European Commission

Sectoral Analysis and Assessment of Geographical Concentration of EU Industries

Study carried out for the European Commission, DG JRC, under contract JRC/SVQ/2017/B.5/0034/NC

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Main Insights

Introduction to the study

The aim of this JRC-Seville commissioned study is to gain a deeper understanding of how the process of EU integration has affected patterns of industrial specialisation, geographic location and clustering across Europe and its regions. To carry out this study required a theoretical definition and assessment of the key terms (specialisation, concentration, and clustering); data collection (across time periods, Member States, regions and sectors); formulation and construction of relevant indicators; and assessment of their evolution and the role played by the Single Market.

The general prediction from theory is that increasing economic integration across the EU, as expressed by the four freedoms (of movement of people, capital, goods and services) and underpinned by harmonisation of regulation, mutual recognition of qualifications and standards, the introduction of a common currency, and similar such measures, should lead to both Member States and their regions becoming more economically specialised, whether because of inherent and inherited comparative advantages, or because of increasing returns associated with scale of production effects. New Economic Geography goes further and argues that such increasing returns effects both lead to and are enhanced by the geographical concentration and agglomeration of economic activity and localised industrial interdependencies. More recent theoretical developments, however, contend not only that that technological changes have permitted such interdependencies – such as supply chains and intra-industry trade – to become geographically dispersed (delocalised), but also, as a result, for countries and regions to become specialised in functions and tasks rather than in particular industries.

The period of study, the past two decades, required an assessment of the extent to which EU integration had progressed over these years, because evidence of the effects of integration (on specialisation, concentration, and agglomeration) would most likely be observable in areas (Member States, sectors, etc) where integration had strengthened the most. This is particularly the case when other developments, such as the increase in globalisation of supply chains, and the financial crisis and great recession which followed, are coincidental to this period and created their own impacts and dynamics which could obscure any integration-driven effects. Particular (integration-related) events occurring during this period include the accession of many eastern European countries, the launch of the euro, and several initiatives (such as the Services Directive and the Single Market Act I and II) intended to deepen integration into areas of the economy less affected by earlier directives (which tended to focus more on tradeable goods).

Main findings

The results present little evidence to suggest that, as EU integration has progressed over the past two decades or so, Member States have become more export specialised. Rather, overall, the Member States have become more similar in terms of their degree of specialisation, as measured by their average sector export structures over this period. There have only been a few exceptions to this trend, most notably the UK's increase in specialisation in financial services.

At the same time, the geographical specialisation of sectors, when export performance is averaged across Member States, has also tended to become more similar. Also, when analysed in groups according to their accession date, Member States that increase in specialisation (Malta and the UK) are the exception to the rule. In other words, it would

appear that there is little support at the Member State level for the hypothesis that integration encourages nations to increase their specialisation in those sectors in which they have a comparative or competitive advantage. As the results are averages, it is feasible that these mask changes in specialisation within particular sectors, although the general agreement with findings from the analysis of export trends would tend to support the 'becoming generally more similar in sectoral structure' argument.

As in the case of specialisation, there is little evidence to suggest that, as EU integration has progressed over the past two decades or so, economic activities – measured by employment in individual sectors – have become more geographically concentrated, either between or regionally-within Member states. While the limitations of data have to be borne in mind, it does not appear to be the case that agglomeration forces have been sufficient to produce any significant increase in the geographical concentration of employment within industries, at least at the spatial scale for which analysis has been possible.

Finally, our analyses find some evidence of pairwise co-location or geographical agglomeration of certain activities. The findings are strongest for pairs of industries for which there are clear supply-chain, input-output linkages, such as textiles and apparel; electrical equipment and computer, electronic and optical products; chemicals and chemical products; rubber and plastic products and other non-metallic mineral products; and basic metals with fabricated metal products, except machinery and equipment; and manufacturing of wood and wood products, with that of pulp, paper and paper products. There is also limited evidence that some of these co-location concentrations have increased over the period of the study. Overall, however, the findings do not suggest that there has been any substantial increase in geographical agglomeration and co-location across sectors since the early-2000s.

Comparison with previous research

Several empirical papers have assessed whether specialisation and concentration of economic activity have increased across the EU over recent decades, though much of this work refers to the 1980s and 1990s and is also at national level.

- Sapir (1996), using the Herfindahl index to measure country specialisation across 100 manufacturing industries, found that specialisation remained constant over the 1977-1992 period in Germany, Italy and the UK, but increased in France after the mid-1980s.
- Amiti (1999) using data for manufacturing industries and the Gini coefficient, found that specialisation had increased for most of the countries in her samples.
- In his study of 32 manufacturing industries across 13 Member States over the 1972-1996 period, and using a variety of measures, Brülhart (2001) found that national employment specialisation had generally increased, not only in traditional resource and labour-intensive sectors, but also in technology-intensive industries. However, he also found that specialisation in exports, though higher than in employment, fell over his study period. In other words, while countries appeared to have become more specialised in terms of the sectorial distribution of their manufacturing employment, at the same time they had become more diversified in terms of their manufacturing exports.
- In her study of EU regions, Cutrini (2010) employed a new version of the Thiel Index to examine trends in both specialisation and concentration of manufacturing, covering 12 sectors, across some 145 NUTS2 regions for 10 European countries, at three points in time, 1985,1993 and 2001. Overall, she found a decline in the localisation (spatial concentration) of almost all of the 12 manufacturing activities over these years, and a fall

in regional specialisation in almost all countries. In short, her analyses suggest a process of regional de-agglomeration and de-specialisation of manufacturing activity, and thus run somewhat counter to the cross-national findings identified by the above previous studies.

- In their study for the European Commission, Middlefart-Knarvik et al (2000) looked at the period from the 1970s through to the mid-1990s and found, using detailed industrial data at Member State level, divergence in industrial structure (from an EU benchmark) from the 1980s onwards. They also identified certain (often low-skill) sectors that were concentrating activities, while the mid to high-end technology sectors were showing signs of dispersion.

Empirical findings have thus varied, according to the period studied, whether the analysis is for countries or regions, and the data sets used. A key problem affecting all such studies is that of data availability, both on a sectoral basis and in terms of geographical (especially regional) coverage. The additional challenge is that of imputing the trends identified with the evolution (both integration, or deepening, and expansion or widening) of the European Union, when so many other processes and developments have been underway over recent decades (not least technological change and accelerating globalisation). Constructing a counterfactual of what would have happened to regional specialisation across the EU had integration not taken place is a major challenge.

The findings from this study are closest to those of Cutrini (2010), whose work was also replicated and extended with a reduced sample of sectors and regions. The analysis would seem to confirm the trends that Cutrini's earlier studies established, that if anything both economic specialisation and spatial concentration have continued to decline, on average. The findings also lend support to Krugman's (2008) general argument that perhaps within advanced economies the era of regional specialisation, whether due to comparative advantage or the increasing returns effects of industrial localisation, has passed. This is in line with growing evidence that production processes are fragmenting across borders with countries trading tasks and functions rather than products.

Lessons learned

A major lesson learned during the empirical analysis has been the limitations of regional-sector data quality and quantify in Europe. A large proportion of the available resources were spent on developing the most comprehensive and consistent regional-sector database which could be seen as representative of the EU in terms of Member State coverage. Despite these efforts, the best that could be achieved was four time periods (2003, 2007, 2001 and 2015) covering around 200 NUTS2 regions and some 20 sectors. This is an order of magnitude below the sector-regional coverage being used in similar studies based on US metro level data.

At the same time, assessing the precise contribution of increasing integration on the economic geography of the EU is complicated by the fact that other transformative processes and events have also been at work over the period of the study, including globalisation (and competition from emerging economies, especially China), technological developments, the global financial crisis and the national and EU policy responses to that crisis (including fiscal consolidation). All of the latter can be expected to have impacted differentially across the Member States and regions of the EU, thereby interacting with, possibly intensifying or possibly countering, the effect of increasing EU integration. The implications of this is that a longer, consistent time series would be needed to disentangle the multitude of effects, as well as having a meaningful measure of EU integration itself.

Another way forward would be to focus only on one sector in more detail, in the form of a case study, which would allow more effort to be made on understanding the supply-chain structures through qualitative techniques such as surveys and stakeholder workshops.

In addition, in today's turbulent times, policies are needed that assist regions – especially those that been left behind over recent decades – to develop the adaptive resilience to navigate future economic, technical and social challenges and opportunities. Policies that promote regional economic diversification may be more consistent with that aim than those aimed at increasing the specialisation and agglomeration of activities across the EU.

Suggestions for future research

A key lesson from this study is that much better data are needed in order to allow more incisive tests of the impact of EU integration - and especially the impact of specific individual integration measures and policies – on the geographical distribution of economic activity across Member States and their regions. More particularly, data need to be at a much more detailed level of sectoral disaggregation, since the data that are available, and which were used in this study, may well mask important aspects of regional specialisation, co-location, and concentration to be found for certain activities. Further, and relatedly, there is a need for more spatially disaggregated data, since, again, the geographical units used in this study are arguably too coarse to reveal localised clusters of industrial specialisation and co-location. Perhaps, most crucially, what will be needed for future research are firm or establishment level data. These would allow a much more detailed and precise investigation of geographical patterns and shifts in the spatial distribution of specialised and related activities, ideally with information on the sizes of firms, their ownership (domestic versus foreign), and so on. Allied to this, and now regarded as of key importance, data on supply chains and inter-and intra-firm trade are possibly more relevant than data on sectors and should be the focus of studies aimed at assessing the impact of economic integration (and disintegration) processes. A previous EU research initiative, MICRO-DYN[1], attempted to achieve such an objective by establishing a pan-European firm-level database from Member State sources. It is the view of this study's authors that such an initiative should be revisited and given similar priority and status to sectoral databases such as EU-KLEMS and the macroeconomic AMECO maintained by DG EcFin.

This latter point has implications for how the impact of economic integration is, or should be, theorised. Most the economic-geographical theory used to predict how increasing economic integration (such as removal of trade barriers, and improving the geographical mobility of labour, etc), impacts on the spatial distribution of economic activity assumes, explicitly or implicitly, that sectors are the key economic entities that will be affected. This was the theoretical framework used in this study. However, more recent theoretical developments have moved away from this straightforward sectoral focus to consider the process of regional and local economic development in somewhat different terms. For example, one theme has been based on the idea of 'related variety'. This is the notion that what drives regional development is the presence of, and changes in, local sets of complimentary ('related') activities, technologies and skills. 'Related variety' is argued to be conducive to regional growth, resilience and adaptability. The question then follows as to how far and in what ways related variety influences how regions respond to measures to promote economic integration, of the sort adopted by the EU. Another theoretical theme argues that what matters for regional development is the role of regions in, and their connection to, supply chains, and whether such supply chains are localised or geographically dispersed. How

[1] https://www.case-research.eu/en/microdyn-competitiveness-in-the-knowledge-based-economy

different regions are linked into different supply chains will have implications for how those regions are impacted by EU integration policies. However, exploring these two aspects of regional development in the context of further integration across the EU would require relevant data sets, of the sort mentioned in the previous paragraph, that are not at present collected or available.

1 Introduction

1.1 Context and purpose of the report

The JRC-Seville is interested in gaining a deeper understanding of how the process of EU integration, through the development of the Single Market, has affected patterns of industrial specialisation and geographic location and clustering across Europe and its regions. To do this, it commissioned a study to develop indicators for each of these areas and to calculate their evolution over recent history, so that judgement can be made as to the role that market integration has had on their patterns of development.

The work involves a mix of:

- theoretical definition and assessment of the key terms (specialisation, concentration, and clustering);
- data collection (across time periods, Member States, regions and sectors);
- formulation and construction of relevant indicators;
- assessment of their evolution and the role played by the Single Market.

This consolidated report brings together all the separate reports in once publication, with each chapter reformulated from these studies. focuses on the theory, measurement, and empirical findings concerning sector specialisation across Europe and its links to economic integration and the Single Market.

1.2 Structure of the report

The remaining parts of this report are as follows.

Main insights Preceding this introduction is a stand-alone 'main insights section'. This…

Methodological considerations Chapter 2 revisits the implications from economic theory of how economic integration could affect sector specialisation, while also summarising the findings from the literature which have already looked at this issue (particularly across Europe). It also reports on the development of the Single Market, what measures of EU integration are available, and what they say about how far and how fast this has happened across Member States and the sectors within them.

Database Chapter 3 describes the data collected for empirical analysis. Two datasets were compiled. Firstly, a national-sector export-share database for constructing Balassa indices of revealed comparative advantage (and which feed into the analysis of specialisation). Secondly, a national-regional-sector database to be used for constructing measures of specialisation, concentration and clustering as outlined in the methodological approach, and which feed into subsequent analytical work.

Specialisation and concentration Chapter 4 focuses on the theory, measurement, and empirical findings concerning sector specialisation and geographical concentration across Europe and its links to economic integration and the Single Market. The empirics include the Balassa indices of revealed comparative advantage and the Theil indices. Findings are presented and discussed in the context of the theory and previous literature.

Clustering and agglomeration

Chapter 5 revisits the implications from economic theory of how economic integration could affect clustering and agglomeration, while also summarising the findings from the literature which have already looked at this issue (particularly across Europe). It then reports on the measurement of clustering and agglomeration, through the use of Location Quotient correlations and the Elisson-Glaeser index of co-agglomeration. Findings are presented and discussed in the context of the theory and previous literature.

References and appendices

This is followed by references, and any further technical detail is provided in Appendices.

2 Methodological Approach

2.1 Introduction

This chapter focusses on the Single Market has developed over time and how this is reflected in measures of EU integration. This is important because the premise for the study, prominent in some seminal New Economic Geography works such as Krugman and Venables (1990), is that increased EU integration (through the harmonisation of rules and regulations and general removal of trade costs) has provided an impetus to trends in specialisation, concentration and clustering of activities across Europe and its regions. But the process is neither smooth or regular in terms of pace. Different regulations come into operation at different periods and take time to have effect. Also, it is possible that the pace of harmonisation differs across different Member States and different sectors and so this also needs to be taken into account.

The chapter goes on to provide details on the measures of regional industrial specialisation, regional concentration, and clustering which will be developed and applied in later chapters. It outlines the theoretical definition of these concepts and highlights any ongoing academic debate as to the formulation of indices to capture them. Finally, a proposition is made for each theme of analysis as to which is the most appropriate indicator to use, and what the implications are in terms of data collection.

2.2 EU Integration and the Single Market

Development of the EU Single Market

Background

The European Union evolved gradually from the aftermath of World War II, initially as an aid to peacekeeping in the region with six members[2], to become the world's largest economy with an integrated network of 28 Member States. During this time a number of treaties have been signed, institutions and organisations established, and policies formed, all with the aim of increasing the degree of political and economic integration among the EU's members.

Specific focus for current study

For the purposes of the current study, we are more interested in recent initiatives and developments (i.e. over the past 15-20 years). These are the ones that are most likely to have deepened the level of integration among the Member States which we will be observing over the period of analysis, and which (a priori) we expect to be reflected in the measures of regional-industry specialisation, concentration and clustering to be calculated in subsequent studies. Developments may fall into two broad categories – there may be background effects which facilitate general integration or focus on a Member State (i.e. when it joined the EU), or there may be industry-specific initiatives which have been designed to focus on particular sectors.

Timeline of developments

This sub-section reports on recent EU developments and initiatives. The purpose is mainly to identify things which are relevant to the study and point to how they might have an impact, but not to discuss in any great depth.

- EU Accession

[2] Belgium, France, (West) Germany, Italy, Luxembourg, the Netherlands formed the European Steel and Coal Community in 1951, and subsequently signed the Treaty of Rome in 1957.

Since 2000, the following countries have acceded to the EU:

- Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia (2004)
- Bulgaria, Romania (2007)
- Croatia (2013)

Although the process leading up to accession involves a gradual adoption of EU laws, regulations and conditions, it can be expected that integration within the EU system will continue to take place for some years after joining. Therefore, for the more recently-joined members, one might expect to observe an increasing level of integration through the study period which may have an effect on measures such as specialisation, concentration, and clustering.

- Introduction of the euro currency

Although some years in the preparation[3], the euro was officially launched at the start of 1999. Prior to this, however, some countries were part of the Exchange Rate Mechanism (ERM) where participating currencies floated within fixed margins. Other countries opted to have their currencies pegged to the Deutschmark. The euro can be argued to be a part of the European integration process, as the removal of currency fluctuation between members removes a friction to trade and should thus lead to previously unprofitable transactions being made viable. In addition, membership of the euro was based on achieving convergence criteria (covering budget deficit and debt ratios, inflation, interest rates, and exchange rate stability) which themselves, in theory, should mean that integration and euro area membership reinforce each other.

In terms of grouping countries over the period of the analysis:

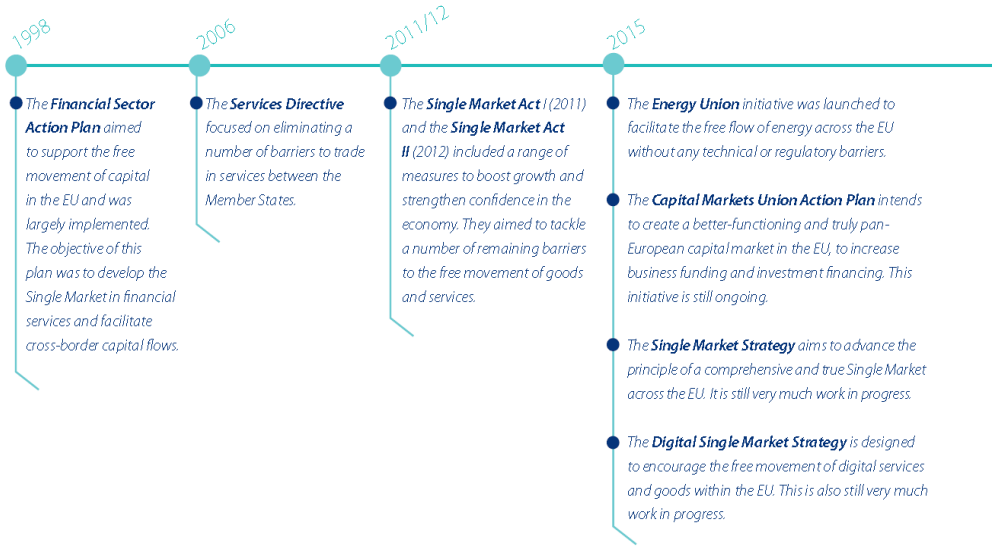
- a core group that were members throughout the period or which have maintained a fixed exchange rate to the euro (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain);
- more recently acceded Member States which adopted the euro on membership of the EU (Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, Slovenia);
- countries which have mostly maintained a floating exchange rate (Croatia, the Czech Republic, Hungary, Poland, Romania, Sweden, the UK).

- Other initiatives

[3] The principles of the currency were laid out in the Maastricht Treaty of 1992.

A recent report for the American Chamber of Commerce to the EU (2017) provided a summary timeline of events which can be used by our study to point towards where integration is still occurring in particular areas of the economy.

Figure 2.1 Timeline of EU Initiatives



Source: AmChamEU (2017, p9)

While tariff barriers have long-since been eliminated, there remain frictions (i.e. non-tariff barriers) which continue to impede the process of integration[4] in some areas of the economy, particularly services but also in energy. It is therefore likely that any sector-based measures of integration will show less integration in these areas than in manufacturing, but also that integration is continuing to increase.

Integration and the Geography of Industry: Propositions from Economic Theory

Traditional trade theory

A central tenet of traditional ('old') trade theory is that (free) trade between nations encourages countries to specialise in those sectors and industries in which they have some comparative advantage. This might be particular natural endowments (resources), cheap abundant labour, superior technology, certain expertise, or other factor-specific attributes that confer a competitive advantage in particular industries in international markets. In such circumstances, under free trade, country A could become specialised in, say, industry *i*, while country B would become specialised in industry *j*.

Extended to geographical location

Trade theory has undergone several developments over the past four decades or so. One such innovation is the recognition that it is not necessarily particular factor endowments as such that confer a comparative advantage, but that the geographical localisation of industries within nations may itself be

[4] The Single Market is ultimately based on four freedoms of movement (goods, people, services and capital), but not all of these have proceeded at the same pace as the EU has developed.

a source of competitive advantage. Such geographical localisation can generate various external economies which give rise to increasing returns effects to the firms in the industry in question. Thus it was observed that, in many instances, the sectors in which a country enjoys a trade advantage are often geographically localised (or 'clustered') within that country. This idea underpins the so-called New Trade Theory, where trade is driven not by comparative advantage based relative cost (price) differences, but by increasing returns effects associated with economies of scale, monopolistic competition, and geographical agglomeration externalities.

New Economic Geography

This revised view of trade has become a key component of the New Economic Geography (NEG) models of the spatial distribution of economic activity (for example, Krugman, 1991; Fujita, Krugman and Venables, 1999; Fujita and Thisse, 2002; Baldwin et al, 2003; Brakman, Garretsen and Marrewijk, 2009). The models combine the (increasing returns based) 'New Trade Theory', urban Marshallian economics, and the 'New Urban Economics' to explain how firms and households locate across geographic space, and how those distributions can change in response to changes in transport costs, wage costs, labour mobility and the like. One issue such models have been used to explore is what happens to the geographical distribution of economic activity as the level and nature of economic integration increases.

The link with integration

Economic integration between countries, such as that has occurred between the Member States of the EU, can be viewed as lowering the transactions costs between the countries and the regions within them. Transaction costs can take the form of transportation costs, tariffs, differences in regulatory arrangements, restrictions on the movement of labour and capital, or exchange rate controls, or other such barriers and frictions. According to NEG theory, a reduction in such transaction costs will make it more likely that any given degree of external economies will be sufficient to lead to the geographical concentration of an industry. This runs something as follows. Before integration assume that all regions of the set of countries under consideration operate a particular industry, so that the industry is essentially geographically dispersed. What happens to the spatial distribution of the industry if there is a move towards economic integration of the countries in question depends on three key issues: the extent and pattern of cost differences (and hence advantages) in the industry between regions across the countries, the pre-existing pattern of regional specialisation in the industry, and the extent to which the industry in question is subject to location-specific external economies. A regional cost advantage may be the result of either a larger local market in the region concerned, or because of some other local factor cost advantage.

Industrial specialisation and geographic concentration

NEG models typically assume a prior geographical distribution to be an equilibrium one. Now assume that the process of economic integration lowers the transaction costs between countries and hence between regions across those countries. If there were no cost differences amongst regions for the industry in question then a geographically dispersed pattern of the industry will be a stable (assumed to be 'equilibrium') state. If some regions enjoy cost advantages, then the reduction of transaction costs, such as a removal of tariffs, will encourage a shift in the geography of the industry towards those regions with a pre-existing cost advantage and away from those with a cost disadvantage. So, according to this theory, increasing economic integration should ordinarily lead to a divergence in economic structure (ie increased

specialisation) between regions in terms of their industrial structure, and to an increasing geographical concentration of the industry in particular regions, which then becomes a new stable ('equilibrium') pattern.

Krugman's EU reference

Krugman (1993) used this line of argument to suggest that as the countries belonging to the European Union become progressively integrated economically, so – other things being equal – they should become increasingly specialised in particular industries, with those industries concentrated in those regions in which the external economies benefits of localisation were greatest. His argument was based not only theoretical reasoning, but also on appeal to the United States, an internally integrated economy with a common currency – the sort of economic space to which Europe was moving. The fact that the United States had a higher degree of internal spatial economic differentiation and regional specialisation than the European Union at that time indicated, in his view, what to expect in the European Union as it moved closer towards the sort of unified integrated economy exemplified by the United States, and especially as the EU moved towards monetary union. He also argued that regions across the EU became increasingly specialised, so too, like their US counterparts, they might be expected to become increasingly prone to idiosyncratic demand shocks and cyclical fluctuations. In summary, Krugman argued that increasing integration across the European Union would result in a European economy that was characterised by (i) greater regional specialisation, (ii) increased region-specific shocks, and (iii) possible greater disparity in regional growth rates, because with increased factor mobility (aided by the integration process), both labour and capital are likely to move to and concentrate in those regions in which economic activity is already concentrated, agglomeration economies are greater and productivity is higher (see Bertola, 1993).

Additional forces of technology and globalisation supply chains

As more recent work suggests, these predictions need to take into account another trend in the spatial organisation of economic activity that is both an outcome and a source of increasing integration, namely the rise of complex, geographically dispersed production networks and supply chains (see Baldwin, 2016). In combination with technological advances, the removal of tariff barriers, the harmonisation of regulatory arrangements, and the like, permits regional specialisation by function as well as or instead of by sector. Instead of vertically integrated industries in particular locations, It is now possible, and common, for an industry to be horizontally integrated across geographic space, with different stages of production or different functions located in different regions. Such spatial webs or networks of supply and functional specialisation are now an important feature of the European economy. The car industry is a typical example, with most European producers having supply chains that span several regions and indeed countries.

