italy, Spain, Sweden and the United Kingdom. The reason for this is the lack of long time series for the other countries. Even now we only have data up to 2007.

We find that the relatively high similarity of the largest countries is easily matched by Austria and almost by Sweden and Denmark. The lowest level of manufacturing value added similarity can be found in Ireland and Luxembourg. Over time, the similarity has declined in the UK, Finland (reversed after 2000), Ireland, Luxembourg, Hungary, the Czech Republic and Slovenia. There has been an increase in similarity in Spain, Austria and Greece.

Figure 7 Similarity of manufacturing industry value added structure vis-à-vis the combined production structure of ten countries (see note)



Note: See the note to Figure 4. Sources: OECD, own calculations.

5 Specialisation and similarity in 2012

We have argued that specialisation and dissimilarity are risky from the point of view of asymmetric shocks. We have plotted the EU27 countries according to their HH and similarity indices in 2012. Similarity is measured vis-à-vis the EA17. HS2 data in Figure 8 give an industry level view while the HS6 data in Figure 9 give a product level view. The EA17 countries are marked with solid red dots while the other EU countries have diagonal lines in their dots.

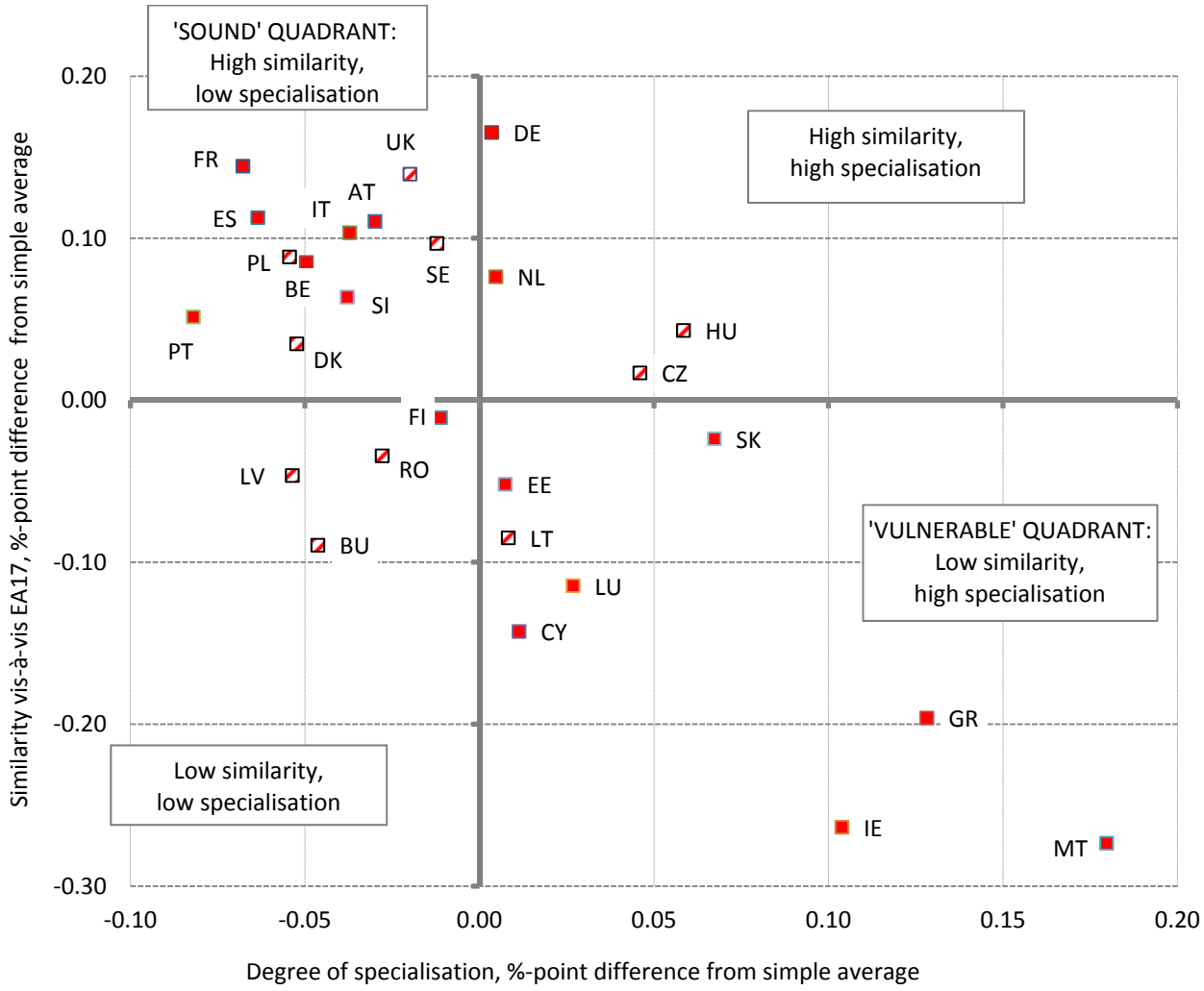
The correlation between HH^{HS2} and HH^{HS6} is 0.766 across the countries while the correlation between the HS2 and HS6 similarity index values is 0.923. Consequently, there is much more variation between the HH values at the two different levels of product aggregation than there is in similarity.