Measuring EU Integration

EU Single Market Integration can be measured in various ways but is possibly best captured by indicators which follow the four fundamental freedoms of movement which underpin it: goods, people, services and capital. All elements are examined for evidence of integration patterns, although it is the freedom of goods, services and capital that can be mostly tied to particular sectoral activity.

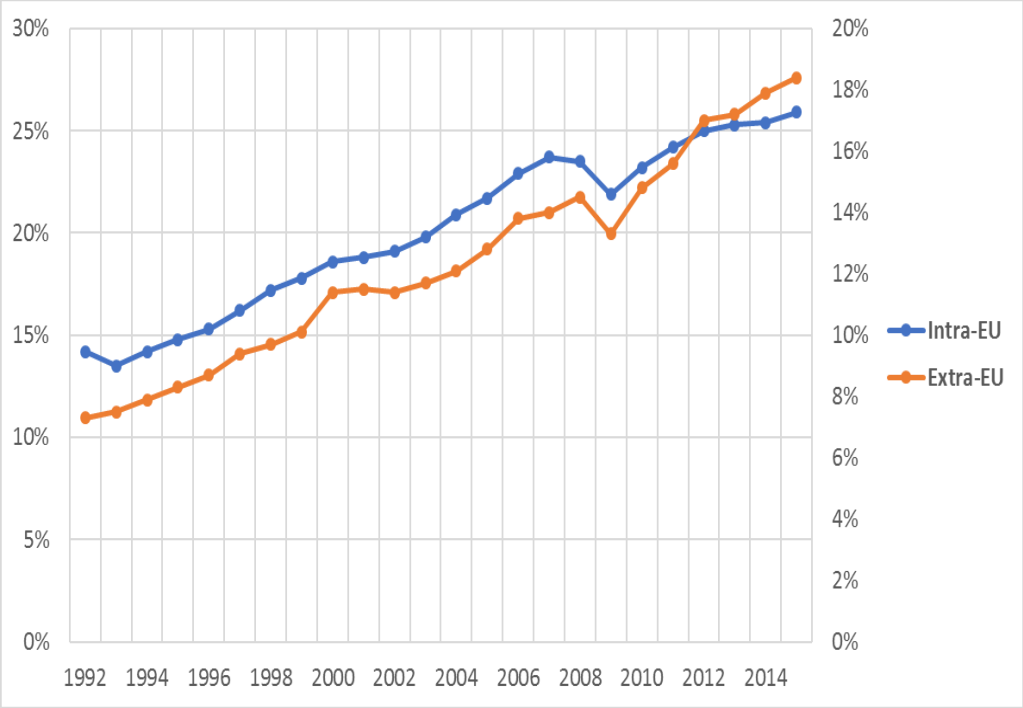
Movement of goods and services

The flow of goods and services can be measured by trade within EU Member States (intra) and between EU Member States and non-member countries (extra). Intra and extra EU imports and exports are available from E3ME (a global-sectoral model maintained by Cambridge Econometrics[5]) from 1970 to 2015 for 69 industry sectors[6] . Specific indicators such as the share of total intra-EU trade in total trade, total or intra-trade as a percentage of GDP, can then be calculated.

- Total trade

A priori, one would expect trade between EU members (intra-EU) to increase as the integration brought about by the Single Market process deepens further. The graph below shows the percentage of intra-EU trade to GDP (left-hand-axis) between 1992-2015, which (apart from the disruption caused by the great recession) follows the expected pattern. Alongside is shown the equivalent pattern of extra-EU trade (right-hand axis).

Figure 2.2 EU Trade as a % of GDP



Note: The term EU refers to the number of Member States included in the EU-wide aggregate during the period for which the label is shown in the figure (respectively, EU-15 (1992-2003), EU-25 (2004-06), EU-27 (2007-12) and EU-28 (2013-)). Intra-EU trade is equal to the average of intra-EU exports and imports expressed as a percentage of the total GDP. This includes trade in goods and services.

Interestingly, when compared against extra-EU trade it appears that the increase in intra-EU trade shares is no greater than that of extra-EU trade, and in more recent years has been on a slower trend. At least part of the increase

[5] See https://www.camecon.com/how/e3me-model/ for more information.

[6] Aggregate trade in services is derived from the bilateral trade in services data from the OECD EBOPS (Latest series:https://stats.oecd.org/Index.aspx?DataSetCode=TISP_EBOPS2010) to derive the sectoral detail. The bilateral flows are then aggregated across trade partners into within the EU and external to the EU. The sectoral estimates are then scaled to the Eurostat data on total trade in services within the EU and external to the EU for each member state from the series (nama_10_exi).

in the intra-EU measure must simply be following patterns of globalisation and increased general openness to trade.

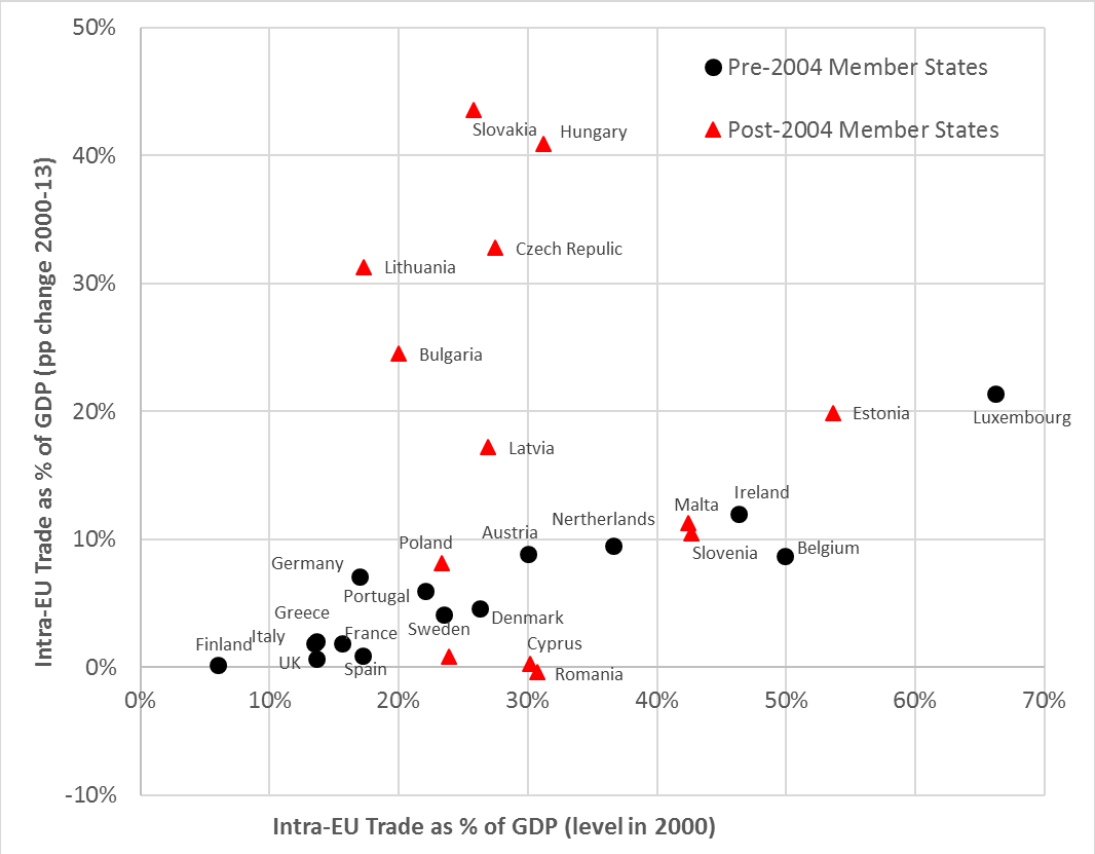
The overall picture (for intra-EU trade) presented by Figure 2.2 can be split across Member States and sectors to provide a more detailed view of integration. The findings are summarised below.

- Trade by Member State

In this section, we measure the individual Member States' integration into the Single Market for each sector by using the total of a country's intra-EU exports and imports. To compare this indicator across all MS, we are using the share of total trade to the country's GDP, i.e. the same measure as in Figure 2.2, but at Member State level. It would be expected that when a country has acceded to the EU its share of intra-EU trade will increase as it integrates within the trading system, while those countries which have been members of the EU for longer periods of time would show less increase in integration, having already achieved this in earlier periods. Figure 2.3 also separates out Member States between those established members of the European Union and those which joined from 2004 onward.

Clearly, and as exemplified by Member States such as Luxembourg and Belgium, the ratio of trade to GDP is as much a measure of size and openness of an economy as it is of the degree of EU integration. Also,

Figure 2.3 Intra-EU Trade by Member State



Note: Intra-EU trade is equal to the average of intra-EU exports and imports expressed as a percentage of the total GDP. This includes trade in goods and services.
Source: Cambridge Econometrics

historical linkages (e.g. UK with its Commonwealth trade relations, and Finland with Russia and other international partners) also complicate the picture. Among the more recently acceded Member States, most are among those that have increased their trade intensity with the EU quite rapidly while a few (Romania, Croatia, Cyprus, Malta, Slovenia and Poland) do not look much different from the more established Member States[7].

- Trade by sector

The same analysis can also be undertaken by averaging intra-EU trade as a % of GVA across Member States for each sector. Figure 2.4 provides a summary of the findings, with the 69 sectors grouped into broad categorisations in order to visualise patterns more easily.

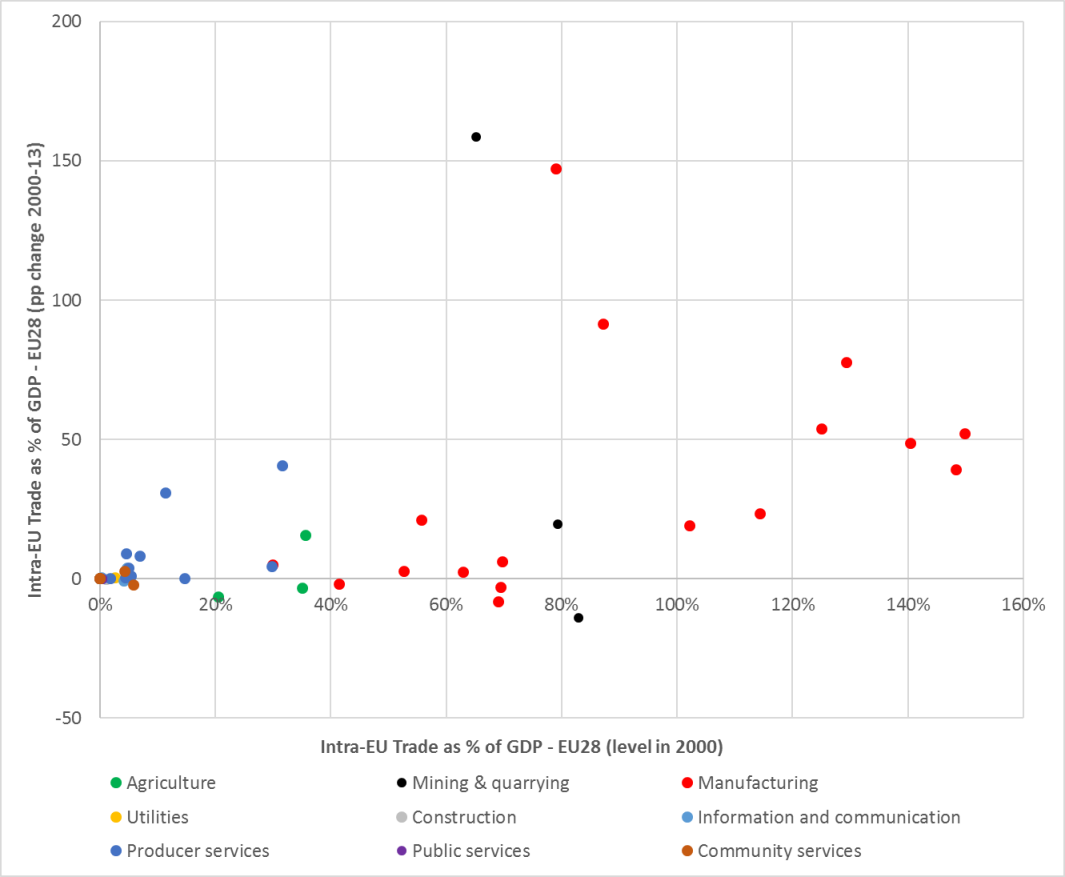
Overall, the ratio of intra-EU trade to GDP in most of manufacturing sectors is much higher than for services sectors. It is also the case that those

[7] Further investigation of whether the more recently acceded Member States had experienced a shift in their trading patterns (towards the EU) revealed mixed findings. For Bulgaria and Romania their accession coincided with the onset of the Great Recession, and so nothing can be concluded, while for Croatia accession is too recent. Among the other Member States, the Czech Republic, Hungary, Malta, Slovakia and Slovenia display slight upward trends post-accession, although this assessment is from visually assessing trends and is not a statistical conclusion.

manufacturing sectors with the highest ratios in 2000 (this includes Electrical equipment, Motor vehicles, Textiles, Basic metals, Chemicals, and Transport equipment) are also among those with the largest increase over the following period.

Those service sectors of note include two which have increased their ratios by around 25pp over the period (R&D, and Other professional services) and two others which have higher than average ratios of intra-EU trade, but which have not shown any sizeable change over the period (Security and investigation, and Rental & leasing).

Figure 2.4 Intra-EU Trade by Sector



Note: Intra-EU trade is equal to the average of intra-EU exports and imports expressed as a percentage of the total GDP. This includes trade in goods and services.
Source: Cambridge Econometrics

Movement of capital

The movement of capital between countries can be captured by Foreign Direct Investment (FDI), and in particular the extent of EU integration can be expressed as the ratio of intra-EU FDI (inward plus outward stock) to total FDI.

The OECD FDI statistics[8] contain sufficient information to undertake the analysis:

- 65 industries according to according to the industry of the direct investment enterprise;

[8] Benchmark Definition 3rd Edition (BMD3).

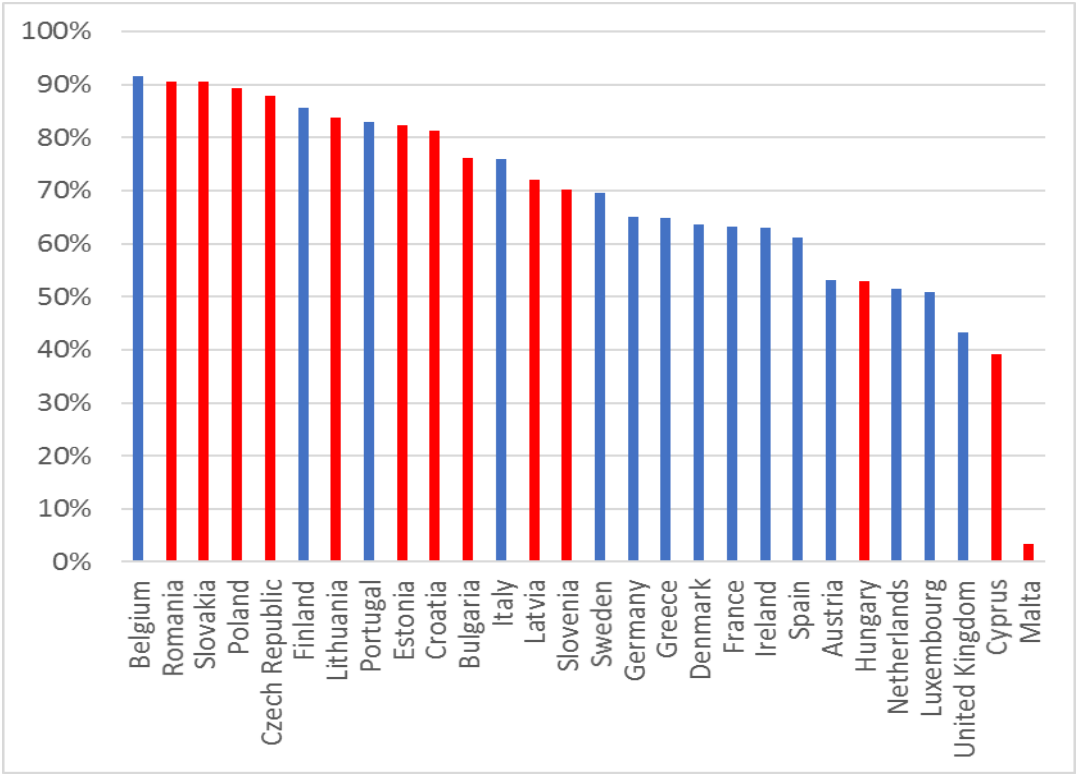
- time coverage can be as far back as 1995 for some countries and some sectors up to 2013, but the more certain period is 1998-2013;
- countries available: 21 out of EU28 plus Norway (countries not covered: Bulgaria, Malta, Cyprus, Latvia, Lithuania, Romania and Croatia);
- FDI flow as well as stock[9].

As FDI flows are not a direct component of GDP, and the sector disaggregation from the OECD database are different from those presented in the trade section, the average ratios of intra-EU FDI calculated for Member States and sectors are made relative to total FDI.

- FDI by Member State

Due to the quality of the annual FDI data series, Figure 2.5 presents the average ratio for Member States over the 2008-16 period. There is some difference between pre- and post-2004 accessions Member States, with the latter cohort mostly grouped at the high FDI-share end of the chart. This could reflect the attractive (lower-cost) location for European FDI of the newly-acceded Member States.

Figure 2.5 Intra-EU FDI by Member State



Note: Intra-EU FDI is equal to the average of intra-EU inward and outward FDI assets expressed as a percentage of the total FDI assets.
Source: OECD

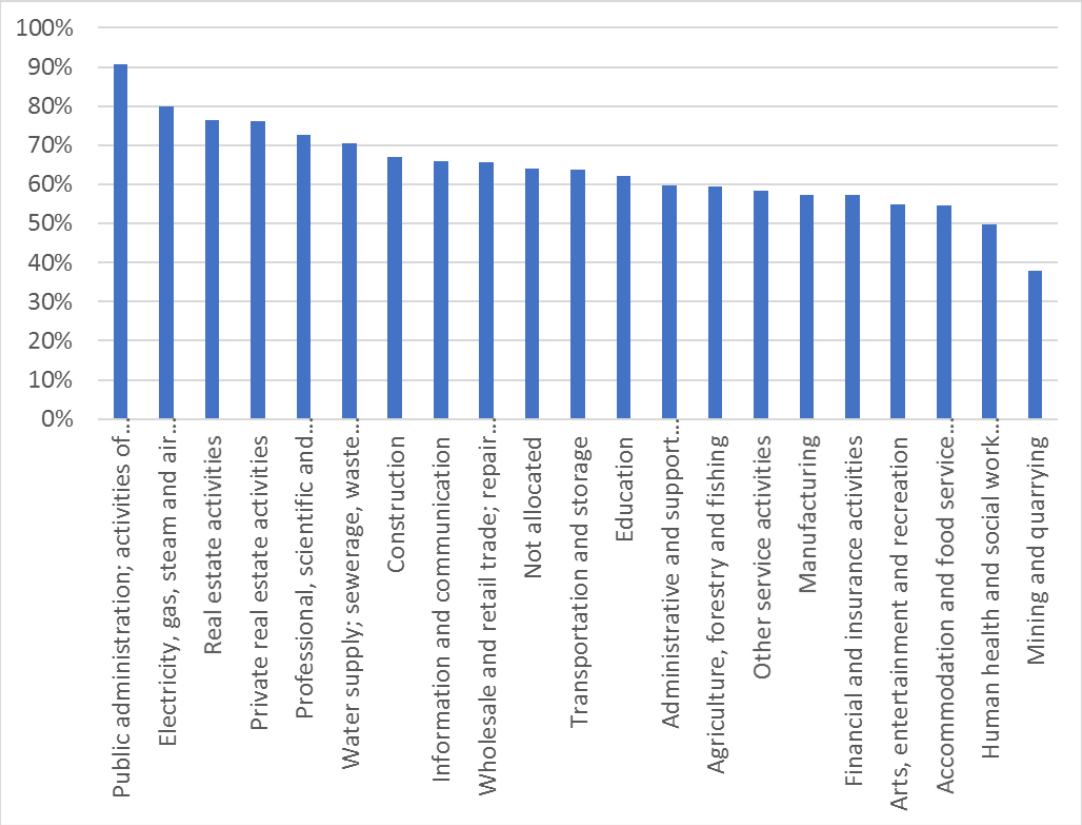
- FDI by sector

[9] When looking at capital movement, this analysis uses FDI positions, also known as stock of FDI, rather than FDI flows, because FDI stock is more stable as it measures the total of FDI at a given point in time, rather than the flow which measures the change in level of FDI in a given period.

Figure 2.6 shows the same ratio calculation by sector, over 2008-15 (again period averages only due to data limitations).

The service sectors dominate the higher ratios, while the manufacturing sectors are at the lower end. This is most likely a reflection of the importance of physical trade as a means of exchange and competition for manufacturing sectors, while services rely more on direct foreign investment due both to the nature of their activities being less amenable to physical trade, and also the continued lack of harmonisation that persists across Europe.

Figure 2.6 Intra-EU FDI by Sector



Note: Intra-EU FDI is equal to the average of intra-EU inward and outward FDI assets expressed as a percentage of the total FDI assets.
Source: OECD

- FDI Regulatory Restrictiveness Index

The OECD's FDI Regulatory Restrictiveness Index provides a measure of friction to FDI in the form of 'all discriminatory measures affecting foreign investors, including market access restrictions and departures from national treatment'[10]. The dimensions of this database are as follows:

- time frame: 1997, 2003, 2006, 2010-2016
- sectoral coverage: 22 economic sectors
- Member States: 24 countries out of EU28 (countries not covered are Bulgaria, Malta, Cyprus and Croatia)

It should be noted that the index does not focus on restrictions to EU28 FDI in particular, but is a general measure of restrictiveness for any FDI regardless of

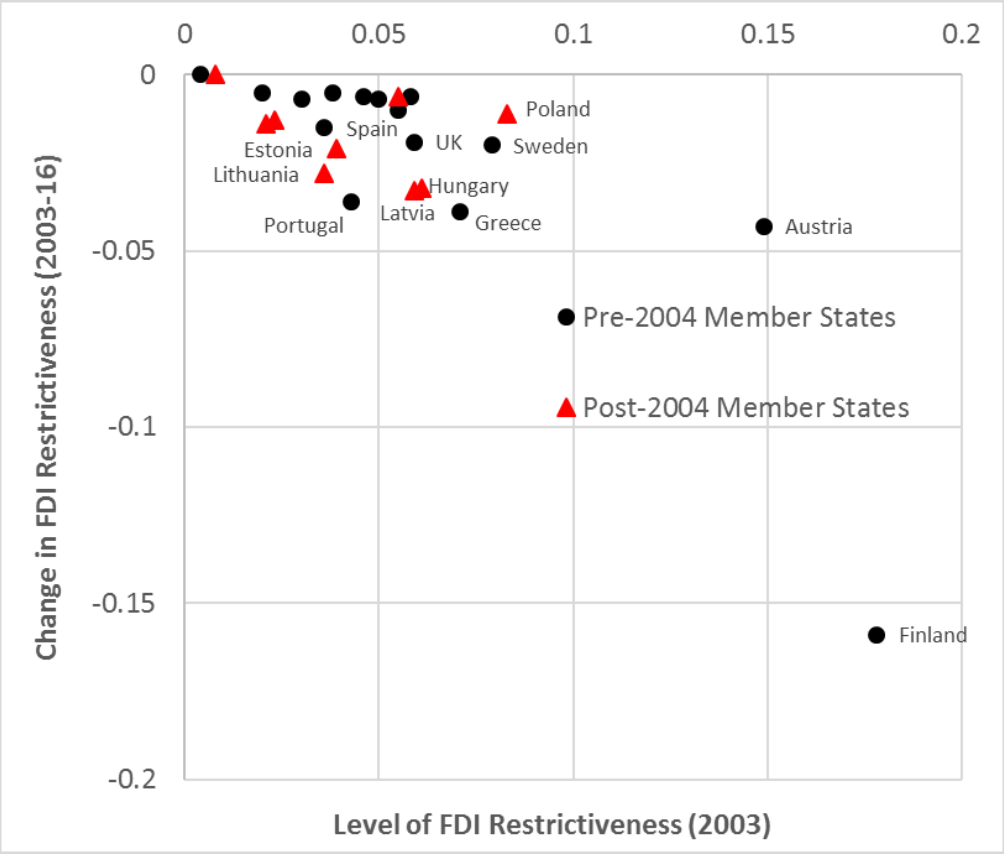
[10] See https://www.oecd.org/daf/inv/investment-policy/FDIRRIndexPPT.pdf for more information.

origin. It does, however, still provide another way of assessing openness to international movement and ownership of capital.