We have named the upper left-hand quadrant as a 'sound' quadrant because there we find high relative similarity and low specialisation. We do not mean that specialisation is bad as such; actually the opposite may be true because it may reflect high productivity, but rather we argue that higher specialisation increases the risk of asymmetric shocks. In the same spirit, the lower right-hand quadrant is named a 'vulnerable' quadrant because it combines low similarity with a high degree of specialisation. Most countries are in either one of these two quadrants, and the other two quadrants, especially the one with high similarity and high specialisation, are emptier.

We find the largest countries together with Austria, Belgium, Denmark, the Netherlands and Sweden in the 'sound' quadrant. There are also a couple of ex-transition countries, especially Poland. On the other hand, Finland, Latvia and Romania are found in the lower left-hand side quadrant with low similarity coupled with low specialisation. The 'vulnerable' quadrant is occupied by Cyprus, Greece, Ireland, Luxembourg and Malta.

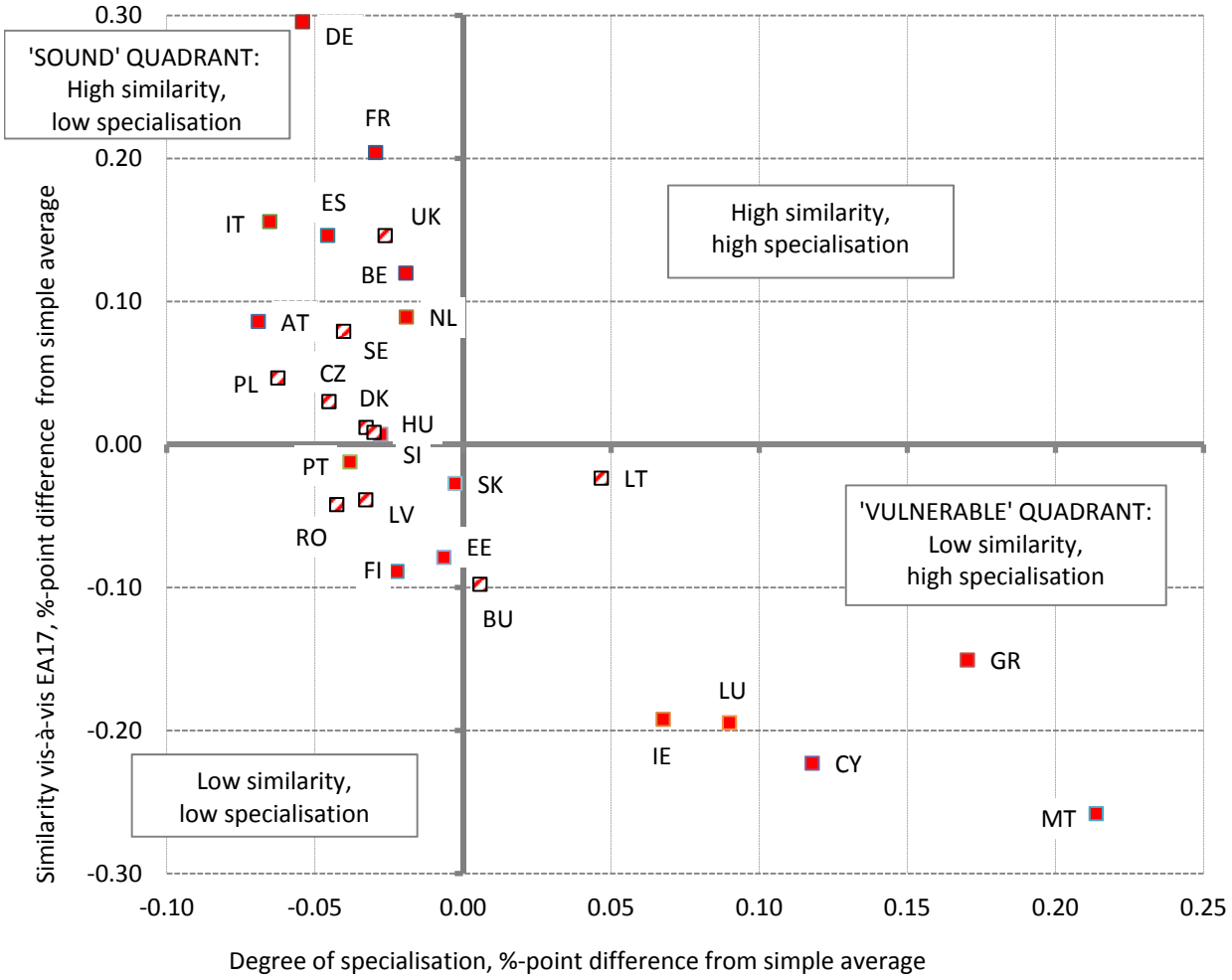
The respective figure with value added data has fewer countries and uses data from 2007/2008 (see above for the description of the value added data). The picture is relatively similar to the trade data. However, Germany is now more specialised (as it was slightly in the HS2 data, too), and Belgium and the Netherlands have moved to the 'vulnerable' quadrant. There have been considerable structural changes at least in Finland after 2007, so it is difficult to say, where the Finnish dot would now situate. The countries found deepest into the 'sound' quadrant are France, Austria and Spain.