Figure 2.7 shows how FDI restrictiveness has changed between 2003 and 2016 across available Member States[11].

Clearly, the majority of Member States were already relatively open towards FDI by 2003, and so there has been little change over time since then. Austria and Finland stand out as being more restrictive (though still quite low on the overall index), while Austria remains so at the end of the period, showing much less reduction than Finland (which by 2016 is no different than the majority of other countries).

Figure 2.7 FDI Restrictiveness by Member State



Note: A value of 1 implies complete closure to FDI, a value of zero complete openness.
Source: OECD

Data by sector are less available and so are not reported in detail. What data do exist do not show much variation over time (mirroring the aggregate country results). For Austria, the most closed of Member States covered by the dataset, the Electricity sector is completely closed to FDI, while the Transport sector has opened up dramatically in both Austria and Finland in the late-2000s, as have other service sectors in Finland (which mostly explains it shift in Figure 2.7).

- Movement of people

The movement of people can be captured by migration statistics which monitor gross intra-EU migration flows (in + out) as a proportion of total

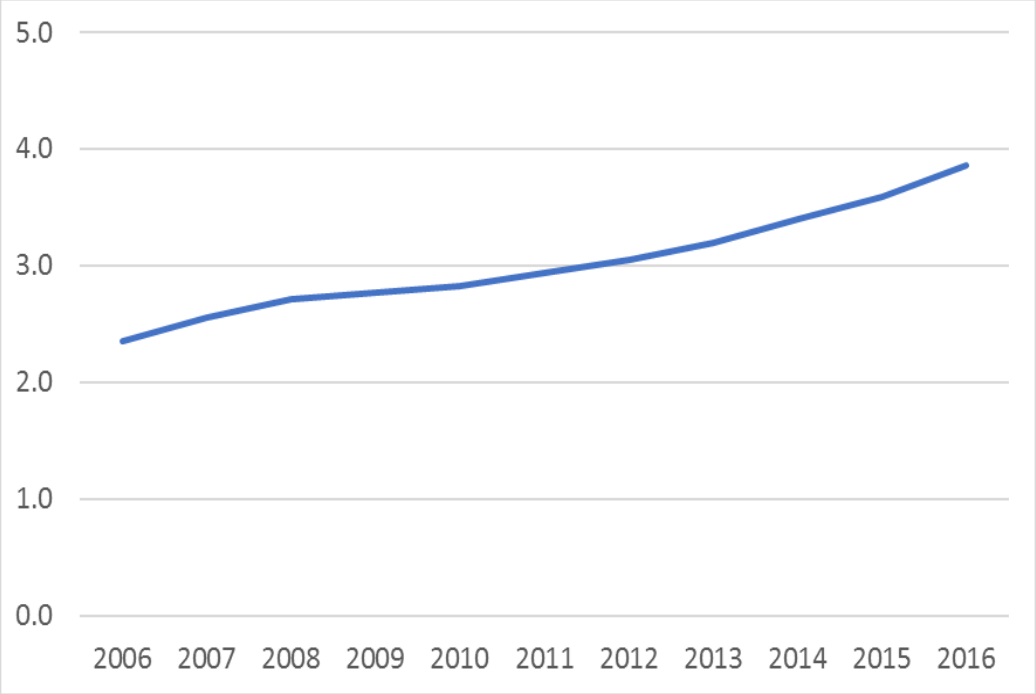
[11] For Romania the start date is 2010 as earlier data were not available.

population, and also employment data which capture the citizenship of employees in each country. In addition, there exist data on the recognition and movement of professional activities around the EU[12] which can be used as a proxy for regulation and acceptance of human capital movement. Both aspects of labour mobility are considered below.

- EU employment patterns

The Eurostat LFS data allows the identification of employment by citizenship for each Member State. Figure 2.8 shows non-native (EU-28) employment as a proportion of total employment (obtained by adding up across all Member States).

Figure 2.8 Share of EU workers from outside host country employed in host country (EU average)



Note: EU28 average (EU27 average pre-2011)
Source: Eurostat

In 2006 most of the restrictions on movement of labour from the newly-acceded Member States expired, leading to a continually rising trend (seen above) from what had previously been a fairly stable indicator.

For a Member State perspective, Figure 2.9 provides the level (2006) and change (2006-16) of the share of non-host country workers in total host country employment. Luxembourg immediately stands out as a haven for cross-border workers, with both the highest share and highest increase in share of non-native workers. The vast majority of Member States remain low on both level and change, with only a handful having shown much increase in the last 10 years and most of these being among the more prosperous Member States where (presumably) most jobs have been created to attract workers from other countries.

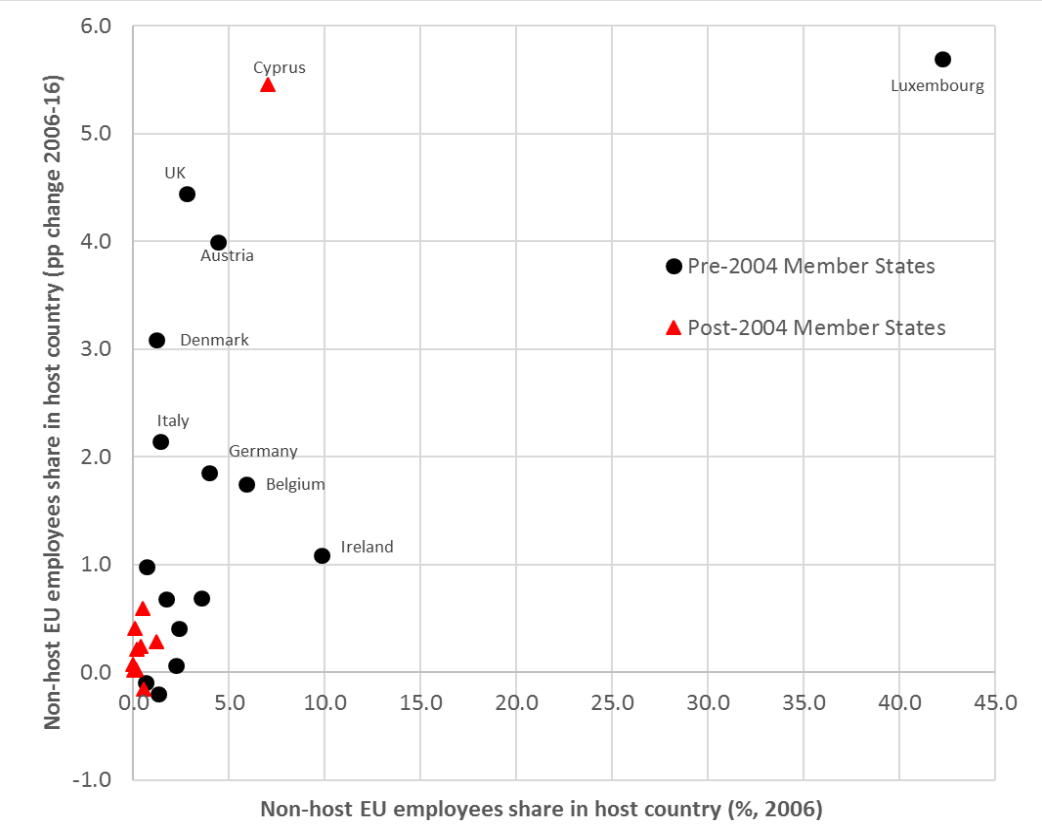
- Movement of professional activities

[12] See http://ec.europa.eu/growth/tools-databases/regprof/.

Various Directives (in particular 2005/36/EC and, more recently, 2013/55/EC) allow for an EU-wide system of recognition of professional experience and qualifications. These initiatives have allowed for free movement for professionals such as doctors, nurses, and architects within the EU. Indeed, examination of the database for free movement of professionals reveals that the three most mobile professions across the EU are nurses, secondary school teachers, and doctors of medicine.

The process remains far from complete, however, and in 2016 the EC created the European Professional Card (EPC)[13] to aid the recognition process further – the system is currently available for general care nurses, physiotherapists, pharmacists, real estate agents and mountain guides. Such developments will aid the process of integration in the services sector, where the majority of professional qualifications reside (and differ across Member States).

Figure 2.9 Share of EU workers from outside host country employed in host country



Note: EU28 average (EU27 average pre-2011)
Source: Eurostat

2.3 Specialisation, Concentration, and Clustering

Different Dimensions of the Geographical Distribution of Economic Activity

Four major dimensions, or aspects, of the distribution of economic activity across geographic space can be identified from the vast literature that now exits of the subject: regional specialisation, regional concentration, regional agglomeration and local clustering. Concentration and agglomeration are both concerned with the question of whether a particular part of economic activity – a particular industry - can be found at a few locations, be these certain cities, regions or countries. Although both concentration and agglomeration deal with

[13] See https://ec.europa.eu/growth/single-market/services/free-movement-professionals/european-professional-card_en

location of economic activity, their focus is somewhat different. According to Brülhart (1998), typically concentration analyses the location across space of an individual sector of activity, whereas agglomeration analyses the location across space of several sectors, for example several different manufacturing industries, or several different types of services. In the view of Brakman, et al (2009), studies of agglomeration analyse how aggregate economic activity, say the broad category of manufacturing, is distributed across geographic space; whereas, the empirical analysis of concentration does the same only for a particular type of economic activity, say the production of motor vehicles, and then tries to show at this lower level of aggregation how the production of motor vehicles is distributed geographically.

Concentration and agglomeration can be distinguished from specialisation (see Hallet, 2000; Gorter, 2002, Brakman et al, 2005). Specialisation deals with the question of whether or not a location's (nation, region, city, etc.) economic structure (in terms of shares of employment or output) is dominated by one or just a few related sectors, for example, motor vehicles or textiles. It is usually measured by comparing the location's economic structure against a relevant benchmark, for example in the case of say a member state of the European Union with the aggregate EU's economic structure, or in the case of a region or city, with the economic structure of the nation of which the region or city is a part. The issue of specialisation has long been a key notion in trade theory, where it is argued that nations, cities and regions will tend to specialisation in those activities in which they have a comparative advantage. Thus, the degree of economic specialisation in a city or region is typically taken to be an indication of the extent of that city's or region's 'revealed' comparative advantage in the sector(s) concerned. In certain circumstances, however, specialisation and concentration can be the two sides of the same coin, since a very high level of concentration of an industry in a particular region may well mean that the region is in fact specialised in that sector, in as much that it dominates the region's employment structure.

Thus, as Brakman, Garretsen and Marrewijk (2009) point out, concentration, specialisation and agglomeration may or may not coincide, depending on contingent circumstances. Further, when considering the regional effects of the economic integration within the European Union, there are (at least) two geographical levels involved: the country level, and the regional. Thus, it is possible to have specialisation between nations (that make up the EU), but not necessarily between regions within those nations. For another, it is possible to have concentration of an industry between nations, but no regional specialisation within nations. Some examples are illustrated stylistically in Figure 2.10, in which there are two industries and two countries each with four regions. For simplicity, assume a pre-integration pattern in which both industries are equally distributed across the four regions in each country (Figure 1a). Following integration of the two countries, and assuming this reduces transport costs, removes barriers to trade and factor movements, and so on, then a variety of outcomes are possible, depending on the specifics of the industries, regions and countries.

In one case (Figure 1b), integration leads to a shift in both industries such that industry 1 becomes concentrated in country A, which is thus specialised in that industry, while industry 2 shifts to Country B, which thus becomes specialised in that industry. But note there need be no regional concentration or specialisation in either country. Other possible outcomes are illustrated in

Figure 1c, Figure 1d and Figure 1e. In Figure 1c, country A becomes specialised in industry 1, which is also concentrated in one of its regions (which thereby specialises in that industry), while country B becomes specialised in industry 2, which is also concentrated in one of its regions. In Figure 1d there is a concentration of both industry 1 and 2 in country 1, and an agglomeration of the two industries in one particular region of that country. In Figure 1e, both industry 1 and industry 2 are concentrated in country A, there is regional specialisation (of both industries in country A, and of industry 1 in country B), and regional agglomeration in country A. These examples merely illustrate the complex range of outcomes that are possible and which might follow integration, and the different geographical levels at which such outcomes can be analysed. They also suggest that decomposability would be a desirable feature of any measure used to assess the geographical distribution of economic activity in an integrated multi-country, multi-region system such as the European Union.

The notions of specialisation and concentration is closely related to that of clustering. The spatial concentration of an industry in a particular location (city or region) is often described as being geographically clustered. Such clustering may form one of the specialisations of the region in question. Indeed, the presence of clusters is often associated with specialisation. However, the concept of a cluster is usually taken to have a rather more specific meaning, based on the extensive work of Michael Porter (see for example, Porter, 1990), who defines a cluster as a "geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (1990, p. 199).

Thus, while a cluster implies local specialisation, it goes beyond the mere localisation of an industry to highlight the interdependencies, both upstream and downstream, of that industry with related activities, which typically will include "end-product or service companies, suppliers of specialised inputs, components, machinery and services, financial institutions, and firms in related industries", as well as "government and other institutions providing specialised training, education information, research and technical support". Although both specialisation and concentration are implied in this definition of a cluster and can be used to identity the likely presence of a cluster, much else is required for a specialisation or concentration to function as a Porter-type cluster.

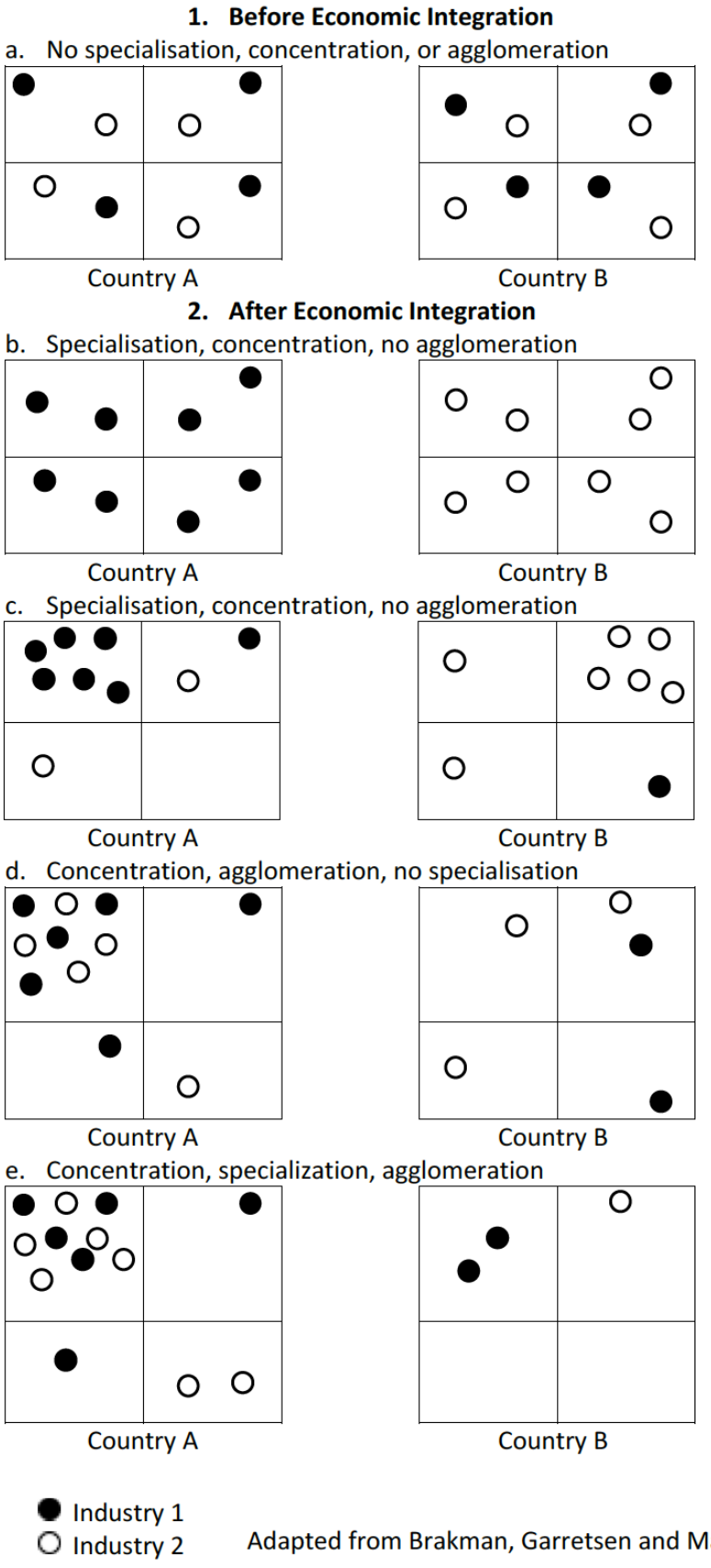
To summarise our definitions:

- *regional specialisation* is the degree to which the (proportional) economic sectoral composition of a region differs from the (proportional) economic sectoral composition of all other regions taken together;

- *regional concentration* (of a given sector of economic activity) is the degree to which that sector is localised, i.e. where it is based more in just a few, rather than in all, of the regions; and finally,

- *agglomeration* is a situation where more than one sector is co-localised with other sectors in certain regions.

Figure 2.20 Some Stylised Geographical Outcomes of Economic Integration



Adapted from Brakman, Garretsen and Marrewijk (2009).

Measuring the Geographical Distribution of Economic Activity

The literature on devising measures of the geographical distribution of economic activity, on regional industrial concentration, specialisation, and agglomeration, is vast, and stretches several decades. One of the earliest discussions is that by the founding father of regional science, Walter Isard (1960), in which various measures are compared and their inter-relatedness highlighted. Another early comparison of alternative measures is that by Thirlwall and Harris (1967). Since then, numerous additional measures have been added, although many are in fact versions of one another: in this sense, one may talk of a 'family' of measures and indices. Most seek to measure the degree to which industry is localised across geographic space, and, more especially, whether particular industries are localised in particular regions. And most involve comparing the actual pattern of industry across regions against some 'reference' pattern. This might be a hypothetical distribution (such as one of equal shares of an activity between regions), or the national industrial structure (which is of course itself a weighted average of regional structures).

One thing all measures have in common is that they are 'cause-free', in that they imply no particular regional development theory or process is necessarily at work, although in many cases inferences are made from conceptual arguments about processes (such as those of Marshallian localisation economies, or external economies claimed to derive from the spatial agglomeration of activity) to specific indices and measures; or conversely, particular measures are intended (or assumed) to reveal the presence of such processes.

The literature is simply too extensive to refer to all of the many relevant papers individually. However, there are certain studies that have a particular relevance to this project, in that they explicitly develop and utilise specific indices and measures to examine recent trends in the geographical distribution of economic activity across the European Union (among the more important papers may be listed Amiti, 1999; Hallet, 2000; Midelfart-Knarvik et al., 2000; Ciccone, 2002; Brülhart 2001a, 2001b; Bülhart and Traeger, 2005; Brülhart and Mathys, 2008; Cutrini, 2010). In his study, Hallet (2000) uses a number of indices to measure changes in regional specialisation (the Krugman Specialisation Index) and regional concentration of industry (a variety of indices) across the EU over the period 1980-1995 (his study is for 119 regions and 17 sectors of economic activity). He finds a general trend of declining regional specialisation over this period, and that the degree of concentration for most sectors has remained more less unchanged.

Brülhart and co-authors (see references above) use a variety of measures to investigate the (changing) geographical concentration and specialisation of economic activity across the EU, including location quotients, Gini coefficients, Balassa indices, and entropy measures (the latter affording a decomposition into between-country and within-country effects). Among their findings they suggest that industrial specialisation of EU members states increased over the period covered by the 1970s, 1980s and 1990s, that this process appeared to have been boosted by the Single Market project, but that there was neither increased geographic concentration in core EU countries nor movement towards peripheral EU countries. It should be noted, however, that Brülhart and his co-authors often use the terms specialisation, concentration and clustering more or less interchangeably, whereas in our we argued they should be kept distinct.

In her interesting work, Cutrini (2006, 2010) also derives Theil indices for both specialisation and concentration that again test for both within-country and between-country effects across the EU. She also relates these measures to the Balassa index. Her analysis is for some 145 regions and 12 manufacturing industries, over the period 1985-2001. The findings are particularly significant since they suggest that, as far as manufacturing is concerned, and for the period covered, Krugman's (1993) prediction, that as integration in the EU deepens regional specialisation and the spatial agglomeration of economic activity should both increase, has not been borne out.

Industrial Specialisation

Definition and measurement

The debate over whether regional economic (industrial) specialisation is advantageous or disadvantageous is long-standing (for a recent discussion, see Kemeny and Storper, 2012). Interregional differences in both the *level* and *pattern* of industrial structure are of interest for two main reasons. First, because many studies have argued that differences in industrial structure are an important source of interregional differences in economic performance. Second, because of a possible relationship between regional specialisation and comparative (or absolute) advantage, for example with respect to trade.

Due to the increasing interest in the possible effects of economic integration on economic specialisation, the measurement of interregional and indeed inter-country industrial composition has attracted considerable attention, as mentioned above. Empirical analyses of international and interregional specialisation use a wide range of statistical tools. Yet there is no general agreement on which measure or index best captures the level of specialisation.

- Absolute and relative specialisation

One of the most useful surveys is that by Palan (2010), who compares the strengths and weaknesses of a number of such indices, both in terms of their statistical properties and their empirical application to industrial specialisation among European countries. Palan distinguishes between those indices that measure *absolute* specialisation and those that focus on *relative* specialisation.

A region (or country) would be considered to be characterised by *absolute specialisation* if a small number of industries account for high shares of that region's (or country's) total employment (Palan, 2010, p2). Indices of *relative specialisation* are concerned with measuring the deviation of a region's (or country's) industrial structure from that of another economy. The difference between the two types of index is in the type of benchmark they use. The benchmark used for absolute measures is typically that of a hypothetical statistical distribution, most typically a uniform (equal) distribution of employment across industries. Thus in the case of N industries this would be where each industry has an employment of 1/N (the lower limit of such an index). Increasing departures from an equi-share distribution would indicate rising degrees of absolute specialisation, with complete specialisation being a situation with all employment in just one industry, (equivalent to a maximum value of 1.0). With measures of relative specialisation, the benchmark is the

distribution of industry shares in some other *actually existing economy*. Where regional specialisation is the focus of attention, this would typically be the relevant national economy being studied. In the case of a countries, the reference might be the trading bloc to which the country belongs. It is clearly also possible to compare regions across a group of countries using the industrial distribution of the group of countries as a whole as the benchmark.

- Decomposability

This latter case raises the issue of *decomposability*. A decomposable specialisation index is one which permits specialisation to be split into a weighted average of the specialisation existing within and between groups. In the present context, this would be where it is possible to decompose a country's specialisation into comparative advantages inherent in a given country (member of the European Union) in relation to other countries in the group (the European Union as a whole) – the 'between country' component - and regional comparative advantage within the given country, that is comparative advantages of some regions compared to the national level – the 'within-country' component.

Palan's very useful discussion covers five absolute specialisation measures and four relative specialisation indices (Table 1). Of the absolute measures both the Hirschman-Herfindahl index and the Shanon Entropy index possess this decomposability feature. Of the relative indices, only the Theil index satisfies the decomposability criterion. When applied to the analysis of specialisation among European countries (but not regions), the Palan analysis is quite revealing, leading to a number of key conclusions. First that there is little correlation between absolute and relative measures of specialisation: the two types of index measure different aspects of specialisation. Second, among the absolute measures, the Hirschman-Herfindahl index is the most closely correlated with the other absolute measures. Third among the relative measures, the Krugman Index is the most closely correlated with the other relative measures. To these conclusions should be added two further salient points. As is well known, all measures of specialisation are sensitive to the level of sectoral and geographical disaggregation used. Although there is no generally agreed preferred levels of sectoral and spatial disaggregation, it may be possible to undertake some 'robustness' tests by carrying out the analyses for different sectoral levels and different scales of geographical unit. And while all give some indication of the degree of specialisation, none of itself tells us which industries a region (or country) is specialised. Finally, none of the indices tells us about the underlying processes driving specialisation (or diversification).

Table 2.1 Regional Specialisation Measures (based on Palan, 2010)

Type of Measure	Index	Decomposable?	Bounded?
Absolute	Hirschman-Herfindahl	Yes	Yes
	Shannon Entropy Index	Yes	Yes
	Ogive	No	Yes
	Diversification Index	No	No
	Absolute Gini Index	No	Yes

Type of Measure	Index	Decomposable?	Bounded?
Relative	Krugman Index	No	Yes
	Index of Inequality in Productive Structure	No	Yes
	Relative Gini Index	No	Yes
	Theil Index	Yes	No

Note: While having bounds might be a desirable feature of a measure, in that it provides a direct way of comparing different instances or cases, it is not a necessary feature. Arguably what is more important in the case of analysing specialisation (or concentration) of economic activity across the EU is whether a measure or index is decomposable, into between and within member country effects.

Probably the most frequently used measure of regional relative specialisation is the Krugman Specialisation Index (KSI), also sometimes known as the Coefficient of Regional Specialisation (CRS). This is calculated as sum of the absolute differences between each industry's share of regional employment and that industry's share of national employment. In effect, it is an index of regional structural dissimilarity (in relation to the national industrial structure), that is

$$KSI_r = \sum_i \left| \frac{E_{ir}}{E_r} - \frac{E_{iN}}{E_N} \right|$$

where

E_{ir} is employment in industry *i* in region *r*

E_r is total employment in region *r*

E_{iN} is national employment in industry *i,* and

E_N is total national employment

Krugman has used this index to compare the degree of regional specialisation in Europe with that in the United States (eg. Krugman, 1993).

It is usually stated that the index has a range of between 0 and 1. If a region has exactly the same industrial structure as the nation of which it is a part, (that is the shares of employment are the same for all industries) then the index takes the value 0. Whether the maximum value of 2 is possible depends on the reference benchmark. If the benchmark were, say, another region, then the maximum of 2 is possible since the two regions could have completely non-overlapping industry structures, so that each industry share would be counted twice. But if the benchmark is the national economy, which is usually the case, then the maximum must be less than 2 since by definition if the region in question has a certain industry i, then so must the nation of which that region is a part. In this case, the maximum is given as [2(N-1)]/N. It should also be pointed out that even if a region has an index of 0, meaning it has the same industrial structure as the national economy, it does not necessarily mean that the region is not specialised, only that it has the same structure as the national economy, which itself may be specialised.

Preferred indicator

However, and importantly, the Krugman Index is not decomposable. Our preferred measure of regional specialisation is the version of the Theil index developed by Cutrini (2006, 2008, 2009, 2010), as this does permit a decomposition of specialisation into a 'within-country' component and a 'between-country' component. The added advantage of using her index is that it allows a comparison with the trends she identified across the EU up to 2001, while at the same time we are able to extend her analysis by applying the technique to a greater degree of sectoral disaggregation over a more recent time period.

Let E denote employment, and subscripts c, r and k denote country, region and industry respectively. Then,

E_{ijk} = employment in industry k, in region j belonging to country i

E_{ij} = Total employment in region j of country i

E_{ik} = total employment in industry k in country i

E_i = Total employment in country i

E_k = Total employment in industry k in the European Union

E= Total employment in the European Union

N = number of industries

R = number of regions in the European Union

Then, following Cutrini (2010), concerning specialisation, it is possible to evaluate the dissimilarity between the economic structure of a given region and that of a supra-national economy, here the EU, into three 'raw' indices:

First, the specialisation of region j in country i relative to the European Union, given by

$$T_{ij} = \sum_{k=1}^{N} \frac{E_{ijk}}{E_{ij}} ln\left(\frac{E_{ijk}/E_{ij}}{E_k/E}\right)$$

Second, the specialisation of region j in country i relative to that country - the 'within-country' component, given by

$$T_{ij}^{Within} = \sum_{k=1}^{N} \frac{E_{ijk}}{E_{ij}} ln\left(\frac{E_{ijk}/E_{ij}}{E_{ik}/E_i}\right)$$

And third, the national specialisation of country i relative to the European Union – the 'between-country' component - given by

$$T_i^{Between} = \sum_{k=1}^{N} \frac{E_{ik}}{E_i} ln\left(\frac{E_{ik}/E_i}{E_k/E}\right)$$

These indices can be calculated for different years, and mapped accordingly

As Cutrini (2010) points out, the national specialisation relative to Europe, that is $T_i^{Between}$, can be envisaged as a residual of the average regional specialisation in country *i* relative to Europe once differences in regional

industrial structures within that country have been accounted for. Thus, if we define

$$aRS_i = \sum_{j=1}^{N} T_{ij} \frac{E_{ij}}{E_i}$$

as the average regional specialisation of all the regions of country *i* relative to the European industrial structure, and

$$aRS_i^{Within} = \sum_{j=1}^{N} T_{ij}^{Within} \frac{E_{ij}}{E_i}$$

as the average regional specialisation of all the regions within country *i* relative to that country's industrial structure, then the average regional specialisation of a country relative to Europe, aRS_i, is composed of two elements: the within country component and the country bias (Cutrini, 2010). Both of these average indices can be graphed to indicate differences between countries in trends in average regional specialisation over time. Finally, it follows that

$$aRS_i = aRS_i^{Within} + T_i^{Between}$$

National specialisation and revealed comparative advantage

In studies of national specialisation, the Balassa index (BAL) is commonly applied to sectoral export data to provide an indicator of 'revealed comparative advantage' (RCA), first introduced in Balassa (1965). This is usually defined as

$$BALASSA_{kj} = RCA_{kj} = \left(\frac{X_{kj}}{\sum_j X_{kj}} \Big/ \frac{\sum_k X_{kj}}{\sum_k \sum_j X_{kj}} \right)$$

where X_{kj} is the value of exports by sector k from region j. Although this index could be calculated for EU member states, using national export statistics, the requisite data on regional exports are not available for most EU countries. In this case, the index can be calculated using regional employment (or regional output), though it should be recognised that employment or output need not necessarily equate directly to export activity, so that in this instance the assumption cannot be made that the index measures 'revealed comparative advantage' as such.

Geographic concentration

Definition and measurement

Whereas the measurement of regional specialisation is viewed from the perspective of the region – the extent to which region's employment or output is accounted for by one or at most just a few industries - the idea of concentration is essentially an industry focused notion: the extent to which a given industry is based more in certain regions than in others. The idea of concentration is often described in terms of the degree of localisation of an industry, as outlined by the work of Brülhart and co-authors discussed in

$$CL_i = \sum_r \left| \frac{E_{ir}}{E_{iN}} - \frac{E_r}{E_N} \right|$$

Section 3.3. Indeed, one simple way of measuring the degree of concentration of any given industry across geographic space is the Coefficient of Localisation (CL), given as

$$CL_i = \sum_r \left| \frac{E_{ir}}{E_{iN}} - \frac{E_r}{E_N} \right|$$

where the individual employment terms are as defined above. This gives a geographical concentration (or localisation) index for each industry, but it does not reveal in which regions the industry in question is concentrated.

To overcome this limitation, the Location Quotient (LQ) is a commonly used index, which can be computed for each industry and each region. In its simplest form this is the ratio of a region's share of a given national industry to its share of total national activity, that is:

$$LQ_{ir} = \left(\frac{E_{ir}}{E_{iN}} \Big/ \frac{E_r}{E_N} \right) = \left(\frac{E_{ir}}{E_r} \Big/ \frac{E_{iN}}{E_N} \right)$$

If LQ is greater than unity then the industry in question is generally considered to be more localised in region r than in other regions: the higher the value of the index the greater the degree of regional concentration. Thus, mapping the LQs for a given industry i can reveal where and to what extent that industry is concentrated geographically. In fact, many authors use location quotients as a measure of regional specialization in a given industry, and it has also been used to identify local clusters. There is a relationship between the location quotient, in terms of ratios, to the components (expressed in terms of differences) of the measure of the level of regional specialisation (the KSI or CRS) and industrial localisation (CL) above.

As with all measures of the geographical distribution of economic activity, the spatial scale of the areal units of observation can influence the findings. This is particularly the case with concentration (and agglomeration), where spatial dependence may be important. For this reason, some authors have argued that the calculation of location quotients should be modified so as to take the location quotients of neighbouring areas into account. To do this Cromley and Hanink (2012) define what they call a focal locational quotient (FLQ) (see also Liu, 2014), which takes the form

$$FLQ_{ir} = \left(\frac{\sum_{k=r}^{s} w_{ik}E_{ik}}{\sum_{k=r}^{s} w_{ik}E_{k}}\right)/(E_r/E_N)$$

Where w_{ik} is the weight linking region r to region k determined from the form of spatial dependence specified. There are several possible spatial weight that could be specified, although the simplest is first-order neighbouring regions. The region's own spatial weight, w_{ir} could be set to unity, or to 1/s, where s the total number of contiguous regions for region r, including that region itself. In effect this version of the location quotient can be seen as the ratio of relative specialization of the industry of interest at the regional level, geographically larger than the individual spatial units because of the use of spatial weights, to its relative specialization at the national level.

Other approaches to measuring the geographical concentration of economic activity include the Hirschman-Herfindahl index, which in this case compares the distribution of an industry across regions compared to a uniform distribution in which employment (or output) is equally spread across all regions (when the index has the value 1/n where n is the total number of regions). The value of the index increases with the degree of concentration reaching its upper limit of unity when the industry in question is concentrated in just region. As an absolute measure, the Hirschman-Herfindahl measure of geographical concentration displays a bias towards large regions, since the latter are likely, other things being equal, to have larger shares of employment in any given industry.

Another index used by economic geographers is the Locational Gini coefficient. This is a relative measure of geographical concentration of a specific industry in comparison to a reference distribution rather than a uniform one. The coefficient takes the value zero if the industry's employment (or output) is distributed across regions in the same proportion as the distribution across those regions of total employment. The coefficient takes values greater than zero the more the distribution of the industry's employment is skewed compared to that of total employment. If total employment is not uniformly distributed, then an industry which is uniformly spread across all regions will appear to be concentrated in areas with little other employment. In contrast with the Hirschman-Herfindahl Index which gives greater weight to large regions, the Locational Gini, as a relative measure, gives greater weight to small areas.

Preferred indicator

In her study of the distribution of economic activity across the regions of the European Union, Cutrini (2010) uses another version of the Theil index she developed to measure regional specialisation (referred to above) to compute a corresponding measure of concentration that distinguishes between the within- country relative concentration of an industry and the between-country relative concentration of that industry. This is our preferred measure of regional industrial concentration. The relevant indices are defined as:

Total relative concentration of industry k

$$T_k = \sum_{m=1}^{M}\sum_{r=1}^{R_i}\frac{E_{ijk}}{E_k}\,ln\left(\frac{E_{ijk}/E_k}{E_{ij}/E}\right)$$

Within-country relative concentration of industry k

$$T_k^{Within} = \sum_{m=1}^{M} \sum_{r=1}^{R_i} \frac{E_{ijk}}{E_k} ln\left(\frac{E_{ijk}/E_{ik}}{E_{ij}/E_i}\right)$$

Between-country relative concentration of industry k

$$T_k^{Between} = \sum_{i=1}^{m} \frac{E_{ijk}}{E_k} ln\left(\frac{E_{ik}/E_k}{E_i/E}\right)$$

where the definition of the terms is that used above for the Theil specialisation indices above.

Clustering and agglomeration

Definition and measurement

As mentioned above, many studies have used the Location Quotient (LQ), or some variant thereof, to identify industrial 'clusters', in the sense that such an approach reveals those local areas in which a given industry has a high degree of localisation, in terms of its share of local employment (or output). Given that most analyses of this sort utilise sectoral employment (or out) data, much obviously depends on the level of sectoral disaggregation used, as well as the geographical size of the areal units for which such data are available. A more accurate version of this approach would use micro-level data sets of individual firms, to examine the co-location of firms in given sectors. When micro-data of this sort are available, with precise (geocoded) information as to the actual addresses of individual firms, various statistical proximity (eg distance) procedures are available which can be used to identify clusters that are not confined or conditioned by the limitations of pre-given geographical administrative units (such as NUTS areas).

But, as also mentioned above, the spatial and industrial identification of proper *functioning* clusters, as defined by Porter (op cit), requires more than finding particular localisations of a given industry or even numerous co-located firms in that industry. It also requires empirically demonstrating that the firms in question have interactions and interdependencies both with one another and with firms and activities in related and associated industries, as well as local institutions of various kinds. The notion of a functioning cluster is more than just a set of co-located firms

As suggested above, in the discussion of Figure 2.10, the idea of agglomeration is best defined in terms of the co-location of groups of industries (or firms in different industries). Thus, while a cluster (especially a large one) might be said to involve a degree of agglomeration, an agglomeration does not necessarily constitute a cluster in the Porterian sense.

In the urban and regional economics literature, the identification of industrial agglomeration is most usually done using the approach devised by Ellison and Glaeser (1997). Interestingly in their work there is something of a confusion,

or at the very least a blurring, between the notions of clustering and agglomeration. In Ellison, Glaeser and Kerr (2010), for example, the authors state "Why do firms cluster near one another? We test Marshall's theories of industrial agglomeration by examining which industries locate near one another, or co-agglomerate". This statement conflates the idea of 'cluster' which seems to be equated with Marshall's work on 'industrial districts' (not industrial agglomerations; indeed, Alfred Marshall's interest was in the economies of localised industrial specialisation), with the notion of agglomeration.

Preferred indicator

In their original paper, Ellison and Glaeser (1997) treat agglomeration as the combined effect of natural advantage and industry spillovers. In this model, Q firms sequentially choose amongst R locations (regions). An individual firm must choose whether to follow a prior firm's location decision or choose a location randomly, 'by throwing a dart' at a map. From this model, Ellison and Glaeser drive their index of agglomeration for a given industry *k* across regions as

$$EG_k^{Agglom} = \frac{\sum_{r=1}^{R}(E_{rk} - \widehat{E_r})^2 - \left(1 - \sum_{r=1}^{R}\widehat{E_r}^2\right)\sum_{p=1}^{Q} z_p^2}{(1 - \sum_{r=1}^{R}\widehat{E_r}^2)(1 - \sum_{p=1}^{Q} z_p^2)}$$

where $\widehat{E_r}$ measures the aggregate size of region *r*, typically modelled by its share of total (say, EU-wide) employment, the sums are over all regions or areas (say, in the EU), and the $\{z_p\}$ are the sizes of the firms (or plants) in industry *k*. The last term in both the numerator and denominator of the EG measure is the Hirschman-Herfindahl index, hence, the agglomeration measure is often written as

$$EG_k^{Agglom} = \frac{\sum_{r=1}^{R}(E_{rk} - \widehat{E_r})^2 - \left(1 - \sum_{r=1}^{R}\widehat{E_r}^2\right) H_k}{(1 - \sum_{r=1}^{R}\widehat{E_r}^2) H_k}$$

where H_k is the Hirschman-Herfindahl index for industry *k.*

Clearly, this measure of industry agglomeration requires micro-level (that is firm-level) data. Ellison, Glaeser and Kerr (2010) use a simpler version of the measure to study the 'co-agglomeration' of pairs of industries, namely, for industries *k* and l,

$$EG_{kl}^{Co-agglom} = \frac{\sum_{r=1}^{R}(E_{kr} - \widehat{E_r})(E_{lr} - \widehat{E_r})}{1 - \sum_{r=1}^{R}\widehat{E_r}^2}$$

This measure thus requires industry (sectoral) level data only. Other (more sophisticated) versions of the Ellison-Glaeser indices can be found in the literature.

2.4 Summary

Purpose (and relevance) of the study

There have been numerous investigations of the (changing) patterns of economic activity across the European Union, with special reference to whether and in what ways specialisation, concentration and agglomeration differ across member states and across the regions within them. Many of these studies have used the economic geography of the European Union to test the empirical validity of the various theories or explanations of these phenomena. Some studies have sought explicitly to determine whether and in what ways patters of regional specialisation, concentration and agglomeration have changed in response to the process of increasing integration (deepening) of the EU. Again, there are some theoretical arguments as to what should be expected as a result of this process (see below).

Most studies deal with the period from around the beginning of the 1970s to around 2000. Much has happened to the economic context and conditions of the European Union since then, including another phase of enlargement of the membership of the Union, an acceleration in the process of globalisation, and the disruption caused by the global financial crisis of 2008-9 and the Great Recession this triggered. There is, therefore, in the light of these and other events, a strong case for revisiting the topic of the changing geographies of economic activity across the Union. There have also been some advances in the techniques and indices used to measure specialisation, concentration and agglomeration, as well the availability of improved and contemporary data. In addition, in recent years there has been something of a reappraisal of the importance of specialisation, concentration and agglomeration as empirical trends in the global economy. For example, a decade ago Paul Krugman (2008) voiced some doubt as to whether increasing return to regional specialisation, concentration and agglomeration are now as important as they once were, that

> there's good reason to believe that the world economy has, over time, actually become less characterised by the kinds of increasing returns effects emphasized by new trade theory and new geography… In the case of geography, in fact, the peak impact of increasing returns occurred long before the theorists arrived on the scene. (p. 161)

And some recent empirical studies find that agglomeration may not be the most important factor driving the economic growth of regions and cities (see for example, Martin, Gardiner and Tyler, 2011). For these reasons also, a new appraisal of the geographical pattern of economic activity across the EU is warranted.

Possible geographical outcomes of increasing integration

The precise impact of increasing economic integration (and enlargement) within the European Union on the geographical distribution of economic activity across its member states and their regions is not possible to predict a priori with any certainty. There are several potential outcomes, and these in fact may change over time, for example as the technologies of production evolve, extra-EU conditions change (for example the rise of major overseas competitors, such as China), and shifts in policies and regulatory

arrangements occur. At least four alternative scenarios can be distilled from the literature:

(i) That increasing economic integration will encourage regional specialisation and concentration of activity, as different areas are able to exploit comparative advantages and increasing returns to scale in particular sectors due to the improvements in trade and in flows of capital and labour. This is what might be called the 'traditional' view, as found for example in standard trade theory and in Krugman-style 'new economic geography'.

(ii) That with improvements in transport and advances in technology that allow the 'de-verticalisation' of production, increasing integration could encourage the spatial dispersal and regional de-concentration of economic activity and the emergence of a more geographically even distribution of production, including the 'delocalisation' of supply chains and networks. If there are also limits to the returns from ever more geographical concentration of activity, this too could reinforce this tendency. Interestingly, this was what Krugman has more recently suggested is happening in the United States, where, for example the car industry, which was previously concentrated in the industrial mid-west regions, especially around Detroit, has become more geographically dispersed across the country.

(iii) In the case of the EU, a third possibility is for a geographically-differentiated combination of these first two possibilities. Progressive integration of the EU has gone hand in hand with increasing enlargement, specifically with the addition of new member states in Eastern Europe. Typically, these countries have lower wages and costs than the original 'core' member states. They thus have a competitive advantage in this regard and have attracted substantial growth-enhancing FDI as a result (see, for example, Sapienza, 2009; Popescu, 2014). There has also been a shift of manufacturing operations in certain sectors from the core member states to these new members. Further, as the new member countries have become exposed to a larger market, this may have allowed them (in certain sectors) to benefit from increasing returns to scale from trade with the rest of the EU. In short, while economic activity may be dispersing within the core members, and regional specialisation falling there, the converse could well characterise the new member states, where both regional concentration and specialisation might be expected to have increased.

(iv) A yet further possibility follows the line of argument advanced by Baldwin, referred to above, namely a decline of regional sectoral specialisation across the EU, but a shift to functional specialisation, as different stages and functions of an activity (such as motor vehicle production, or finance) are carried out in different regions. As discussed above, a lack of suitable data (principally on occupations and skills) makes it difficult to explore this possibility for the EU.

The extent to which any of these four scenarios can be identified as playing out across the countries, regions and sectors of Europe depends mainly on two things:

(i) The available data - how detailed regionally and sectorally they can be obtained, as well as temporally (how long is the period of data obtainable).

(ii) Other forces and factors acting on the economy. The process of integration and enlargement in Europe has not taken place in a vacuum. There have been other events occurring, the most important of which is the financial crisis and subsequent recession which spread across most of Europe from 2008 onwards, and which is likely to have disrupted patterns of underlying industrial behaviour.

A summary of findings on European integration is presented below. The general conclusion would be, however, that the longer the time period (i.e. outside of the effects of the financial crisis) that is available to the study, the easier it will be to identify patterns of development related to integration. In addition, a sector-by-sector approach to expected findings is also likely to be necessary given the different forces of specialisation, concentration and agglomeration which might be at play, and which may work differently depending on the type of activity being analysed.

Empirical findings

Measuring integration

Data and indicators on different measures of integration which follow the four freedoms of the EU (goods, services, capital, and people) have been investigated to see how these measures have evolved over the study period and across Member States and sectors. In particular:

- EU trade (goods and services) as a % of GDP
- Intra-EU FDI as a % of total FDI
- Non-native (but within EU) employees as % of Member State workforce
- Amount of regulatory restrictions by Member State

Period of study

The recent financial crisis seems to have disrupted the EU integration process through lowering the proportion of intra-EU trade as a % of GDP (see Figure 2.2). However, this downturn is not evident when looking at the share of EU workers from outside the host country (see Figure 2.8), probably because the financial crisis led to an exodus of workers looking for work in those Member States with relatively strong jobs markets.

In addition, when comparing the evolution of intra- and extra-EU trade shares there is no apparent difference in trend between the two for the majority of the period, and even a slight slowing of intra-EU trade relative to extra-EU trade in the last few years. This suggests that much of the increasing trade shares could simply be related to globalisation forces rather than anything to do with EU integration, and in addition that EU integration has struggled to get back on track following the financial crisis. Balanced against this is the argument that more countries are becoming open to trade around the world and it would be difficult to expect EU trade shares to keep pace with the rest of the world as more opportunities have opened up.

Member States

Using indicators to proxy integration is a difficult process, as any single indicator can reflect a variety of forces. For example, with EU trade proportions, it is typically the case that small countries, and those which act as trade hubs, will be more open to trade and will thus have higher shares of intra-EU trade. This largely explains the situation for Luxembourg, the Netherlands, Ireland, and Belgium in Figure 2.3.

Among the more recently-acceded Member States it is possible to detect increased levels of integration. Looking at the change in intra-EU trade shares, Slovakia, Hungary, Lithuania, Czech Republic, and Bulgaria have all increased fairly rapidly (as shown in Figure 2.3). Many of the newer Member States are also at the top end of the scale when looking at intra-EU FDI proportions, with the flow of capital (from western / more established Member States to east) having been both a symptom and factor in the integration process.

Finland and Austria stand out from most other Member States on measures of FDI restriction (see Figure 2.7). This is due largely to utility and service sector limitations, many of which have decreased over the period of analysis meaning that by the end of the study period there is little difference between them.

Sectors

As would be expected, manufacturing dominates the EU trade-GDP shares, both in level and change (see Figure 2.4). There are, however, some service sector activities (R&D, and Other professional services) which have seen reasonable increases over the study period.

Integration across service sectors, and the related recognition of professional qualifications remains a work in progress. Recent Directives and initiatives (such as the Digital Single Market Strategy and the European Professional Card) are moving the process along, and so these are the areas most likely to be showing signs of change over the study period.

Data implications

Use of employment as the benchmark indicator

From reviewing the literature on specialisation, concentration and agglomeration, it is clear that the majority of studies and indicators use *employment* as their standard variable of choice - this is due to several main advantages:

- employment generally has more complete coverage than other measures of activity such as GVA;
- employment is a less controversial indicator than GVA, particularly for the services sector where measurement of output (and by corollary productivity) is more difficult to measure;
- employment does usually not require additional manipulations (to do with currency or inflation adjustments) to ensure comparability across countries.

Because of this employment is seen as a more robust indicator, and due to its wide use in the literature it makes sense to continue this in the current study so that results can be compared directly without having to take account of the implications of different variables being used.

The only exception to this will be for the national Balassa Index calculations, where export shares from the COMEXT database will be calculated.

Sectoral vs firm-level data

The calculation of most indices can be undertaken on sectoral data, whether these are at national or regional level. The exception to this is the calculation of the Ellison-Glaeser index for measuring agglomeration, which can be calculated at both sector and firm level.

3 Database

3.1 Introduction

This chapter is concerned with the collection and construction of a national-regional-sector database suitable for the construction of indicators to be used to calculate measures of specialisation, concentration and clustering. The database deliverable can be split into two components:

(i) A database suitable for applied statistical analysis, containing sufficient country coverage, regional-sectoral detail, and time periods (of annual data).

(ii) An accompanying user guide which describes the process of data sourcing, collection and construction.

Aims of the database

The database has two components.

National-sector export share database

As no detailed data on regional-sector export shares exist for Europe, these data are confined to national analysis. The OECD's STAN database and the export data from WIOD (World Input-Output Database) were identified as the most promising sources for detailed sector export shares over a sufficient period of time and sectoral detail.