Figure 8 HH and similarity indices (HS2) relative to their simple averages in 2012



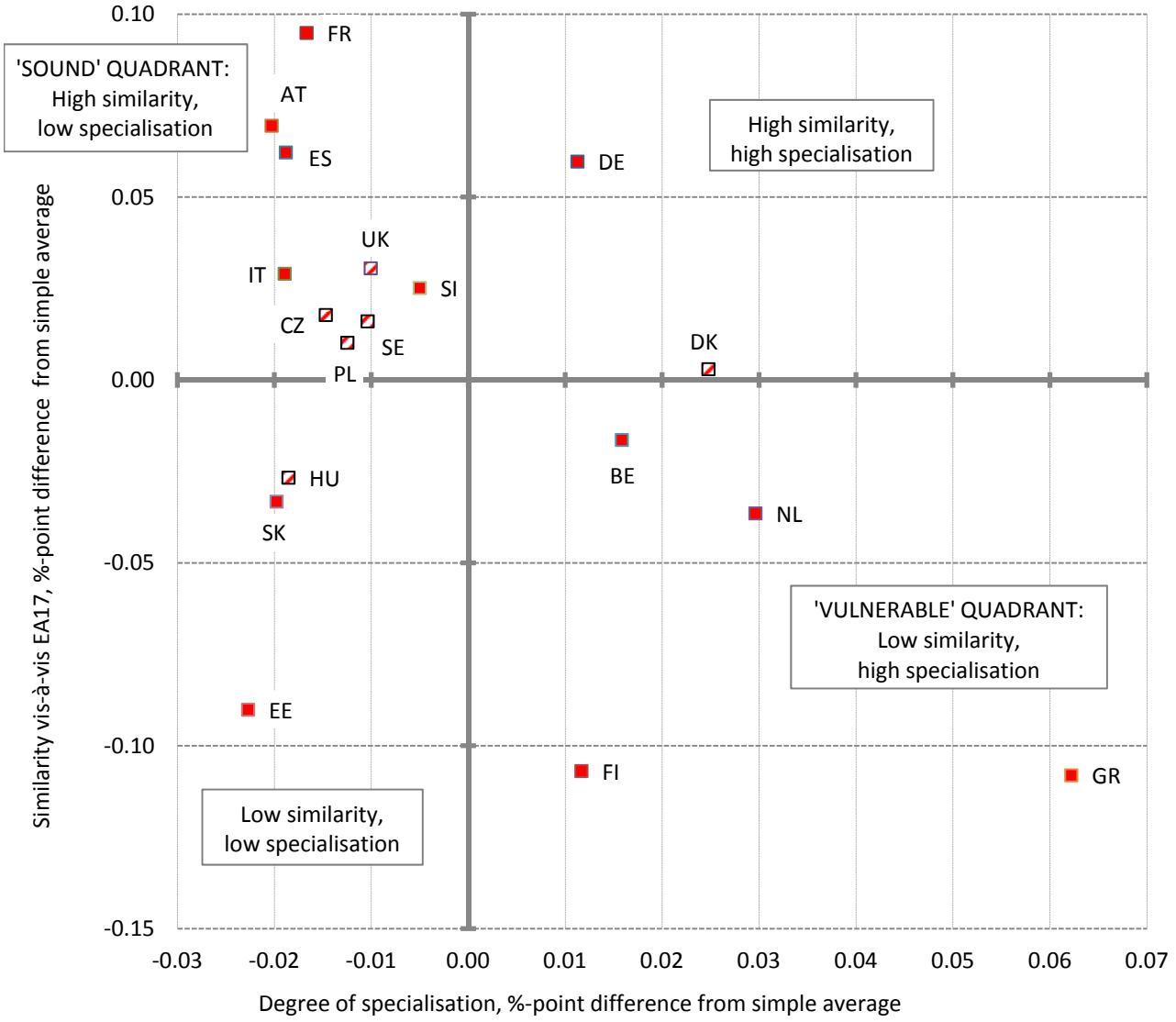
Note: The EA17 countries are marked with solid red dots while the other EU countries have diagonal lines. Sources: Eurostat, own calculations.