National-regional-sector database

At the outset it was not considered feasible to include all Member States in the analysis, as both data quality and resource issues would prevent such a task. Instead, the aim was to construct a database of sufficient Member State coverage that the findings would be representative for the EU as a whole. At the outset, Eurostat's SBS database was considered to be the main source of data, to be supplemented by data from National Statistical Offices as necessary. On further investigation it was decided to place additional focus on the Bureau van Dijk (BvD) firm-level database as a supplementary source of information.

- Countries and regions (NUTS2)

A total of 16 Member States were proposed for inclusion in the regional-sector analysis – a stipulation of the work was that these should include the largest five Member States (France, Germany, Italy, Spain, and the UK). The remaining Member States considered to have sufficiently good quality regional data for inclusion were: Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Greece, Hungary, The Netherlands, Slovakia, Slovenia and Sweden. Taken together, this selection accounted for 88% of EU GDP in 2015 and 81% of population.

- Sectors

For most of the countries (and their regions) mentioned above, it was considered that a full coverage of the market-based sectors was desirable. This includes Manufacturing (all sectors) and services sectors including: Wholesale and retail trade; repair of motor vehicles and motorcycles, Transportation and storage, Accommodation and food service activities, Information and communication, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities.

- Time period

From prior analysis it was considered that the most robust data could be found over the period 2005-2015. However, given the occurrence of the global financial crisis near to the start of this period, it was considered desirable to push the data back further (to 1995) if possible.

3.2 Data sources and availability

Export data by country and sector

In considering the sources for the export database, the three main contenders were the OECD's STAN database, Eurostat's COMEXT database, and the WIOD export data. The criteria on which the databases were assessed were that they should provide full coverage of EU Member States, detailed sectoral detail (sufficient to calculate the Balassa index of "revealed comparative advantage" – following the work by Brülhart (2001a)), and span a long period of time (preferably back to 1995).

- OECD STAN

The OECD's STAN (STructural ANalysis) database[14] is a comprehensive source of industry covering a range of indicators, including exports. Within this, the Bilateral Trade Database by Industry and End-use category (BTDIxE) provides sufficient coverage to be of interest for the project.

- Eurostat COMEXT

COMEXT[15] is a Eurostat database dealing with international trade (exports and imports) in goods which dates back to the early 1990s and provides one of the most detailed sources of European trade data available.

- WIOD exports

WIOD is an internationally recognised source of input-output data for countries across the world, which has been in operation for many years and is part-funded by the European Commission. There are two releases of data available on the WIOD website[16].

Coverage

The table below provides a comparison between the three options.

Table 3.1: Export database comparison

	STAN	COMEXT	WIOD
Time Period	1995-2016	1995-2016	1995-2011[17] (2013 release) and 2000-14 (2016 release)
Countries	All Member States	All Member States	EU27 (no data for HR)
Sectors	Once aggregations have been removed and compatibility with	The COMEXT database does not allocate exports by sector,	For the 2013 release 59 sectors (NACE Rev1), while for the 2016 release, 64 sectors

[14] See http://www.oecd.org/sti/ind/stanstructuralanalysisdatabase.htm.
[15] See http://ec.europa.eu/eurostat/web/international-trade-in-goods/data/focus-on-comext.
[16] See http://www.wiod.org.
[17] 1995-2009 for BG, CY, EE, EL, LV, LT, LU, MT, PT, RO, SK, SI, 1995-2011 for all other countries.

	STAN	COMEXT	WIOD
	NACE codes established, the remaining coverage is 31 sectors. The export data deal mostly with trade in goods, with a limited coverage of services and utilities[18].	but only distinguishes data by products (about 4000).	(NACE Rev2). Both releases include services, i.e. complete coverage of the economy.
Coverage	Data coverage of the is very good with only a few missing data observations, Some countries also start a bit later[19].	Not investigated as it was considered too time-consuming to pursue the COMEXT option.	As with STAN, data coverage is very good although possible missing observations have been noted across a range of sectors and countries[20].
Other notes			WIOD data for services exports are based on estimated data[21]. However, they are based on reliable sources and are considered the best option available in lieu of no directly observed data.

The disadvantage of the STAN database is its inability to cover service sectors, which are an important part of the structure of many EU Member States and can also provide strong export earnings (e.g. Luxembourg, UK). In this context, the WIOD database was explored as either a substitute for, or complement to, the STAN data.

Comparison between the databases has revealed some differences in levels of exports, while the trends seem broadly similar. Given that the use of these data is for relative (Balassa index) calculations, we consider that they are mostly complements (as the STAN provides additional manufacturing disaggregation) and so the proposal is to use them alongside one another in the analysis of revealed comparative advantage.

Eurostat SBS database

The Structural Business Statistics database contains detailed enterprise data for a wide range of activities across the European Union (including services). Most importantly for the project, it also has a regional dimension and it is this part of the SBS database that is to be used as the backgrounds structure for the project data.

[18] Taken together, the last three sectors in account for under 1.5% of total exports of EU goods and services in 2016.
[19] Luxembourg starts in 1999, Slovakia in 1997 and Bulgaria in 1996.
[20] In the raw WIOD data there are several instances of zero entries, which seem strange as other periods have non-zero entries, and thus could be missing.
[21] See http://www.wiod.org/publications/source_docs/WIOD_sources.pdf (p11) for details.

Coverage The SBS regional data are split into two sub-datasets which are identified by the time period covered.

- Database 1: 2008 – 2015 (sbs_r_nuts06_r2)

These data are a mix of different spatial definitions (NUTS 2013 and NUTS 2010) – this mix varies by Member State. On a sectoral basis, activities are according to NACE Rev.2 definitions[22], and range from Section B (Mining and Quarrying) to N (Administrative and support service activities) at two-digit level. The table below summarises any issues of completeness and consistency with Database 1, focussing on employment data for the 16 Member States which are part of the national-regional-sector analysis, and providing detail on whether the main issues are to do with time period coverage, regional mix, or available sectoral detail (or some combination thereof).

Table 3.2: SBS Database issues (2008 – 2015)

Member State	Issues with Employment Data
Belgium	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors.
Bulgaria	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors and some sub-sectors within Section E (Water supply; sewerage, waste management and remediation activities).
Czech Republic	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors.
Denmark	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B and some Section C sub-sectors. Missing data for sub-sectors within Section H for some regions.
Estonia	Periods: No major problems. Regions: No disaggregation - the country is a NUTS2 region. Sectors: Missing data for Sections B, E and H sub-sectors.
France	Periods: Large number of missing data in 2008 and 2009. Regions: Mixed between two NUTS classification (2010 and 2013) - data available in NUTS2010 covers period 2008-2012 and NUTS2013 covers period 2013-2015. Sectors: Missing data for Section B and Section H and Section J sub-sectors

[22] See Appendix A for a list of NACE Rev.1 and 2.2 definitions and how they match together.

Member State	Issues with Employment Data
Greece	Periods: No major problems. Regions: Mixed between two NUTS classification (2010 and 2013), data available in NUTS2010 covers period 2008-2012 and NUTS2013 covers period 2013-2015 Sectors: Missing data for Section B sub-sectors and some Section E sub-sectors.
Germany	Periods: No major problems. Regions: Mixed between 2 NUTS classification including NUTS2013 and NUTS2006. Sectors: Missing data for Section D and Section E. Missing data for Section B sub-sectors in some regions.
Hungary	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors.
Italy	Periods: No major problems. Regions: Mixed between 2 NUTS classification including NUTS2013 and NUTS2006. Sectors: Missing data for Section F in some regions.
Netherlands	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors. Missing data for some Section C and Section E sub-sectors in some regions.
Slovakia	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors and some Section C, Section E and Section H sub-sectors.
Slovenia	Periods: No major problems. Regions: Mixed between 2 NUTS classification including NUTS2013 and NUTS2010. Sectors: Missing data for Section B sub-sectors.
Spain	Periods: No major problems. Regions: No major problems. Sectors: Missing data for Section B sub-sectors. Missing data for Section H in some regions.
Sweden	Periods: No major problems. Regions: No major problems. Sectors: Missing data in Section B sub-sectors and some Section C sub-sectors.

Member State	Issues with Employment Data
UK	Periods: 2011-15 missing for some regions (UKD2, UKD5) and for 2008-10 (UKD6, UKD7) and for 2013-15 (UKI1, UKI2) and for 2008-12 (UKI3, UKI4, UKI5, UKI6, UKI7) most likely due to changes in NUTS classification mentioned below. Regions: Mixed between 2 NUTS classification including NUTS2013 and NUTS2006. Sectors: Missing data in Section B sub-sectors. Missing data in Section E sub-sectors in some regions.

- Dataset 2: 1995 – 2007 (sbs_r_nuts03)

For the earlier time period dataset, the regional disaggregation is a mix between NUTS 2006 and NUTS 2010 at NUTS2 level. For sectoral split, the coverage at NACE Rev.1.1 is from Section C (Mining and Quarrying) to K (Real estate, renting and business activities).

Table 3.3: SBS Database issues (1995 – 2007)

Member State	Issues with Employment Data
Belgium	Periods: Missing data for 1995 and 2002 in all levels of geography. Large number of missing data in 1996 to 1998. Regions: No major problems. Sectors: Missing data in Section J and sub-sectors in Section C and Section D.
Bulgaria	Periods: Missing data for 1995 in all levels of geography. Data is available only at 2007 for regional level. Regions: Disaggregated into only 2 regions, with only 2007 data available. Sectors: Missing data for Section J.
Czech Republic	Periods: Missing data from 1995 to 2001 and 2003 in all levels of geography. Regions: No major problems Sectors: Missing data for sub-sectors within Section C, Section D and Section I. Missing data for Section J.
Denmark	Periods: Large number of missing data from 1995 to 1998. Data is available only at 2007 for regional level. Regions: Missing data for regional level. Sectors: Missing data for sub-sectors within Section C and Section D. Missing data for Section J.
Estonia	Periods: Missing data from 1995 to 1999 and 2003. Regions: No regional disaggregation. Sectors: Missing data in Section J and sub-sectors within Section C and

Member State	Issues with Employment Data
	Section D.
France	Periods: Large number of missing data in 1995. Regions: Missing data from 1995-2000 in FR10. Sectors: Missing data in Section J and sub-sectors within Section C and D.
Greece	Periods: Large number of data missing in 1995-1999. Regions: No major problems. Sectors: Missing data in Section J and sub-sectors within Section D.
Germany	Periods: Large number of data missing in 1995-1998. Regions: Large number of data missing for each region, especially from 1995-1998. Sectors: Missing data in Section J and sub-sectors within Section C, Section D and Section E.
Hungary	Periods: Missing data from 1995 to 2000. Regions: No major problems. Sectors: Missing data in Section C sub-sectors and in Section J.
Italy	Periods: Large number of missing data in 1995 and 1998. Regions: No major problems. Sectors: Missing data in Section C and D sub-sectors.
Netherlands	Periods: Data missing in 1998. Regions: No major problems. Sectors: Missing data in Section J and sub-sectors within Section C and Section D.
Slovakia	Periods: No major problems. Regions: No major problems. Sectors: Missing data in Section J and sub-sectors within Section C, Section D and Section I.
Slovenia	Periods: Data missing in 1995 and 1996. Large number of data missing in 2006. Regions: Data only available at 2007 in regions. Sectors: Missing data in Section I and Section J and sub-sectors within Section C and Section D.
Spain	Periods: Large number of data missing from 1995 to 1998. Regions: No major problems. Sectors: Missing data in Section J and sub-sectors within Section C and Section D.
Sweden	Periods: Large number of data missing between 1995-2006.

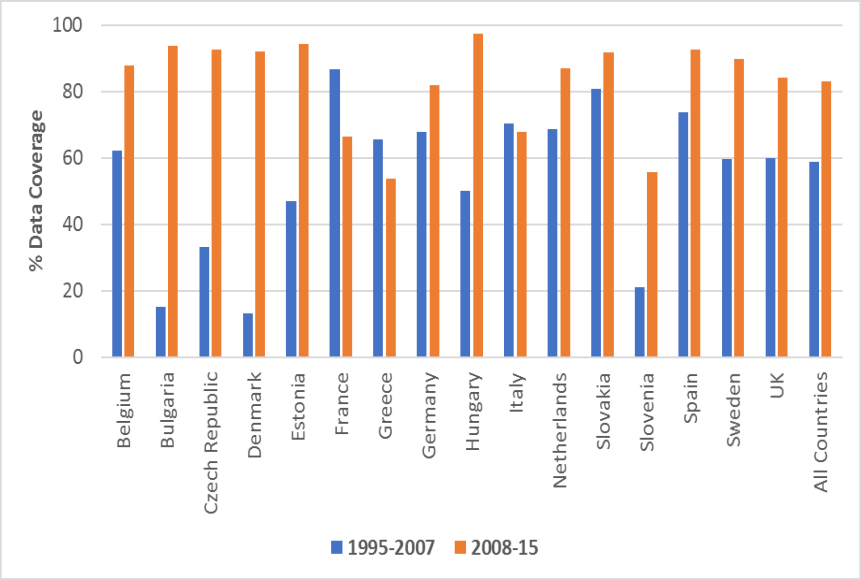
Member State	Issues with Employment Data
	Regions: Data is available only at 2007 in some regions and some missing data from 1995 to 1997. Sectors: Missing data in Section J and sub-sectors within Section C and Section D.
UK	Periods: Missing data from 1995-1997. Large number of missing data in 2001. Regions: No major problems. Sectors: Missing sub-sectors within Section C and Section D. Missing data in Section J.

The tables above provide an indication of the challenges of obtaining consistent data across time, space and activity. As a way of summarising these findings and allowing some degree of comparability, Figures 3.1 and 3.2 look at the proportion of available data, firstly across countries and secondly across time. A value of 0% on the y-axis would imply no available data at all, while 100% would be a full dataset (across regions and sectors).

The charts clearly show several things:

- There is a real mix in the quantity of data covered across Member States. Typically, the longer established Member States are stronger within the earlier database, while for the 2008-15 period the coverage is more even.
- France, Greece and (marginally) Italy are the only Member States for which coverage decreases in the more recent database.
- The quantity of SBS data has gradually improved over time, levelling off at around 85% coverage across the 16 Member States in the more recent database, while continually improving in the previous (1995-2007) database.
- A dip in coverage during the first couple of years of the new database being established.
- A continuous time series approach to the analysis might thus be problematic, while a snapshot of several years (eg 2003, 2007, 2011, 2015) could be a better option.

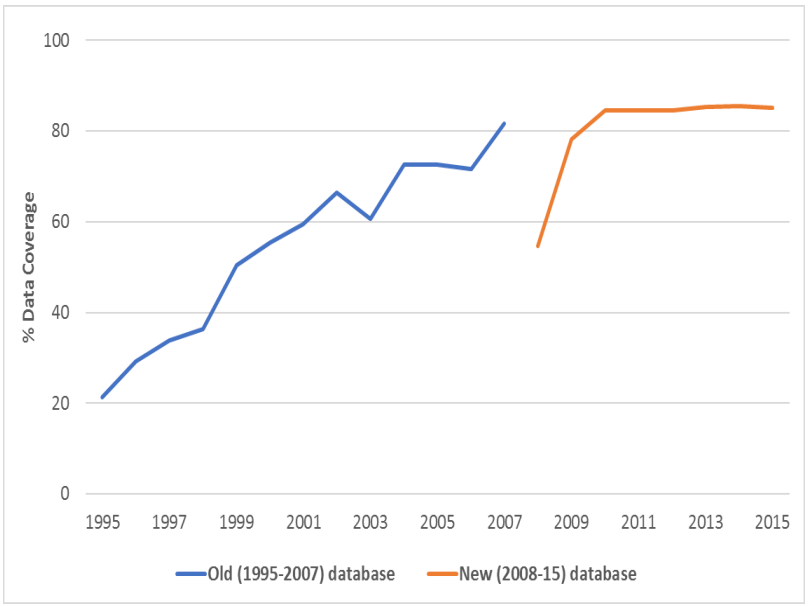
Figure 3.1: SBS data coverage by country



Note: The calculation is approximate as it includes national and sector aggregates as part of the coverage. This explains why Denmark is non-zero for 1995-2007.

Source: Eurostat SBS database, CE calculations

Figure 3.2: SBS data coverage over time



Note: The calculation is approximate as it includes national and sector aggregates as part of the coverage.

Source: Eurostat SBS database, CE calculations

Additional data sources

NSO investigations

The various temporal, spatial and sectoral issues identified within the SBS database led to investigations at country (NSO) level to see whether there were any additional data available which might not have been released to Eurostat. These data could then be used to supplement the SBS data, potentially helping to bridge or fill gaps, aid consistency checking, and so on.

In the period leading up to submission of this report, numerous communications were sent or received during the process of discovering what additional data might be available. The table below provides a summary of the findings from this exercise.

Table 3.4: NSO data investigations

Member State	Data findings
Belgium	Employment data (employees and self-employment) have been provided according to Nace Rev. 1 (2-digit level) and NUTS 2013 for the period 1995-2009 at NUTS2 level.
Bulgaria	To date, no communication has been received back from the Bulgarian NSO.
Czech Republic	The Czech statistical office has provided detailed sectoral data for 2003. No data are available before that date.
Denmark	Due to the 2007 Danish Municipal Reform NUTS2 data are only available from 2008 onwards. However, Danmark Statistics have said they are able to construct equivalent NUTS2 data going backwards over 1995-2006 at NACE Rev 2 classification. Unfortunately, these data are not free, and would cost DKK 9000 to obtain.
Estonia	NA – data are complete from SBS database.
France	A weblink (https://www.insee.fr/fr/information/1302154) was provided whereby you can consult older publications of INSEE. However, the website also notes that “because of the moving of INSEE's offices, the INSEE library will be closed to the public from March 12th, 2018 until the end of 2018.” Further communications with INSEE suggested that, partly due to the ongoing move of their library, there would be no supplementary data available at this time.
Greece	Weblinks were provided for Greek regional data for 2008-15 for Sections H-S. For Section G the data go from 2000-15, although there are breaks in the data. There are no sub-divisions, and nothing for manufacturing, mining or other missing sectors. Pre-2008 data are the on NACE Rev 1.1. definition.
Germany	Communications received indicate that the Destatis did not compile any statistics in the service sectors (they only started to compile them as they became mandatory due to EU legislation). In addition, there are no archives or non-public sources available. A weblink to data compiled by

Member State	Data findings
	Destatis for a variety of activities was provided, but this did not yield anything useful.
Hungary	To date, no communication has been received back from the Hungarian NSO.
Italy	Although communication channels were established, data are sufficiently complete from the SBS not to require supplementary sources.
Netherlands	Communications are ongoing regarding the availability of supplementary data.
Slovakia	Communications are ongoing regarding the availability of supplementary data.
Slovenia	Communications revealed that no supplementary data were available from the NSO.
Spain	NUTS2 2-digit employment data were provided from the Spanish regional accounts for 1995-2002.
Sweden	Communications are ongoing regarding the availability of supplementary data.
UK	N/A – Cambridge Econometrics maintain an ONS-compatible UK local authority level database which can be used to construct the necessary spatial-sectoral-temporal configuration.

Cambridge Econometrics European regional database

The Cambridge Econometrics (CE) database[23] is a NUTS3 level dataset which covers the period 1980-2015 for 6 aggregate sectors. It has been maintained and updated by CE over many years and is designed to be consistent with regional accounts from Eurostat. While the sector aggregation is insufficient for the analysis required of specialisation, concentration and clustering, it could potentially be used to provide a background structure from which more detailed sector proportions can be calculated using firm-level databases listed below.

An additional advantage is that the database is now available free of charge through the JRC data platform[24], with future updates being provided annually by the European Commission (JRC-ISPRA).

Firm-level databases

The proposed combination of the SBS and NSO databases still leaves large gaps in time and sector coverage, as well as a problem of conversion between NACE Rev versions to resolve. For this reason, the possibility of using firm-level databases (from which regional-sector aggregates could be constructed, bottom-up) has also been explored.

LISA database (NL)

LISA (Landelijk Informatiessysteem van Arbeidsplaatsen en vestigingen[25]) is an establishment-based employment dataset which covers the entire population of firms in the Netherlands (where paid work takes place), and thus provides the most comprehensive picture of micro employment data available.

[23] See https://www.camecon.com/european-regional-data/ for more information.
[24] See http://urban.jrc.ec.europa.eu/t-pedia. Search for "Cambridge" or "Econometrics: and you find the list of the currently available indicators (metadata and downloadable zip file).
[25] See https://www.lisa.nl/home.

The data for this work have kindly been processed by Prof Frank van Ort of the Utrecht University, who has made use of these data in the past for his own analyses (see, for example, van Ort et al (2010)). Prof van Ort provided a 3-digit database (NACE Rev2) at NUTS2 level for the period 1996-2015.

Bureau van Dijk database

The Bureau van Dijk (BvD) Orbis database[26] is operated by Moody's Analytics is a private company dataset covering approximately 300 million companies worldwide. The companies are geo-coded and the associated industry codes can be aggregated into NACE classifications. The JRC-Seville has access to the Orbis database and has worked to produce region-sector databases for the Member States being analysed.

- Sectors

Unlike LISA, the BvD database still represents a sample of firms (with a bias against smaller firms who will not be registered). In addition, as it includes only private sector companies, it does not cover the public and own-service NACE sections (O-T) very well. This, however, is not considered a major disadvantage as it is mainly the market-oriented sectors which are of interest for the study (and their relation to EU integration).

Finally, there is also a potential issue of over-representation of some sectors in the database, by which is mean that the proportions of sectors for any given year will not match those of the population due to some sectors being more likely to be reporting in the BvD database than others.

To test this final potential property of the BvD data, sector shares for the BvD were aggregated across regions to calculate national equivalents, within three of the broad aggregate sectors which the CE database uses:

(i) Industry – not including construction (Sections B-E);

(ii) Wholesale and retail trade, Transportation and storage, Accommodation and food service activities, and Information and communications services (Sections G-J); and

(iii) Financial and Business Services (Sections K-N)

These sector shares were compared with equivalent values for the LISA database (for NL), the CE detailed sector data (for UK), National Accounts data from Eurostat. The following figures (3.3 – 3.6) visualise the results.

The findings can be summarised as follows:

For the Netherlands:

- For LISA and the National Accounts (Figure 3.3), the sector proportions within Industry (with the exception of the repair and installation of machinery and equipment) and Services (G-J) correspond extremely well with high correlations.
- The situation is not so good with Financial Business Services (FBS), however, particularly with some sectors ('Employment agencies' and 'Security and investigation, service and landscape, office administrative and support activities' both have a much higher proportion in the National Accounts, whereas 'Legal and accounting activities; activities

[26] See https://www.bvdinfo.com/en-gb.

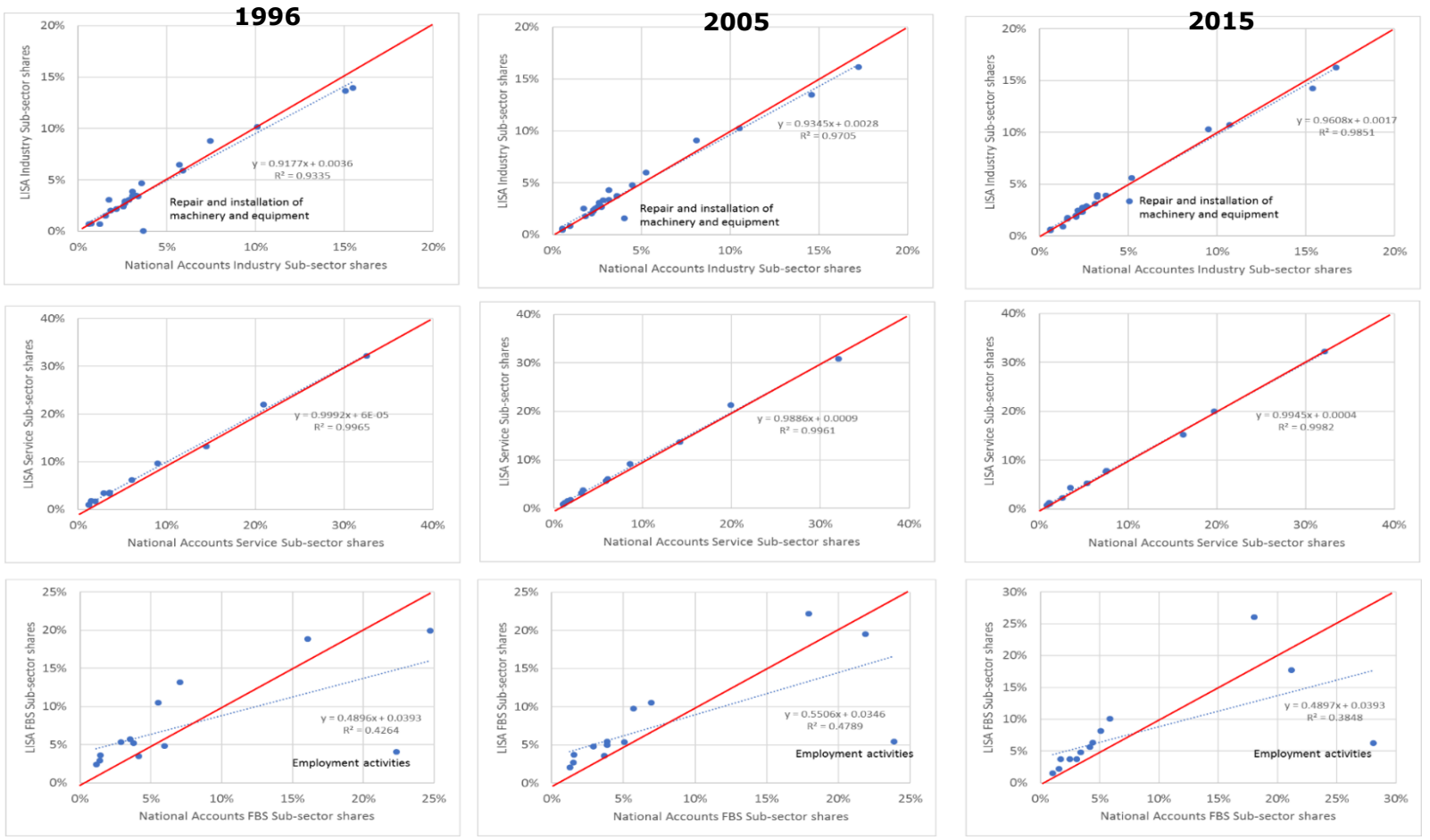
of head offices; management consultancy activities' is consistently higher in the LISA data).

- Between the BvD and National Accounts (Figure 3.4) the degree of correspondence is not so good, even for industries, with some sectors (Manufacture of food, beverages and tobacco products, and furniture/other manufacturing) showing deviations.
- Moving to the service sectors, Wholesale and retail trade show some opposing (over and under representation) proportions in 1996, but this seems to settle down in later periods.
- Probably the largest concern is with the FBS sector, and in particular Financial service activities (consistently over-represented in the BvD) and Employment agencies and Security, landscaping and admin/business support services, which show continued under-representation.

For the UK:

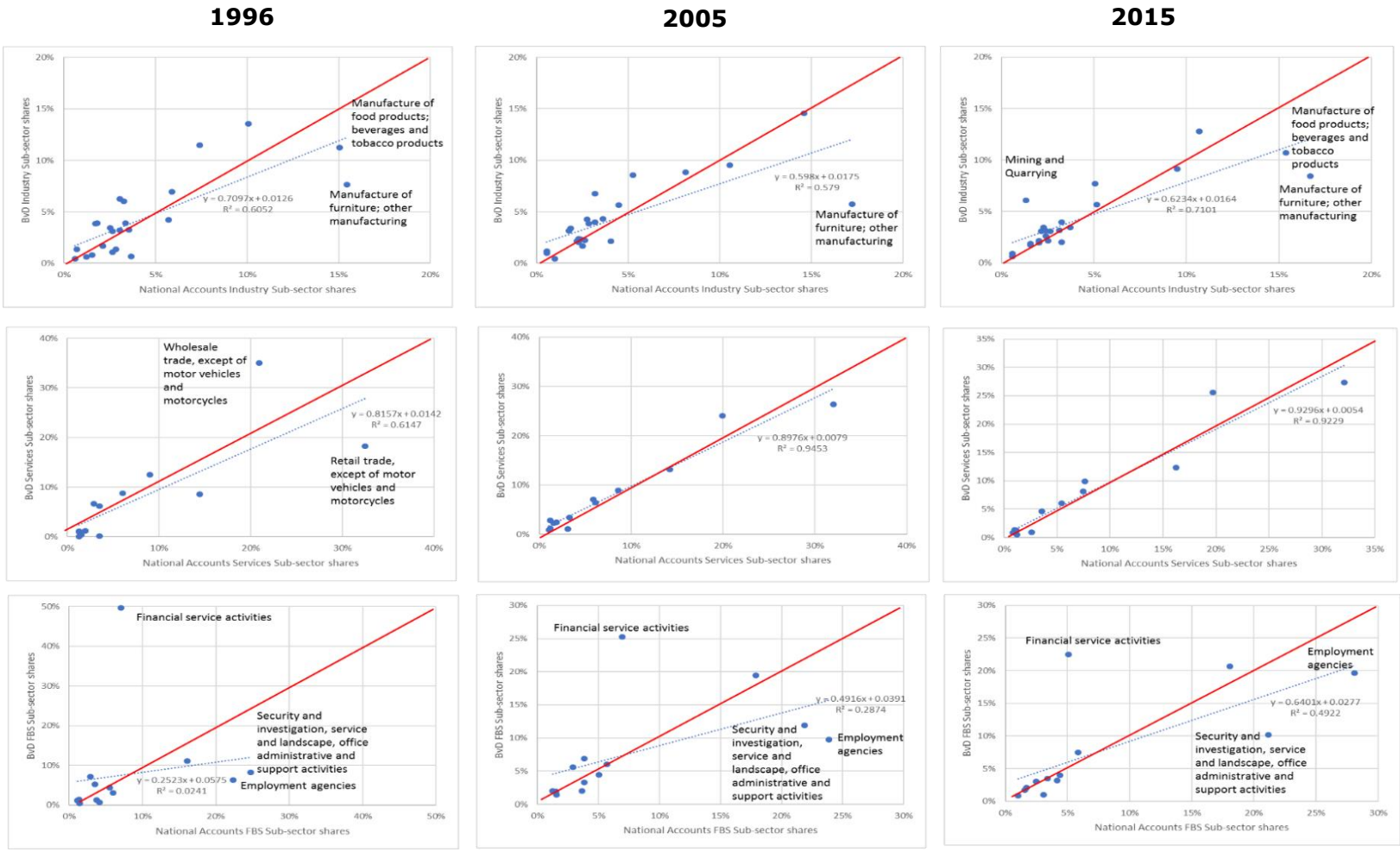
- The comparison between CE data and the National Accounts (Figure 3.5) reveals no major deviations across any sub-sectors.
- For the National Accounts vs BvD (Figure 3.6) there are some deviations for industry sub-sectors (notably food, drink and tobacco and clothing and leather) but these seem to improve over time.
- BvD service sub-sector proportions seem reasonable, but for the FBS sector there are some persistent deviations, notably Legal & accounting activities, and Security and investigation services, while Financial services is also under-represented in the earlier years.

Figure 3.3: LISA vs Eurostat National Accounts (NL) sector proportions



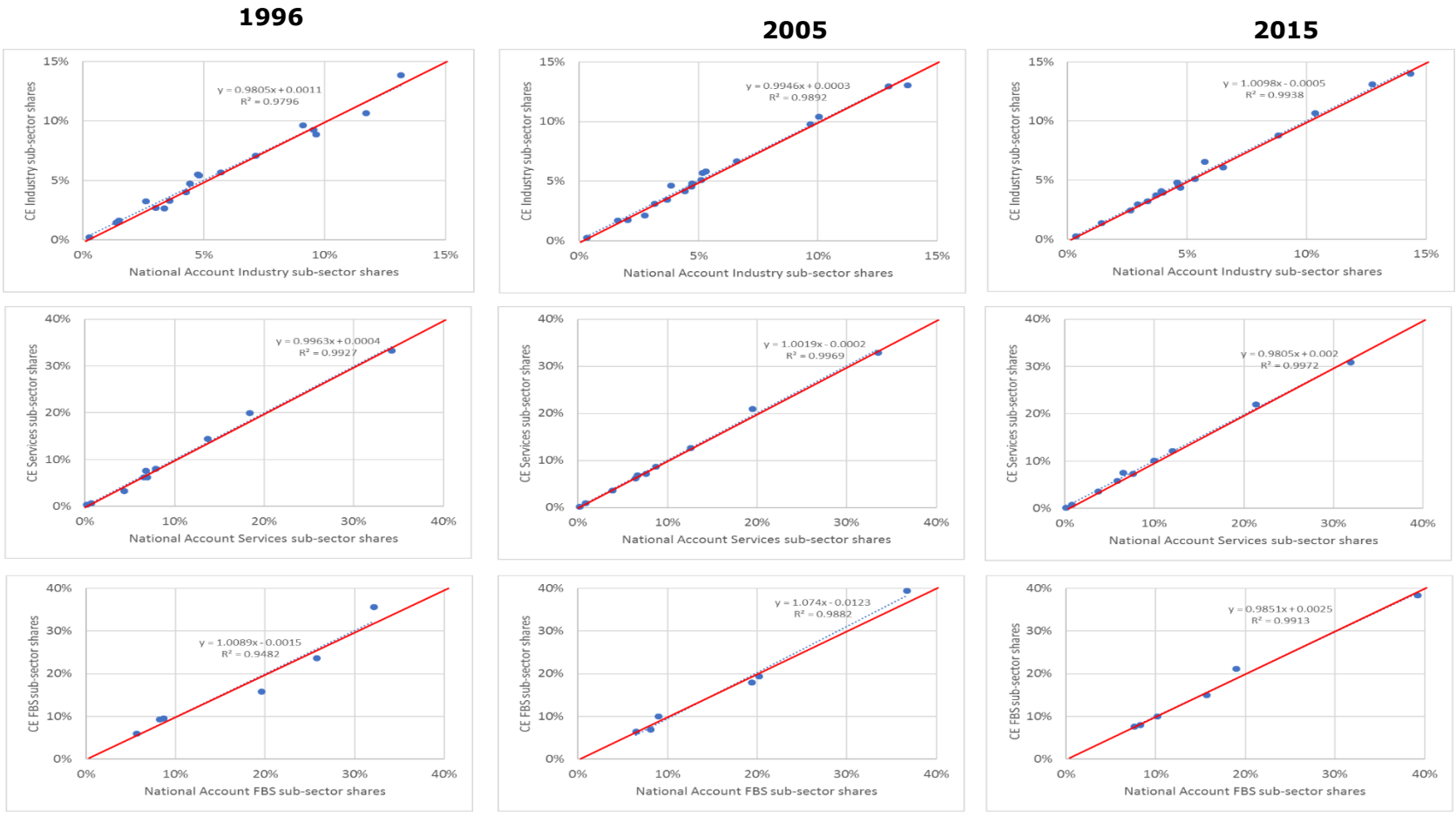
Note: Shares are calculated as proportions of the aggregate sector.
Source(s): Eurostat National Accounts database, LISA database, CE calculations.

Figure 3.4: BvD (NL) vs Eurostat National Accounts (NL) sector proportions



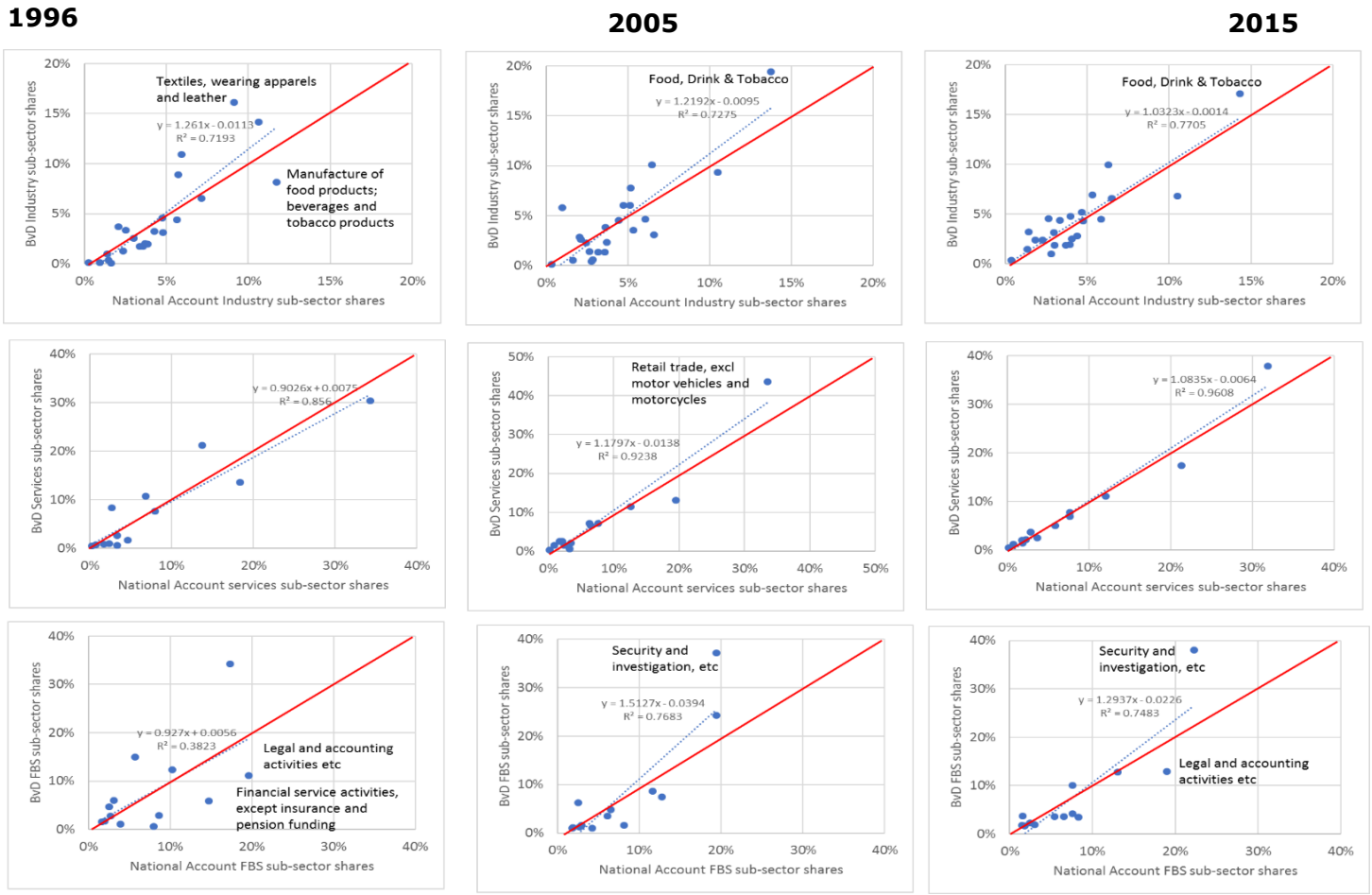
Note: Shares are calculated as proportions of the aggregate sector.
Source(s): Eurostat National Accounts database, BvD database, CE calculations.

Figure 3.5: Cambridge Econometrics UK data vs Eurostat National Accounts (UK) sector proportions



Note: Shares are calculated as proportions of the aggregate sector.
Source: Eurostat National Accounts database, CE database, CE calculations.

Figure 3.6: BvD (UK) vs Eurostat National Accounts (UK) sector proportions



Note: Shares are calculated as proportions of the aggregate sector.
Source: Eurostat National Accounts database, BvD database, CE calculations.

- Time periods

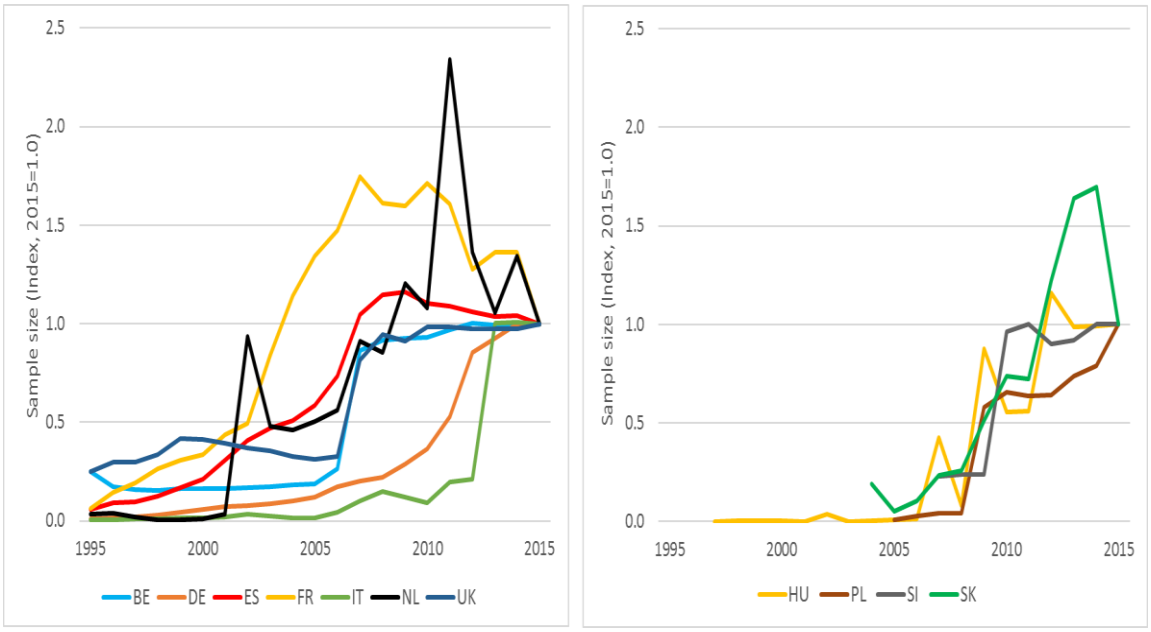
Across the sample of Member States being analysed, there is a range of starting years for the data. The established Member States do go back to 1995, but typically the more recently-acceded Member States do not. For example, Hungary and Poland start in 1997, Slovakia in 2004 and Slovenia in 2007.

- Sample robustness

There are also some concerns over the sample coverage going back through time, meaning that even if the data are reported as going back to 1995 the number of companies being surveyed may be relatively small (to the entire population of the Member State) which would make the data less robust than it otherwise appeared.

To investigate this possibility, the charts below (split between the more established Member States and those acceding from the 2000s onwards) reports on the number of companies being surveyed going back through time across the Member States.

Figure 3.7: BvD sample sizes (relative to 2015) across selected Member States



Source: Eurostat SBS database, CE calculations

Perhaps surprisingly, 2015 is not the best year in terms of sample size, across all countries – for NL (2011), FR (2007), and ES (2009) one must look at earlier years – but it is generally the case among the established Member States. There are similar patterns with those more recently acceded, although for SK (2014) and HU (2012) it also holds true.

There is a general rule, however, that the more recent years have a larger sample size, and this cannot simply be due to more companies being in existence (i.e. a larger population size). This throws open the question at what point in time the sample of companies being surveyed in the BvD no longer becomes representative. In the case of Italy, for example, there seems to be a

rapid decline in sample after only a few years, while for most others the decline is more gradual.

3.3 Database construction method

Having reviewed the availability of data from official sources, this section looks at how best to blend them together to form a consistent database. The focus here is entirely on the national-regional-sector database as the export databases from STAN and WIOD are sufficiently complete to not require additional processing.

Two distinct options are presented:

1. The SBS database, supplemented by national level (NSO) data;
2. The BvD database, used to create sector-region proportions which could then be applied to more aggregated national/regional data.

SBS database

Changing classifications

As mentioned in the previous chapter, to provide a consistent database for the study period, the two SBS databases need to be blended together. This section describes what needs to be done for this to happen.

- Regional (NUTS) classifications

Changes to regional classifications are the first issue to deal with, as when calculating the indicators for a particular sector it is important to make sure that they are identified for the same spatial area, as otherwise this will lead to inconsistencies in measurement. Not all Member States have been affected by changes to NUTS classifications during the study period, however, and so only those for which this is a relevant issue are included in the table below.

Table 3.5: Regional classification issues and proposed solutions

Member State	**NUTS 2006 / 2010***	**NUTS 2013**	**Comments and Proposed Solution (*in italics*)**
Denmark	DK	DK01 – DK05	For Denmark the change in NUTS classification is very important due to the municipal reform which, in 2007, created five NUTS2 regions where previously there had been only one (the whole country). This means that pre-2008 there are no NUTS2 data available for Denmark. *It would seem the main solution is to treat the country as a single region for the entire period or to simply exclude it from the analysis.*
France	FR9 FR91–94	FRA FRA1-A5	An additional region (FRA5) has been added implying some boundary shifts (from FRA1) This shift concerns the overseas regions of France (Départements d'Outre-Mer). *Because these are peripheral and small*

Member State	NUTS 2006 / 2010*	NUTS 2013	Comments and Proposed Solution (*in italics*)
			regions the solution proposed is to only focus on mainland France and thus ignore these changes.
Germany	DE41, DE42 DED1, DED3	DE40 DED4, DED5	Regions have merged. *Solution is to only use DE40 for whole period*. The changes are superficial (codes and names but not boundary changes) and so *there are no real inconsistencies to deal with.*
Greece	EL1*, EL11*-13*, EL14*, EL2*, EL21*, EL22* - EL25*	EL5, EL51-53, EL61, EL6, EL54 EL62 - EL65	The changes are superficial (codes and names but not boundary changes) and so *there are no real inconsistencies to deal with.*
Italy	ITD, ITD1-D5, ITE, ITE1-E3	ITH, ITH1-H5 ITI, ITI1-I4	The changes are superficial (codes and names but not boundary changes) and so *there are no real inconsistencies to deal with.*
Slovenia	SI01*, SI02*	SI03, SI04	The changes are superficial (codes and names but not boundary changes) and so *there are no real inconsistencies to deal with.*
UK	UKI1*, UKI2* UKD2 UKD5	UKI3-I4, UKI5-I7 UKD6 UKD7	Cambridge Econometrics maintain an ONS-compatible UK local authority level database which can be used to construct the necessary spatial-sectoral-temporal configuration. However, for the purposes of this study it was decided to use the NUTS 2006/2010 for UKI and not add the additional split for the London NUTS2 regions.

Sectoral (NACE) classifications

The changes in sector classification concern the shift from NACE Rev 1.1 in the 1995-2007 database to NACE Rev 2 for the 2008-15 data. The shift in definitions is well known and correspondence tables exist[27] along with some papers discussing the issues of matching data (e.g. Perani and Cirillo, 2015).

The main question here is whether a correspondence process is possible, either going forward (i.e. convert NACE Rev 1.1 to NACE Rev 2), or backwards and produce a database with NACE Rev 1.1 definitions. Although Perani and Cirillo (op cit, Figure 1) already have produced a conversion matrix, this is based on Italian employment data which cannot very easily be tested[28] for validity against other countries.

[27] See http://ec.europa.eu/eurostat/web/nace-rev2/correspondence_tables

[28] Detailed micro data for all Member States in the sample would be required.

For this reason, an alternative process was chosen based on matching sectors which have the closest degree of correspondence between the NACE versions[29]. A degree of correspondence of 80% or above was considered sufficient enough for this purpose.

Table 3.6 shows the two-way degree of correspondence across the sectors that could potentially be covered using the SBS data. Those sectors shaded red are the ones with two-way correspondence of 80% or above. Two further (transport-related) sectors[30] are shaded orange as, even though they do not meet the correspondence threshold, they are considered interesting from an EU-integration perspective to warrant taking forward. It should be noted, however, that a high degree of correspondence is no guarantee of sufficient data being available to mean they will be included in the subsequent empirical analysis.

Further filling-in mechanisms

Based on the coverage of the SBS databases, it will not be sufficient to simply put them alongside one another, post-region/sector classification sorting, and to then undertake the analysis. Further filling is required to make the database more complete across time, space and sector.

NSO data

Table 3.4 provided a summary of communications with, and data received from, the various NSOs for the sample of Member States being covered in the analysis. Following the joining of the SBS databases, supplementary data that have been obtained from the NSOs (i.e. for Belgium, Greece, Spain and the UK[31]) have been assessed against this to see if it can provide a useful role in bridging gaps or pushing data forward and back, all the while seeking to maintain consistency with the original data.

Interpolation and extrapolation

Interpolation involves filling in gaps between known values whereas extrapolation is pushing the data forwards or back time. Both can help to improve coverage of the database, but there are costs to using 'estimated' data because (a) there is certain to be some degree of error involved, which ideally we would like to be random, and (b) there is a risk that the method of filling data may affect the quality (and therefore usefulness) of the resulting database for subsequently calculating indicators of specialisation, concentration and agglomeration. An example would be if, to extrapolate a set of industries within a region going forward, fixed shares from the last year of actual data were imposed – such a technique would clearly mean that the method of filling would influence the conclusions drawn from the indicators of specialisation, etc.

[29] Using this product conversion matrix this way means assuming that all products have equal economic weight, which is naturally an approximation but all that can be done in the circumstances.