Figure 9 HH and similarity indices (HS6) relative to their simple averages in 2012



Note: The EA17 countries are marked with solid red dots while the other EU countries have diagonal lines. Sources: Eurostat, own calculations.

Figure 10 HH and similarity indices (manufacturing value added) relative to their simple averages 2007/2008



Note: The EA17 countries are marked with solid red dots while the other EU countries have diagonal lines. HH index values for 2008 except Poland, Sweden and the UK 2007. Similarity index values for 2007 except Portugal 2006. Sources: OECD, own calculations.

6 Changes in the indices: Results for country groups

Diversification vs. specialisation

This section summarises the results for country groups. In export data we can analyse the EU15, EA17, EU27 and the ten ex-transition countries of Central and Eastern Europe. In production data we have to improvise smaller groups depending on the availability of data. We have divided the data into time periods that last about a decade. The results are calculated as simple averages, weighted averages and medians of the percentage-point changes in national index values shown in Figures 2–7.

Table 1 shows the results for the changes in the Herfindahl-Hirschmann index using export data at both the HS2 and HS6 levels. A rise in the index indicates specialisation and a fall indicates diversification.

At the more aggregated level we find that between 1988 and 1999 the values of the HH^{HS2} increased by about 0.025 points for both the simple and weighted averages and the median in the EU15. This means that the EU15 countries' aggregate export structure became more specialised before the introduction of the euro. The development was reversed in 1999–2012 and the difference to the preceding decade – especially in terms of the weighted average and the median – is quite large. The simple average is strongly affected by the development in Greece where the HH^{HS2} index value rises from 0.108 to 0.331 in 2010–2012. We have also divided the latter period in two with the start of the Great Recession as the fault line. Looking at the weighted average and the median, we find no difference for the EU15 countries between the two sub-periods.

The results are interestingly different when using the more disaggregated HS6 data. There we witness specialisation in 1999–2012. Consequently, the EU15 countries' exports have diversified at the industry level but become more specialised at the product level. We argue tentatively that the countries specialised according to their comparative advantages at the product level as e.g. the Forslid and Wooton (2003) model predicts. Furthermore, the development in 1999–2008 in HH^{HS6} does not differ from the development in 2008–2012 in any significant way for the EU15 countries.[11]

Table 1 Exports HH indices, %-point changes

Region	Measurement	HS2				HS6***
		1988–1999	1999–2012	1999–2008	2008–2012	1999–2012
EU15	**simple average**	0.028*	–0.003**	–0.006	0.003	0.021
	weighted average	0.024	–0.019	–0.011	–0.008	0.006
	median	0.025*	–0.017	–0.012	–0.009	0.010
EA17	**simple average**	..	0.001**	–0.002	0.002	0.013
	weighted average	..	–0.017	–0.007	–0.009	0.004
	median	..	–0.013	–0.009	–0.009	0.006
EU27	**simple average**	..	–0.003**	–0.001	–0.002	0.004
	weighted average	..	–0.016	–0.007	–0.009	0.004
	median	..	–0.005	–0.006	–0.007	0.006
Ex-transition	**simple average**	..	0.004	0.011	–0.006	–0.013
	median	..	0.013	0.037	–0.003	–0.005

Notes: * = Without Austria; Belgium together with Luxembourg. Removing all these three countries gives as simple averages 0.030 for 1988–1999 and –0.004 for 1999–2012. ** = Greece has a considerable effect because its HH^{HS2} index value rises from 0.108 to 0.331 in 2010–2012. *** = Slovakia and Poland have data for 2004–2012 and the changes are calculated between these years for these two countries. Sources: Eurostat, own calculations.

Looking at the Euro Area (EA17) we find the same development. This includes all EA17 countries already before some of them became members. Because the countries that joined the Euro Area at a later stage are quite small they do not affect the weighted average. Also the simple average and the median for EA17 are very close to the results we have for the EU15. Not surprisingly, the results for EU27 are also very close to the EU15 and EA17 results. In all cases we find negative values using HS2 and positive ones using HS6.

These results are reversed for the ten ex-transition countries. Now we have positive values at the industry level (HS2) and negative ones at the product level (HS6) in 1999–2012. These countries have become an important part of the international value chains of monopolistically competitive increasing returns to scale industries during these years. For the ex-transition countries we also find a difference in HH^{HS2} between the two sub-periods 1999–2008 and 2008–2012. Before 2008, their HH^{HS2} index values increased indicating specialisation, but thereafter the values turned down indi-

[11] Not shown in the table.

cating diversification. On the other hand, the HH^{HS6} index values remained slightly negative in both sub-periods.

Exports are measured in terms of their gross value. How then have the value added data developed? Table 2 shows the Herfindahl-Hirschmann index results for 19 OECD countries in the EU using 21 manufacturing industries. Here we have data for ten countries in the 1980s and 1990s, and we find that manufacturing industry tended to specialise during that time. The development was stronger in the latter decade. Specialisation continued in 1999–2007 at about the same pace as in the 1990s. This result differs from our HH^{HS2} results according to which the HH index value declined slightly in 1999–2008. The value added data confirm that manufacturing industry became more specialised in the six ex-transition countries in 1999–2007.

There are three factors that affect the results: first, the number of sectors is 21 in value added data and 97 in exports; second, the country groups are not quite the same albeit the large countries are present in both; and third, trade is measured as gross value while production is value added.

Table 2 Manufacturing HH indices, %-point changes

Region	Measurement	1980–1990	1990–1999	1999–2007
10 countries	**simple average**	0.003	0.011	0.008
	weighted average	0.004	0.006	0.008
	median	0.002	0.006	0.010
All 19 countries	**simple average**	..	..	0.008
	median	..	..	0.009
6 ex-transition countries	**simple average**	..	..	0.002
	median	..	..	0.008

Note! The '10 countries' are Austria, Denmark, Finland, France, Germany, Greece, Italy, Spain, Sweden and the United Kingdom. The 'ex-transition countries' are Czech Republic, Estonia, Hungary, Poland, Slovakia, Slovenia. 'All 19 countries' also include Belgium, Luxembourg and the Netherlands. Sources: OECD, own calculations.

Structural similarity

To analyse the similarity of export and production structures we have to construct a point of comparison. Due to data limitations, this differs depending on the data we use. We get a longer perspective using HS2 data with the EU15 (without Austria) as the point of comparison. There we see that the EU15 countries' simple average[12] and median have moved upwards in both 1988–1999 and 1999–2012 meaning that the countries' export structures have become more similar with the aggregate. The ten ex-transition countries' export structures have become much more similar with the EU15 and EA17 export structures in 1999–2012. The results are very similar if we take as the point of comparison the EA17 countries and use the more disaggregated HS6 data. However, splitting the euro era in two we find that similarity increased in 1999–2008, but the trend was either reversed or slowed down considerably in 2008–2012. The same results are found using HS2 data (not shown in Table 3).

[12] Note that the weighted average is our point of comparison.

Table 3 Export structure similarity indices, %-point changes

Region	Measurement	HS2 vis-à-vis EU15 (less Austria)		HS2 vis-à-vis EA17		HS6 vis-à-vis EA17		
		1988–1999	1999–2012	1999–2008	2008–2012	1999–2012	1999–2008	2008–2012
EU15	**simple average**	0.031*	0.016*	0.031	–0.017	0.020	0.028	–0.007
	median	0.017*	0.019*	0.013	–0.010	0.020	0.024	–0.005
EU27	**simple average**	..	0.044	0.054	–0.008	0.053	0.051	0.002
	median	..	0.026	0.048	–0.006	0.034	0.041	0.002
EA17	**simple average**	..	0.019	0.037	–0.017	0.032	0.036	–0.005
	median	..	0.013	0.019	–0.012	0.024	0.029	–0.005
Ex-transition	**simple average**	..	0.088	0.090	0.004	0.107	0.096	0.011
	median	..	0.101	0.085	0.006	0.094	0.082	0.014

Note! * = Without Austria. In 1999–2012 these would be 0.012 and 0.014 with Austria included. Data for Poland and Slovakia are for 2004–2012, and the changes for these countries have been calculated accordingly. Sources: Eurostat, own calculations.

These results are not matched by the manufacturing value added data shown in Table 4. Here we have the three above-mentioned differences compared with the trade data. We find that in the 'ten countries', the structure of manufacturing value added became more similar during the 1980s, but more dissimilar in 1999–2007. The latter result also applies to the six ex-transition countries.

Table 4 Manufacturing value added structure similarity indices, %-point changes

Region	Measurement	1980–1990	1990–1999	1999–2007
10 countries	**simple average**	0.014	–0.006	–0.002
	median	0.026	0.003	–0.005
All 19	**simple average**	..	..	–0.006
	median	..	..	–0.014
6 ex-transition	**simple average**	..	..	–0.002
	median	..	..	–0.010

Note! The '10 countries' are Austria, Denmark, Finland, France, Germany, Greece, Italy, Spain, Sweden and the United Kingdom. The 'ex-transition countries' are Czech Republic, Estonia, Hungary, Poland, Slovakia, Slovenia. 'All 19 countries' further include Belgium, Luxembourg and the Netherlands. Sources: Eurostat, own calculations.