[30] For Manufacture of motor vehicles, trailers and semi-trailers, and for Manufacture of other transport equipment, it was also felt that the product % rule gave undue weight to smaller sectors, although this could not be tested due to lack of data. Given the slightly lower correspondence however, the findings from the empirical analysis will be weighted accordingly due to the higher degree of uncertainty over comparison across periods.

[31] As previously mentioned, local area sector data for the UK come from Cambridge Econometrics, although they are based on original ONS sources.

Table 3.6: NACE Revision Sectoral Correspondence

Rev 1.1	Sector Name	Rev 2	Sector Name	Share of Rev 1.1 in Rev 2 sector	Share of Rev 2 in Rev 1.1 sector
DA	Manufacture of food products, beverages and tobacco	C10, C11	Manufacture of food products; Manufacture of beverages[32]	0.96	0.99[33]
DD	Manufacture of wood and wood products	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.89	0.94
DE21	Manufacture of pulp, paper and paper products	C17	Manufacture of paper and paper products	0.90	0.95
DE22	Publishing, printing and reproduction of recorded media	C18, J58	Printing and reproduction of recorded media; Publishing activities	0.86	0.69
DF	Manufacture of coke, refined petroleum products and nuclear fuel	C19	Manufacture of coke and refined petroleum products	0.61	0.81
DG	Manufacture of chemicals, chemical products and man-made fibres	C20, C21	Manufacture of chemicals and chemical products; Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.92	0.96

[32] The quality of data within the NACE Rev 2 sector C12 (tobacco products) was considered too poor to include in the calculations, while the aggregate sector (food, beverages and tobacco) also did not exist at all. So although there is not complete correspondence between the Rev 1.1 and Rev 2 classifications, it was decided (because tobacco is a relatively small sector) that this would not greatly affect subsequent calculations.

[33] In the correspondence table the Nace Rev 2 relates to food, beverages and tobacco, and not just food and beverages.

Rev 1.1	Sector Name	Rev 2	Sector Name	Share of Rev 1.1 in Rev 2 sector	Share of Rev 2 in Rev 1.1 sector
DH	Manufacture of rubber and plastic products	C22	Manufacture of rubber and plastic products	0.83	0.84
DI	Manufacture of other non-metallic mineral products	C23	Manufacture of other non-metallic mineral products	0.91	0.97
DJ27	Manufacture of basic metals	C24	Manufacture of basic metals	0.88	0.97
DJ28	Manufacture of fabricated metal products, except machinery and equipment	C25	Manufacture of fabricated metal products, except machinery and equipment	0.58	0.84
DK	Manufacture of machinery and equipment n.e.c.	C28	Manufacture of machinery and equipment n.e.c.	0.71	0.88
DL	Manufacture of electrical and optical equipment	C26, C27	Manufacture of computer, electronic and optical products; Manufacture of electrical equipment	0.64	0.86
DM34	Manufacture of motor vehicles, trailers and semi-trailers	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.70	0.72
DM35	Manufacture of other transport equipment	C30	Manufacture of other transport equipment	0.74	0.86
DN	Manufacturing n.e.c.	C31, C32, C33	Manufacture of furniture; Other manufacturing; Repair and installation of machinery and equipment	0.71	0.32
G50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	0.96	1.00

Rev 1.1	Sector Name	Rev 2	Sector Name	Share of Rev 1.1 in Rev 2 sector	Share of Rev 2 in Rev 1.1 sector
G51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	G46	Wholesale trade, except of motor vehicles and motorcycles	0.97	1.00
G52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	G47	Retail trade, except of motor vehicles and motorcycles	0.91	0.99
H	Hotels and restaurants	I	Accommodation and food service activities	1.00	1.00
I60	Land transport; transport via pipelines	H49	Land transport and transport via pipelines	0.98	1.00
I61	Water transport	H50	Water transport	0.93	1.00
I62	Air transport	H51	Air transport	0.93	1.00
I63	Supporting and auxiliary transport activities; activities of travel agencies	H52	Warehousing and support activities for transportation	0.62	0.81
I64	Post and telecommunications	H53, J61	Postal and courier activities; Telecommunications	0.99	1.00
K70	Real estate activities	L68	Real estate activities	0.48	1.00
K73	Research and development	M72	Scientific research and development	1.00	1.00

Interpolation is therefore less 'risky' than extrapolation, because there are known/actual datapoints with which to anchor the data. This can take place using adding constraints across space (total NUTS2 should sum to NUTS1) or activity (sub-sectors must add to a Section total).

With extrapolation, higher-level data can also be used, for example if NUTS2 sector data are missing but NUTS1 or Member State level detail are available they can be used as adding-up constraints or guides for how development is occurring. As mentioned, however, given the purpose for which the data are to be used, care needs to be taken in how these methods are applied and sensitivity testing undertaken to see how the techniques might affect end results.

A final point worth noting is that some of the filling techniques were required also at the reclassification stage. The reason for this is that the move from NACE Rev 2 to NACE Rev 1.1 only works if the sectors are complete, otherwise incomplete proportions will be reallocated and the resulting series will not match one another.

BvD combined with aggregate national-regional databases

Accessing firm-level databases

The other option to consider is the use of firm-level databases, which can be aggregated to appropriate NUTS and NACE classifications. To avoid disclosure issues, proportional share can be calculated and applied to more aggregated / robust datasets and thus create employment levels.

- For each Member State

These exist for most Member States as business register databases which record information on firms liable for value-added taxation (and thus they exclude small enterprises but do cover the vast majority of the population of firms). Examples of these databases are the LISA database (the Netherlands), and for Germany through the Forschungsdatenzentrum (FDZ). However, the lengthy application process and general difficult in gaining access and required learning and processing time meant that this was not a viable option for the current project, although there have been attempts in the past to do this which could be explored as part of further research[34].

As mentioned previously however, the project team were able to assemble two complete Member States databases. Firstly, for the Netherlands, where an aggregated version of the LISA database has been provided by Prof Frank van Ort. Secondly for the UK, where Cambridge Econometrics have aggregated their detailed sector-local area database to NUTS2 classifications.

- Pan-European

The BvD database presents another possibility for remaining Member States. Some of the drawbacks (sample size, sector proportions) of the BvD database were examined earlier in the chapter. The remaining part of this section examines more closely the degree of correspondence of sector-region

[34] See, for example, the MICRODYN FP7 project: http://www.case-research.eu/en/microdyn-competitiveness-in-the-knowledge-based-economy. The project's own website (www.micro-dyn.eu) is no longer operational.

proportions, particularly for NL and UK where a reliable and complete data comparison exists (in the form of the LISA and CE local area database, respectively).

In respect of calculating and applying sector-region proportions, there are two options:

(i) Calculating sub-sector shares which can be applied the CE European Regional database, which provides a long time series of 6-sector regional (NUTS2) data for all Member States. This means that for each of the 6 CE sectors (for each NUTS2 region), the sub-sector proportions within this can be calculated and applied to create employment levels.

(ii) As an alternative, for any detailed sub-sector at national level, the regional proportions can be calculated from the BvD data and applied to the national accounts data, again creating the necessary employment levels.

Both techniques are valid but rely on different distributional properties of the BvD data, both across space, activity, and time – properties which can only be tested empirically.

Creating and testing sector proportions

The data extracted from the BvD has been re-proportioned so that they represent, for each available year, the region-sector employment shares within each of the three aggregate sectors from the CE regional data. These are then the proportions which can be applied to create levels of sector-region employment over time. However, before this occurs, a further round of robustness testing has been undertaken to compare the sector-region shares with those for the Netherlands and the UK (using the LISA and CE local area data).

- Robustness testing

The following sub-section reports on robustness testing of the BvD database to check how employment proportions and trends seem when compared to the LISA and SBS databases. This has already been done previously at national level. Here, the comparison is at regional-sector level to see whether the same issues tend to occur. This is only possible for NL and UK, however, as these are the countries for which consistent and detailed region-sector data exist[35].

For the purposes of assessing the robustness of the BvD database, three years (1996[36], 2005, and 2015) were chosen to assess the degree and quality of coverage. In addition, subsectors within manufacturing (Section C), and services - Wholesale and Retail (Section G), Transport and Storage (Section H), Food and Accommodation (Section I) and Information and Communication (Section J) - are compared for similarity of employment shares, as it is this (rather than levels of employment per se) that are important for assessing robustness of the data source. Missing values (within the BvD, of which there are quite a few in the earlier periods) were not included in the calculations.

[35] The SBS was considered as a comparison for other Member States, but the different sampling, regional and sector definitions described previously would make this a highly uncertain exercise.

[36] Although the BvD extraction is from 1995, the LISA database begins in 1996.

Figures 3.8 and 3.9 summarise the position for the Netherlands and UK respectively, within individual subsectors categorized (but not named as there are too many in most circumstances).

- NL comparison
  - Within the manufacturing section, there is some evidence of grouping (whereby some BvD subsectors are consistently over or under-represented compared to the LISA proportions). Often these are small sectors (such as Manufacturing of other products nec) but the largest differences are for the manufacture of Coke and petroleum products (which are likely to be located for particular reasons). The situation improves somewhat as the time period becomes more recent, with the 2015 snapshot more centred around the 45-degree line than in earlier years, but the clustering largely remains.
  - For services, the situation seems much improved. With fewer sub-sectors the groupings are more evident but the clustering is more consistent and centred around the 45 degree line. There is clear improvement between the 1995 and 2005 period.
  - For FBS, there is clear over-representation of Financial services (except insurance and pension funding) which was already apparent from the national accounts comparisons previously analysed. Over-representation in one sector will naturally affect the proportions of other sub-sectors, although employment agencies seem to also be increasingly over-represented as time moves on (again, as highlighted in the previous national accounts charts).
- UK comparison
  - For manufacturing there are many missing values in the 1995 period, which results in a rather extreme picture in Figure 3.9 where the main sector with values is Pharmaceuticals. Rather worryingly, this situation does not seem to improve when moving to more recent time periods.
  - A similar position is noted with the services sub-sectors, although there are fewer missing values. What seems to be happening is a broadly consistent proportion across the UK NUTS2 regions within the BvD data, which is then spread out when compared to the CE local data. This position improves a little over time, but the lines of subsectors are still very much evident.
  - Within the FBS sector, more sub-sector lines are evident as with the services sector. This seems to be symptomatic of consistent shares, especially for Business Support Services which has the highest proportion within the BvD data, followed by the Finance & Insurance subsector. This situation does not seem to improve much over time, but rather become more entrenched.

Creating and testing regional proportions

In a process analogous to the sector proportion analysis, the data extracted from the BvD was re-proportioned for three sample years (1996, 2005, 2015) to create region shares of the most important (i.e. well-represented in sampling terms) sub-sectors for each of the three aggregate sectors from the CE regional data. These proportions are then compared again the equivalent calculations from the Netherlands and the UK (using the LISA and CE local area data, respectively). Figure 3.10 visualises the findings.

- NL comparison

The results perform very well across all the sub-sectors (Manufacture of fabricated metal products, except machinery and equipment; Wholesale trade (no motor vehicles and motorcycles); and Financial institutions, except insurance and pension funding). Region proportions are close to the 45-degree line and show little sign of change across the three sample years.

3.4 Findings and conclusions

Data quality and robustness

National-sector export data

The quality and robustness of the export data are considered very good and fit for purpose.

National-sector-region employment data

It is evident from the previous analysis that the combination of SBS databases and NSO supplementary information is insufficient to create a consistent database across all time period. There are too many missing data in the early years to undertake extrapolation without risking the quality of the database.

In addition, the BvD data alone are not of sufficient robustness to deal with all Member States/regions/sectors/time periods due to sample sizes and coverage.

An alternative strategy was therefore required.

Moving forward

Selected periods rather than a time series

The combination of SBS-ONS data cover more Member States than the BVD data over a longer time period but do have issues on time coverage in early periods, as well as limitations on sector consistency and completeness. So although the SBS data cannot be used for all time periods, a selection of years and sectors could be made which are sufficient to undertake empirical analysis. It has been proposed that these years should be 2003, 2007, 2011, and 2015.

Matching sectors across NACE revisions

The process of matching sectors was discussed and, in particular, Table 3.7 showed that 16 sectors met the correspondence matching criteria, with a further two transport-related sectors given further consideration for their importance and links to the EU integration process.

Data completion method

To fill-in any remaining gaps, the following ‘algorithm’ has been adopted:

1. For any given year (ie 2003, 2007, 2011 or 2015), Identify which sectors/regions the data need to be completed for.
2. Do the data exist through NSO sources? If so complete with this.
3. If not, do the SBS data exist for adjacent years (eg 2002 or 2004 for the 2003 period)?
4. If yes, test these regional proportions against equivalent BvD data. If proportions match well enough then use BvD proportions for year in question. If proportions don’t match then just use adjacent year shares from SBS.
5. If data do not exist for adjacent years find closest year and repeat 3-5, except use a linear trend to calculate the appropriate SBS share.

6. If there are no SBS data at the NUTS2 level, consider the option of moving up to NUTS1 level if these data exist, as a way of maintaining the sample of Member States as consistent as possible.

7. Always ensure that regional totals scale to the national.

Further round of sector trimming

During this process of filling out, it became evident that additional sectors would need to be removed as there was either not sufficient data from the SBS and/or insufficient data from the BvD to fill in any remaining gaps. This was unfortunate, but it was felt that maintaining data quality was of paramount importance and otherwise there was a risk that the filling process might unduly influence the findings from subsequent sectoral and spatial analysis. The sectors in Table 3.7 are those that remain in the process[37].

Final sample of Member States

Matching the definitions thus allows a sub-set of sectors to be analysed which mostly crossover between the two datasets. There is, however, one other complicating factor which is the coverage across Member States. From preceding analysis we know that Denmark does not have regional data publicly available before 2008, while for Slovenia no data exist before 2007. In addition, Estonia is only a single region.

Therefore, if the SBS sample is to be restricted to sectors which match across the NACE revisions **and** which cover countries which exist for all four periods **and** have regional data, the sample of Member States covered would be narrowed to the final set of 13 countries: Austria, Belgium, France, Germany, Greece, Hungary, Italy, the Netherlands, Poland, Slovakia, Spain, Sweden, and the UK. Table 3.8 provides a % coverage of EU employment across each final selected sector.

Exclusion or replacement of some smaller regions

Some small regions were removed from the country totals as data were missing and it was not possible to fill them in from other sources. This was considered a better option than removing the entire country, particularly as this issue occurs mostly within Spain and France which are large Member States that are important for the analysis. Specifically:

- For all sectors, all FRA NUTS 2 regions (Départements d'Outre-Mer), and ES63 (Ceuta) and ES64 (Melilla) for Spain.

Further, for two sectors, the NUTS2 data were replaced by NUTS1 aggregates to avoid their removal from the analysis (given the size/importance of the Member States concerned).

- For the Manufacture of basic metals, French regions (FR81, FR82, FR83: Languedoc-Roussillon, Provence-Alpes-Côte d'Azur, Corsica) were replaced by the FR8 aggregate.

- For Manufacture of paper and paper products, AT11, AT12, AT13 (Burgenland, Niederösterreich, and Wien) were replaced by the AT1 aggregate, as were the FR81-83 NUTS2 regions for France.

[37] In particular, it should be noted that the two transport-related sectors highlighted previously in Table 3.2 did not make it through this data filling process. For both of these sectors, missing data at NUTS2 level could not be substituted at NUTS1 level due to further missing data for regions in France, Germany, and Greece.

Table 3.7: Final Sector Selection (sufficient NACE correspondence and with good country coverage)

Rev 1.1	Sector Name	Rev 2	Sector Name	Share of Rev 1.1 in Rev 2 sector	Share of Rev 2 in Rev 1.1 sector
DA	Manufacture of food products, beverages and tobacco	C10, C11	Manufacture of food products; Manufacture of beverages	0.96	0.99
DD	Manufacture of wood and wood products	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.89	0.94
DE21	Manufacture of pulp, paper and paper products	C17	Manufacture of paper and paper products	0.90	0.95
DH	Manufacture of rubber and plastic products	C22	Manufacture of rubber and plastic products	0.83	0.84
DI	Manufacture of other non-metallic mineral products	C23	Manufacture of other non-metallic mineral products	0.91	0.97
DJ27	Manufacture of basic metals	C24	Manufacture of basic metals	0.88	0.97
G50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles	0.96	1.00
G51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	G46	Wholesale trade, except of motor vehicles and motorcycles	0.97	1.00

Rev 1.1	Sector Name	Rev 2	Sector Name	Share of Rev 1.1 in Rev 2 sector	Share of Rev 2 in Rev 1.1 sector
G52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	G47	Retail trade, except of motor vehicles and motorcycles	0.91	0.99
H	Hotels and restaurants	I	Accommodation and food service activities	1.00	1.00
I60	Land transport; transport via pipelines	H49	Land transport and transport via pipelines	0.98	1.00
K73	Research and development	M72	Scientific research and development	1.00	1.00

Table 3.8: EU Employment Coverage by Selected Sector

NACE Rev 2 Sector	Member State Sample EU Share in 2015 (%)
C10, C11 - Manufacture of food products; Manufacture of beverages	82
C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	71
C17 - Manufacture of paper and paper products	84
C22 - Manufacture of rubber and plastic products	83
C23 - Manufacture of other non-metallic mineral products	80
C24 - Manufacture of basic metals	85[38]
G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles	85
G46 - Wholesale trade, except of motor vehicles and motorcycles	84
G47 - Retail trade, except of motor vehicles and motorcycles	86
I - Accommodation and food service activities	88
H49 - Land transport and transport via pipelines	81
M72 - Scientific research and development	89

Databases for assessment

The result of the work described above is a dataset contained in an Excel database accompanying this report. The data are as follows:

National-sector exports

This excel files are largely a re-configuration of information extracted from the STAN and WIOD databases, with some limited treatment of missing data. Following an introductory page, the data are sorted by country tabs, with each country having sector x time information. Along with export values (in $), national export shares are also included to allow for consistency checking.

Some minimal filling in of data has been necessary, and two flags have been put alongside the data to identify this:

- a: no data available;
- b: missing data have been replaced with zeros, as in the vast majority of cases this is most likely the case.

National-region-sector employment

For these data, recorded as both levels and national shares, a more elaborate flag system has been devised to reflect the fact that the original SBS data were not as good in terms of coverage and alternative sources and techniques were required to arrive at a complete set of data.

- a: LISA (NL) or CE (UK) data shares used;

[38] There was no EU total for this sector in 2015, so the proportion for 2011 is shown instead.

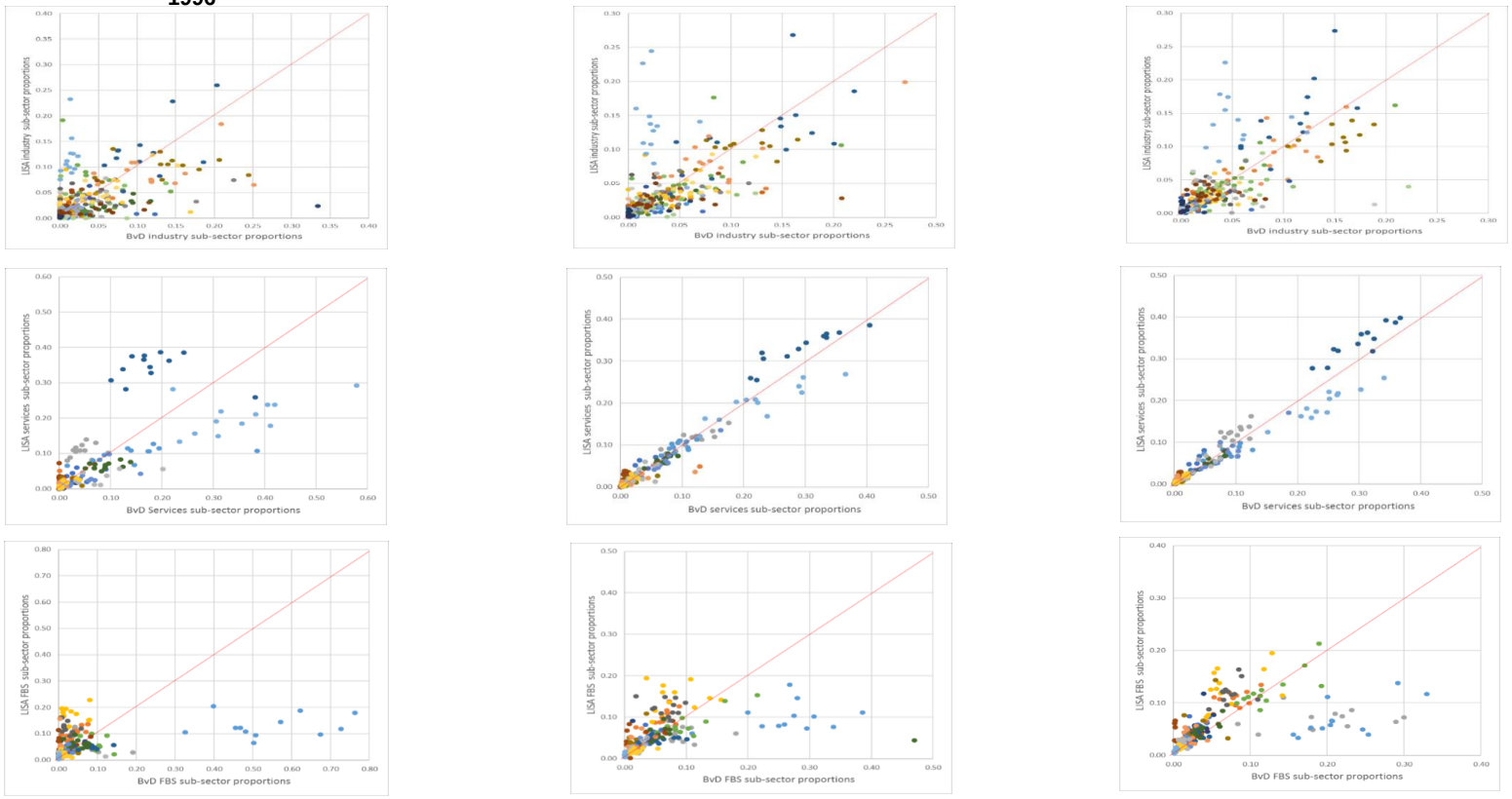
- b: filled with SBS share interpolated from adjacent periods;
- c: filled with BvD share;
- d: filled by subtracting the total of all other regions from the national total;
- e: no NUTS 2 data available, substitute with NUTS 1 data.

In both the export and employment data, no flag implies original data.K

2005 **2015**

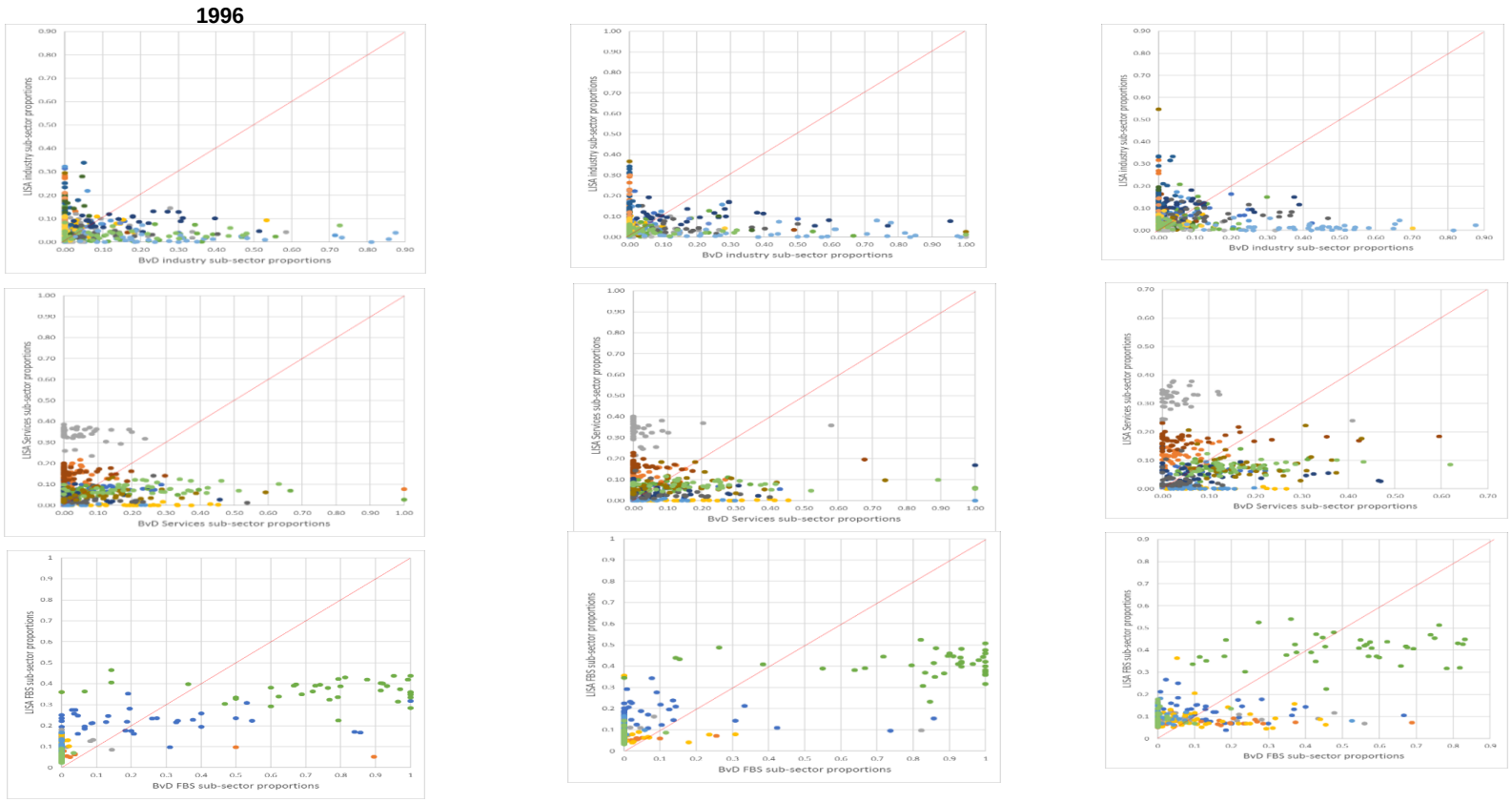
Figure 3.8: BvD (NL) vs LISA (NL) sector-region proportions

1996



Note: Shares are calculated as proportions of the aggregate sector.
Source: BvD database, LISA database, CE calculations.