7 Similarity of annual GDP growth rates

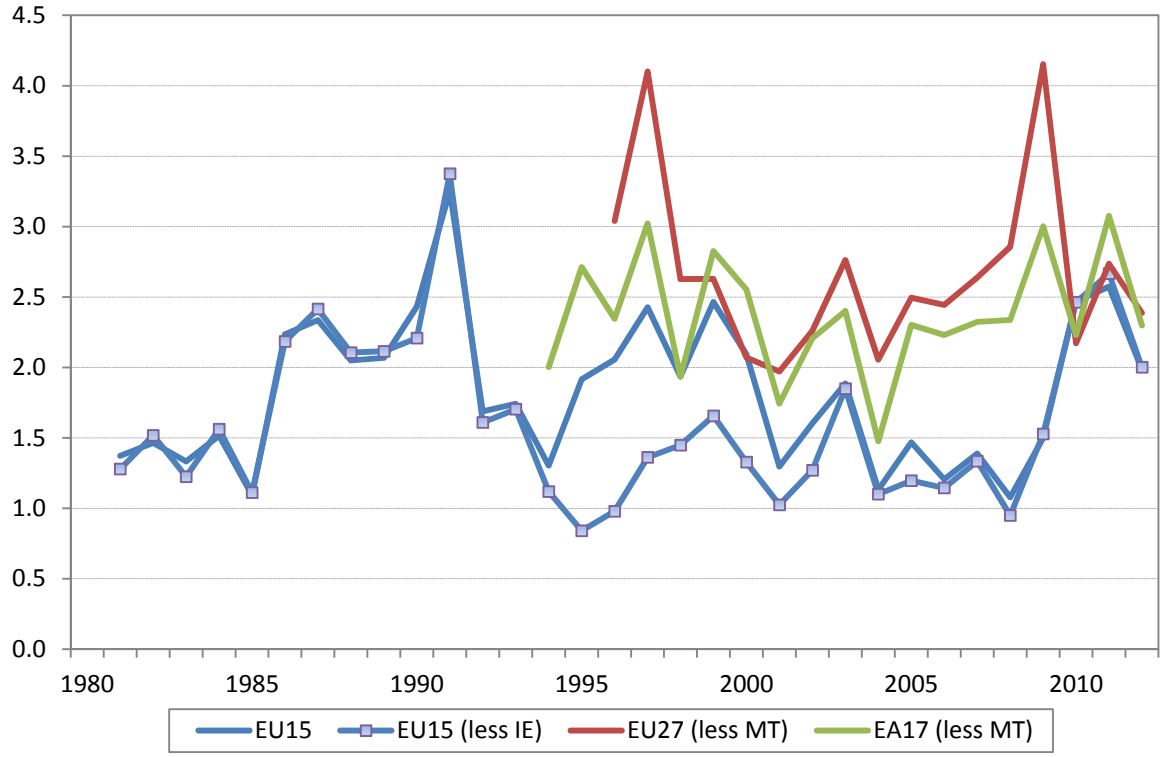
Next we will perform a simple analysis of the development in GDP growth rates in constant prices across the EU. With this section we wish to analyse first whether business cycles have become more similar during the existence of the single currency and second which EU countries' business cycles have been most similar with the EA17 weighted average. In a simple way, this reveals which countries have been most suited to be Euro Area members during its short existence.

In Figure 11 we have calculated the standard deviations of GDP growth rates across country groups. Malta is omitted because its data start from 2001. Furthermore, we have shown EU15 with and without Ireland. For the EU15 countries, the standard deviation was low in 1981–1985 and thus there were relatively small differences between the countries in terms of their annual GDP growth rates. This was followed by a considerable increase in growth-rate divergence in 1986–1991. The high in 1991 is due to the collapse in the Finnish economy. In 1992–2009, the standard deviation

was on average at about the same level as before 1986. A difference can be found if we include the then fast-growing Ireland. The Great Recession again induced a rise in growth-rate differences.

Our principal interest is, however, the development in the Euro Area. The EA17 line has been relatively stable since 1994 with a low in 2001–2004. On the basis of these data we cannot claim that the standard deviation is different between the period before the introduction of the euro and after it.

Figure 11 Standard deviation of GDP growth rates in constant prices



Note: Malta is not included due to lack of data before 2001. Sources: IMF, own calculations.

Table 5 shows the correlation coefficient between member countries' GDP growth rates and the EA17 weighted GDP growth rate. The countries have been sorted by the column that shows the results for 1999–2012. EA17 countries are marked with an asterisk. The simple, unweighted average across the EA17 countries shows a correlation coefficient of 0.641 before the introduction of the euro and 0.838 after its introduction. If we dissect the latter period in two – before and after the start of the Great Recession – we see that average correlation was higher at 0.826 in 2008–2012 than in 1999–2008 when it was 0.686.

The countries with the highest correlation (>0.9) with the EA17 average growth rate are Finland, France, Italy, Denmark, Austria, Belgium and the Netherlands. On the other hand, correlation has been relatively weak in Greece, Poland, Romania, Slovakia, Malta and Lithuania. Comparing 2008–2012 with the beginning of the euro time (1999–2008) we can see that correlation increased in all other countries but Greece, Cyprus and Portugal.

Consequently, it seems that the business cycles have become more uniform across the Euro Area after the introduction of the euro than they were before. On the other hand, there are some Euro Area countries that have been rather off-sync with the average EA17 GDP growth rate and may thus be seen as not fulfilling optimal currency area criteria. There are also several non-EA17 countries in Central and Eastern Europe that can be assessed in the same way.

Table 5 Correlation of GDP growth rates with EA17 GDP growth rate sorted by 1999–2012

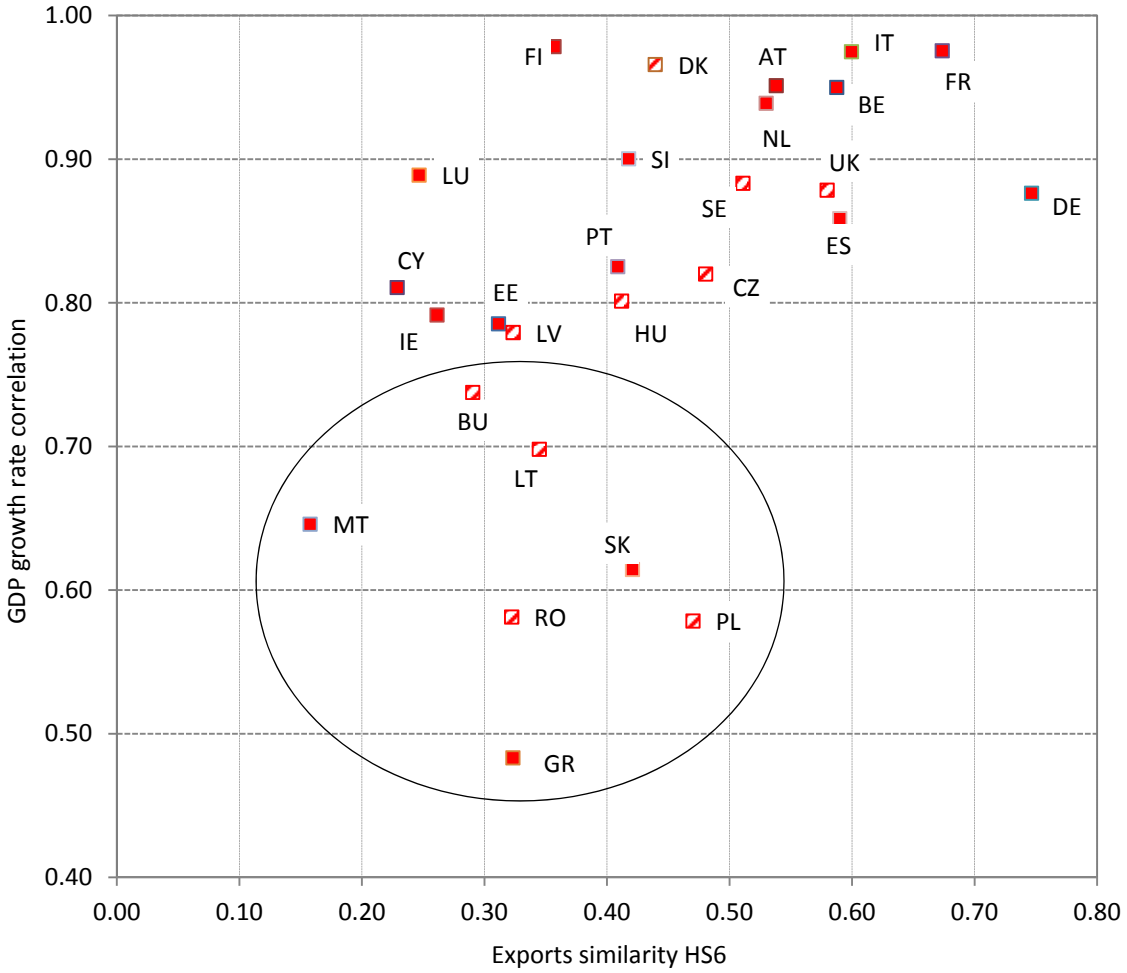
Country	1992-1999	1999-2012	1999-2008	2008-2012
Finland*	0.687	0.978	0.934	0.993
France*	0.930	0.975	0.935	0.982
Italy*	0.908	0.975	0.921	0.981
Denmark	0.700	0.966	0.879	0.987
Austria*	0.877	0.951	0.859	0.977
Belgium*	0.898	0.950	0.841	0.995
Netherlands*	0.806	0.939	0.857	0.945
Slovenia*	0.699	0.900	0.682	0.894
Luxembourg*	0.288	0.889	0.843	0.956
Sweden	0.830	0.883	0.808	0.921
United Kingdom	0.323	0.878	0.590	0.948
Germany*	0.912	0.876	0.868	0.990
Spain*	0.945	0.859	0.845	0.889
Average EA17**	0.641	0.838	0.686	0.826
Portugal*	0.722	0.825	0.841	0.693
Czech Republic	-0.794	0.820	0.355	0.923
Average EU27**	0.529	0.814	0.544	0.837
Cyprus*	0.471	0.811	0.817	0.588
Hungary	0.702	0.801	0.071	0.983
Ireland*	0.777	0.792	0.734	0.778
Estonia*	-0.215	0.785	0.399	0.866
Latvia	0.761	0.779	0.398	0.798
Bulgaria	0.810	0.738	-0.064	0.715
Lithuania	-0.202	0.698	-0.172	0.894
Malta*	..	0.646	0.019	0.880
Slovakia*	-0.396	0.614	-0.065	0.914
Romania	-0.015	0.581	-0.261	0.639
Poland	0.396	0.578	0.414	0.756
Greece*	0.943	0.483	0.333	-0.278

Note: * = EA17 countries; ** = simple average. The 2012 GDP growth rate is preliminary data. Sources: IMF, own calculations.

In order to link the GDP correlation coefficients with the similarity analysis we did above, we have next plotted the average correlation with respect to EA17 GDP growth rate in 1999–2012 against the average similarity vis-à-vis the EA17 HS6-level exports. There is a positive correlation between the two. However, the plot can be divided in two with a smaller group of countries not quite fitting the general picture. The upper group of countries does fit a linear trend (not drawn in Figure 12) rather well.

We can also note that Finland's GDP growth rate correlation is surprisingly high given the relatively low similarity in export structures, while Germany is more or less an opposite case. Of course, many factors other than export similarity affect GDP growth. However, the positive correlation between the two within the group of countries that is not circled is considerable. This confirms our view that lower export similarity would increase risks in the Euro Area.

Figure 12 GDP growth rate correlation and average export structure similarity in 1999–2012, both with respect to EA17



Note: The EA17 countries are marked with solid red dots while the other EU countries have diagonal lines. Sources: Eurostat, IMF, own calculations.

8 Summary

Deeper economic integration affects the structure of exports and production through, among other things, lower trade and investment costs. It is particularly important to analyse the impact of the single currency on European trade and output. We have done this, and also divided the euro years into two sub-periods: before and after the beginning of the Great Recession in 2008.

If the countries have become *less specialised* so that the economies now depend on a larger number of products and sectors than before, they are better protected against asymmetric adverse shocks. We analysed this with the Herfindahl-Hirschmann index. In the meantime, if the economic structures have become *more similar* across the countries the risk of asymmetric shocks has declined and we may expect the common monetary policy in the Euro Area to fit the member countries better than when the euro was first introduced. We analysed this with the similarity index developed by Finger and Kreinin (1979). Furthermore, we analysed the convergence of GDP growth rates over time, before and after the introduction of the euro, and compared it with export similarity.

We found that the largest countries all have a relatively low level of specialisation in goods exports and manufacturing. During the course of time these countries' manufacturing industries have

tended to become more specialised than they were before. This is also what the new trade theory and new economic geography models predict. However, the increase in specialisation is more evident in manufacturing value added than in exports where we find exceptions. This may be due to the development of international value chains of monopolistically competitive increasing returns to scale industries. However, also the number of sectors and products differs between the three datasets we use and this affects the index values.

There is a lot more variation between the smaller countries than between the large countries. Austria, Belgium, Denmark, Finland, Portugal and Sweden have a degree of export specialisation more or less comparable to the large countries. On the other hand, Cyprus, Greece, Ireland and Malta have the most specialised structures. In many cases specialisation has increased. On the other hand, specialisation has decreased in Finland, Ireland, Malta and Portugal. Most ex-transition countries of Central and Eastern Europe have a relatively low degree of specialisation. The relative development in these countries varies a lot.

Overall, EU15 countries' exports tended to become more specialised before the introduction of the euro. Interestingly during the euro era, exports have diversified at the industry level (HS2) but they have become more specialised at the product level (HS6). Furthermore, these results are reversed for the ten ex-transition countries: we find positive values at the industry level (HS2) and negative ones at the product level. We may expect the ex-transition countries to conform to the EU15 countries' development in due time. Using value-added based manufacturing data, we find continuous specialisation in the 1980s, 1990s and during the existence of the euro (before the Great Recession).

EU countries' and especially ex-transition countries' export structures have become more similar vis-à-vis the aggregate. On the other hand, the structure of manufacturing industry value added has become slightly less similar.

We also find that GDP growth rates have converged during the euro era relative to 1992–1999. Consequently, judging ex post the common monetary policy is likely to have suited the member countries better than what we could have expected with ex ante data. We also find a linear relationship between average GDP growth correlation vis-à-vis the EA17 average growth rate and similarity in export structures. However, Greece, Romania, Poland, Slovakia, Malta, Lithuania and Bulgaria are different in this respect and given their economic development in 1999–2012 their vulnerability for asymmetric shocks has been higher than those of other countries.

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