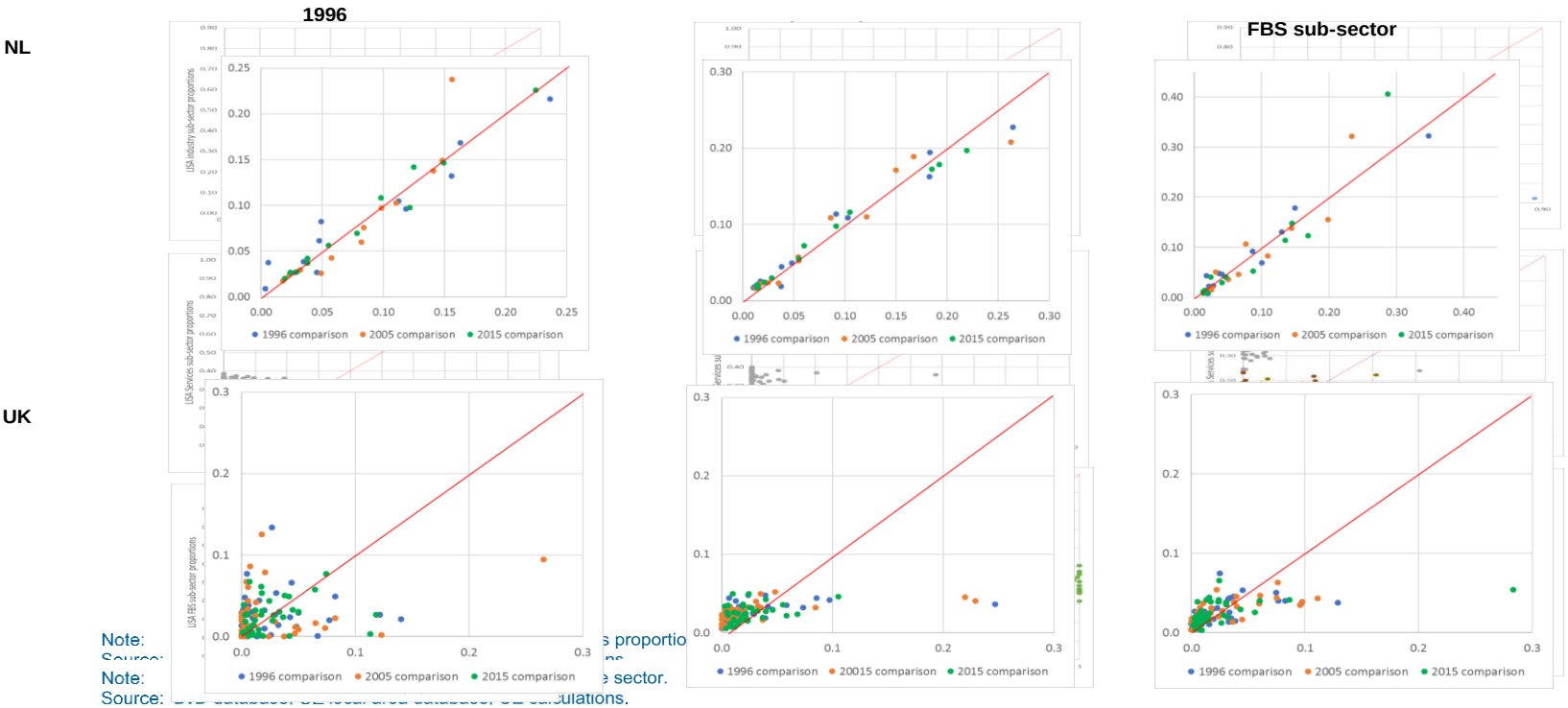
Figure 3.9: BvD (UK) vs CE (UK) sector-region proportions



Note: Shares are calculated as proportions of the aggregate sector.
Source: BvD database, CE local area database, CE calculations.

Figure 3.10: BvD vs LISA (NL) and CE (UK) regional sub-sector proportions

Figure 3.9: BvD (UK) vs CE (UK) sector-region proportions



Note: s proportio

Source: ns

Note: e sector.

Source: BvD database; CE local area database; CE calculations.

- UK comparison

Here the results are not so promising. For all three sub-sectors (Pharmaceuticals; Land transport; and Business support services) the proportions do not seem comparable and this casts serious doubt on the usefulness of the regional proportions application method.

4 Sector Specialisation and Geographical Concentration

4.1 Introduction

This chapter revisits the implications from economic theory of how economic integration could affect sector specialisation and geographical concentration, while also summarising the findings from the literature which have already looked at this issue (particularly across Europe). It reports on the measurement of sector specialisation, namely the Balassa indices of revealed comparative advantage and the Theil indices. Findings are presented and discussed in the context of the theory and previous literature. Finally, it reports on the measurement of geographical concentration, namely through the Theil indices discussed in the theoretical report which are the counterpart of the sector specialisation measures. Findings are presented and discussed in the context of the theory and previous literature.

4.2 Implications from Theory and Findings of Previous Studies

Re-cap on theory and implications

Traditional trade theory

According to traditional trade theory, nations – and regions – will tend to specialise in those industries and sectors in which they have a comparative advantage. The latter may be because of certain raw materials and natural resources, because of cheaper labour, or some technical advantage. Trade arises because of the different comparative advantages of nations and regions, and in turn tends to reinforce the patterns of export specialisation among nations and regions according to those comparative advantages. In new trade theory, it is argued that a key source of a nation's comparative advantage in any particular sector is the increasing returns (external economies) that accrue when that sector is spatially agglomerated: or put another way, when that sector is geographically concentrated in one or just a few locations within the country concerned. As we showed in the methodological section (Chapter 2), different combinations of spatial concentration, agglomeration and speciation are possible among a group of multi-region nations.

New Economic Geography

The key point is that the assumption is that, other things being equal, the removal or lessening of barriers to trade among countries should promote greater specialisation among those countries and among their regions. This was the argument advanced in relation to the European Union by Paul Krugman in his fusion of new trade theory and the New Economic Geography. According to the New Economic Geography, the spatial distribution of economic activity is the outcome of a tension between spatial agglomeration forces on the one hand, and spatial dispersion forces on the other, with both dependent on the level of trade costs. In most NEG models the dispersion force is assumed to be stronger than agglomeration forces when trade is closed: as trade openness increases, the dispersion force is weakened relative to the agglomeration force. Under this theory, therefore, removal of

trade barriers and the lowering of trade costs should lead both to the geographical concentration of economic activity between regions, and as part of this process to increased regional specialisation, reflecting the inherent (and initial) comparative advantage of different regions in different industries. Following this line of reasoning, Krugman's hypothesis was that as the EU became increasingly integrated, so it would be characterised by greater regional specialisation. However, at the same time, increased regional specialisation across the EU would expose regions to increased region-specific (idiosyncratic) shocks. Further, given increased specialisation and region-specific, increased factor mobility - also aided by the integration process - both labour and capital are likely to move to and concentrate in those regions in which economic activity is already concentrated, agglomeration economies are greater, and productivity is higher. As a result, integration could possibly lead to greater disparity in regional growth rates across the EU.

From a policy perspective, therefore, regional specialisation is something of a double-edged sword. On the one hand, increased specialisation can promote faster growth because of the economies of localisation and therefore might be focus for policy intervention. But on the other hand, following Krugman's argument, increased regional specialisation could ultimately widen regional growth disparities. Indeed, in the vast literature in economic geography and regional development studies there has long been a debate over the relative merits and demerits of regional economic specialisation versus regional diversification. The evidence on the matter is best described as equivocal. In terms of the EU case, a basic hypothesis from both traditional trade theory and the New Economic Geography variants is that as integration of the EU has progressed, so we should expect to find that both the member states and the regions within them have become more sectorally specialised. We might also hypothesise that this process is likely to have been faster among the more recent Eastern European member states that have joined the EU in recent years, since the core member states have been integrated into a single market for some time.

Functional versus sectoral views on trade

The above line of reasoning is based on a sectoral view of the economy and of trade. But, as we also discussed in the methodology report, over the past few decades, the creation and expansion of global production networks and supply chains has recast the nature of trade, away from sectors to functions or stages in the production process. Advances in technology have driven a mode of production in which the different stages that make up a product, such as a motor vehicle, can be functionally separated and potentially carried out at different locations. Thus, the issue of functional specialisation and its role in trade has attracted attention. In this perspective, countries and regions will tend to specialise in that function, or those functions, in which they have a comparative advantage. Using a broad fourfold division of functions into R&D, management, marketing and fabrication, and using the Balassa export specialisation index, Timmer et al (2018) find some evidence of functional specialisation across countries. For example, high income countries (such as Germany, France, UK) have higher specialisation in R&D, while lower income countries (such as China, Brazil, Mexico, Poland) tend to specialise more in fabrication. This obviously has different policy implications than those founded on specialisation by sector. Timmer et al also find, for the case of China,

evidence that the provinces there also tend to specialise by function. An interesting question, then, is if increasing EU integration leads to greater regional functional specialisation. To answer this question, however, would require detailed data on the occupational composition of export activities, which at present are not available for the European regions. But this approach to trade and regional specialisation is one that would certainly reward future research.

Review of empirical studies

As summarised in Chapter 2, both the theory and the empirical evidence on whether and to what extent increasing economic integration across the EU increases the degree of sectoral specialisation among the Member States and their constituent regions, is not unequivocal. According to traditional trade theories, national and regional specialisation will reflect differences in comparative advantage, whereas new trade theories suggest that national and regional specialisation will be driven by scale economies. In an early paper and using a combination of new trade theory and 'new economic geography' theory, Krugman (1993) suggested that, as the EU became more integrated over time, it would become more akin to the United States, i.e. a more integrated economy where, he argued, there is a higher degree of regional specialisation. In a later commentary however (Krugman, 2006), he took a different view, arguing that in the advanced economies, the era of increasing regional specialisation and geographical concentration of industry had passed, in part because the pull of agglomeration and other such external economies and increasing returns effects had become less pronounced, at least for manufacturing activity.

Country-level studies

Several empirical papers have assessed whether specialisation has increased across the EU over recent decades, though much of this work refers to the 1980s and 1990s and is also at national level. Sapir (1996), for example, uses the Herfindahl index to measure country specialisation across 100 manufacturing industries and concluded that specialisation remained constant over the 1977-1992 period in Germany, Italy and the UK, but increased in France after the mid-1980s. Amiti (1999) used both EUROSTAT data (for 65 manufacturing industries) for Belgium, France, Germany Italy and the UK, and UNIDO data (for 27 manufacturing industries) for the 10 European countries of Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain and the UK over 1968-1990. For both analyses, and using the Gini coefficient as her measure of specialisation, she found that specialisation had increased for most of the countries in her samples. In his study of 32 manufacturing industries across 13 Member States over the 1972-1996 period, and using a variety of measures, Brülhart (2001) found that national employment specialisation had generally increased, not only in traditional resource and labour intensive sectors, but also in technology-intensive industries. However, he also found that specialisation in exports, though higher than in employment, fell over his study period. In other words, while countries appeared to have become more specialised in terms of the sectorial distribution of their manufacturing employment, at the same time they had become more diversified in terms of their manufacturing exports.

Sub-national studies

Unlike the above studies, all of which (mainly for data reasons) were confined to analyses of national level specialisation, Cutrini (2010) used a new version of the Theil Index and Eurostat's Region-SBS (Structural Business Statistics)

data to examine trends in both specialisation and concentration of manufacturing, covering 12 sectors, across some 145 NUTS2 regions for 10 European countries, at three points in time, 1,85,1993 and 2001. Overall, she found a decline in the spatial concentration (geographical localisation) of almost all of the 12 manufacturing activities over these years, and, at the same time, a fall in regional specialisation in almost all countries. In short, her analyses suggest a process of *regional de-agglomeration and regional de-specialisation* of manufacturing activity, and thus run somewhat counter to the cross-*national* findings identified by the above previous studies.

4.3 Results from measures of sector specialisation

Balassa Index of 'Revealed Comparative Advantage'

It will be recalled from Chapter 2 that a standard way of measuring the comparative advantage of a country, in terms of its success in international markets, is by assuming this is 'revealed' by the country's relative specialisation in particular exports. This assumption follows Ricardo's 'law' or principle of comparative advantage which holds that under conditions of free trade an economic agent (such as a nation or a region) will produce more of a good (or service) for which it has an advantage relative to other nations (regions) arising from particular factor endowments and/or technical knowhow that enable the nation (region) to produce that good (or service) more efficiently (at a lower price) or more effectively (at a higher quality). Thus, assuming the law or principle holds, and that international trade is indeed free, then nations (and indeed regions) will tend to specialise in those sectors in which they have a trading advantage compared to other nations (regions). Hence, actual observed patterns of national (and regional) sectoral specialisation are assumed to reflect or 'reveal' (ex post) each nation's (and region's) comparative advantage.

Measuring national (or regional) revealed comparative advantage is usually done using the index developed by Balassa (1965), defined as:

$$BALASSA_{kj} = RCA_{kj} = \left(\frac{X_{kj}}{\sum_j X_{kj}} \Big/ \frac{\sum_k X_{kj}}{\sum_k \sum_j X_{kj}} \right)$$

where X_{kj} is the value of exports by sector k from country (or region) j. To the extent that the European Union has become increasingly integrated over recent decades, and internally has increasingly moved towards a free trade area, then, other things being equal, member states and their regions might be expected to have become increasingly specialised in those sectors of economic activity in which they have a comparative advantage. As discussed, if export data were available for EU regions, the index could be used to measure each region's revealed comparative advantage, i.e. its specialisation in particular export activities, and how this has changed over time.

The Balassa index has the main advantage that it is relatively straightforward to calculate (simply requiring export data) and it is also a relative index which is consistent with the concept of comparative advantage. Certain drawbacks

should be borne in mind when interpreting results, however. For example, the index cannot account for import trade flows, particularly in cases of re-exports where a country both exports and imports large quantities of a good, perhaps by being integrated in an international value chain (and so the actual value added may be low). A related distortion is that the effects of vertical specialisation (where different parts of the value chain are separated and located in different countries) cannot be captured. Recent work such as Gnidchenko and Salnikov (2015) explore these drawbacks in more detail and suggest alternative indices.

Recap on available data

Since export data are not available across EU regions in anything like a comprehensive or consistent way, our analysis here is for the EU member states only. Two data sets are used, the World Input Output Database (WIOD) covering the period 2000-14[39], and the Structural Analysis Database (STAN) compiled by the OECD, which covers the period 1995-2016. The WIOD database covers 64 sectors, although for the analysis this was reduced to 55[40], and the STAN database, which excludes marketable services, covers 33 sectors. Thus, while the WIOD data have a better sectoral coverage, the STAN data provide an analysis over a longer time period. For this reason, both data sets have been used.

Empirical findings

The detailed matrix of Balassa indices for each sector by each Member State using these two data sets are shown as 'heat maps' in Appendix A. To assist in the detection of trends over time in revealed comparative advantage (specialisation), Figures 4.1-4.2 report the average indices for countries, and Figures 4.3-4.4 report the change in the spread (standard deviation) around the average Figures 4.3 and 4.4 look at the same changes across sectors for the start and end years stated above and Figures 4.5 and 4.6 provide the equivalent standard deviation changes.

Findings across countries

Some key features emerge from Figures 4.1 and 4.2.

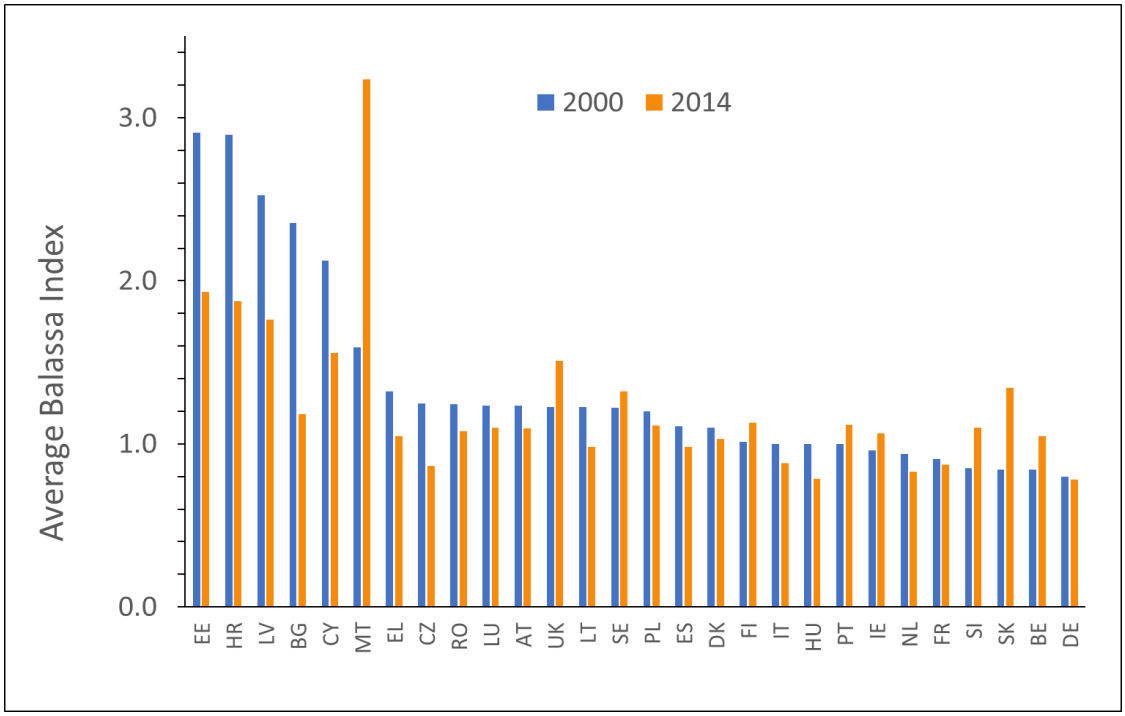
Firstly, export specialisation declined in the majority of EU Member States in both dataset periods, with the decline being especially evident in many of the more-recently acceded Member States (in particular Estonia, Croatia, Latvia, Bulgaria and Cyprus in the STAN data and Cyprus, Poland, Latvia, and the Czech Republic in the more narrowly-defined WIOD data).

By comparing the heat maps across the beginning and end periods in Appendix A, the larger declines in the WIOD data are caused by reductions in the relative export shares in forestry and fishing products, and also in the related sector of wood and wood products (Estonia and Latvia) but also in some public services (particularly public administration and defence, and education).

[39] Another WIOD database also exists for 1995-2011, but this is on a different sectoral classification.

[40] Certain WIOD sectors were excluded from the subsequent analysis as their Balassa values were considered too erratic/unstable, which is often the case with very low export value sectors. A specific rule was adopted whereby sectors with an average share in total EU exports over the 2000-14 period below 0.1% were removed. This led to the following sectors being taken out: CPA_E36 - Natural water; water treatment and supply services; CPA_Q86 - Human health services; CPA_Q87_Q88 - Social work services; CPA_R93 - Sporting services and amusement and recreation services; CPA_S94 - Services furnished by membership organisations; CPA_S95 - Repair services of computers and personal and household goods; CPA_S96 - Other personal services; CPA_T - Services of households as employers; undifferentiated goods and services produced by households for own use; and CPA_U - Services provided by extraterritorial organisations and bodies.

Figure 4.1: Balassa Index Average across EU Member States based on WIOD data



Note: Balassa Index is calculated as a simple arithmetic average of country-sector export shares relative to EU27 total exports of goods and services.
Source: WIOD export data, CE calculations

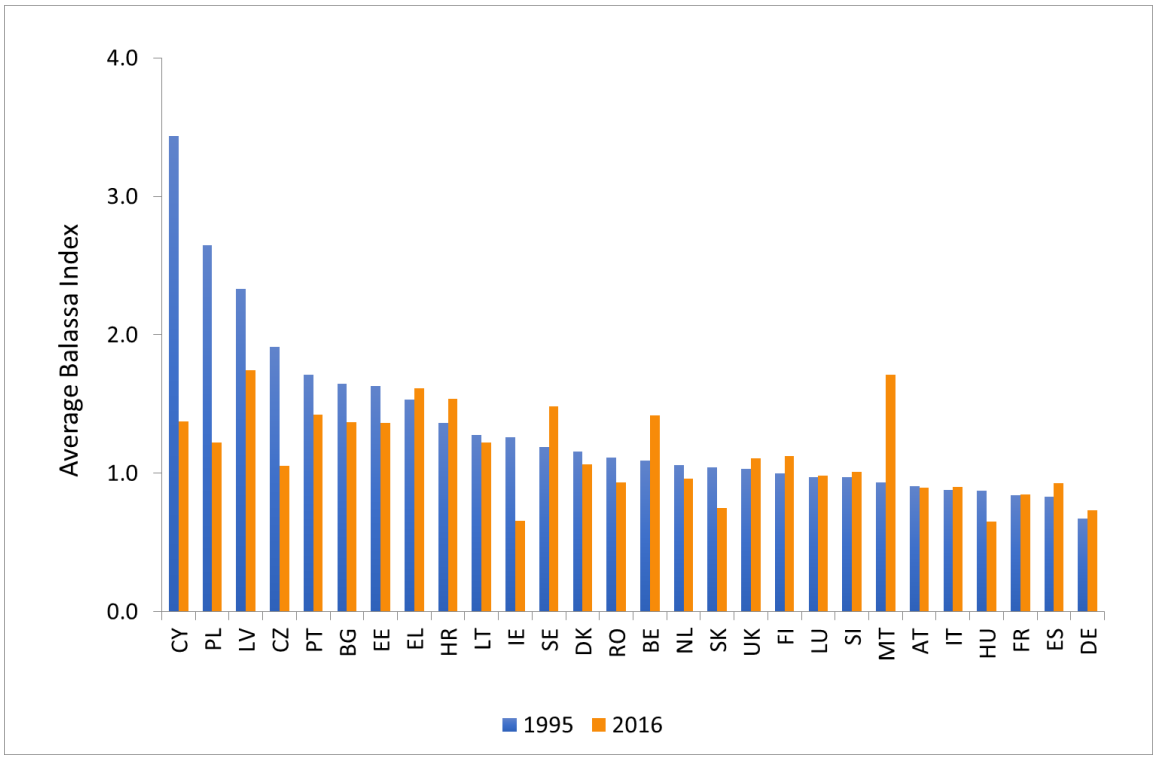
Although there are a few Member States where the Balassa averages increase, by far the most notable case is that of Malta, due (for the WIOD data) to the increase in the sector 'Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services', which covers Malta's rapidly expanding on-line gaming sector, and also in Printing and recording services.

In the STAN data, the increase is mostly driven by increased revealed comparative advantage in Fishing and aquaculture, Printing and reproduction of recorded media, and Coke and refined petroleum products.

The spread of Balassa indices across the broader set of WIOD sectors, as shown in Figure 4.3, also shows some notable declines[41] among the more recently-acceded Member States, with some exceptions (Malta), while Ireland and Slovakia also show large increases. For the tradeable goods sectors in the STAN dataset, the decreases are more uniform although Malta and Belgium stand out as having increased over the 1995-2016 period.

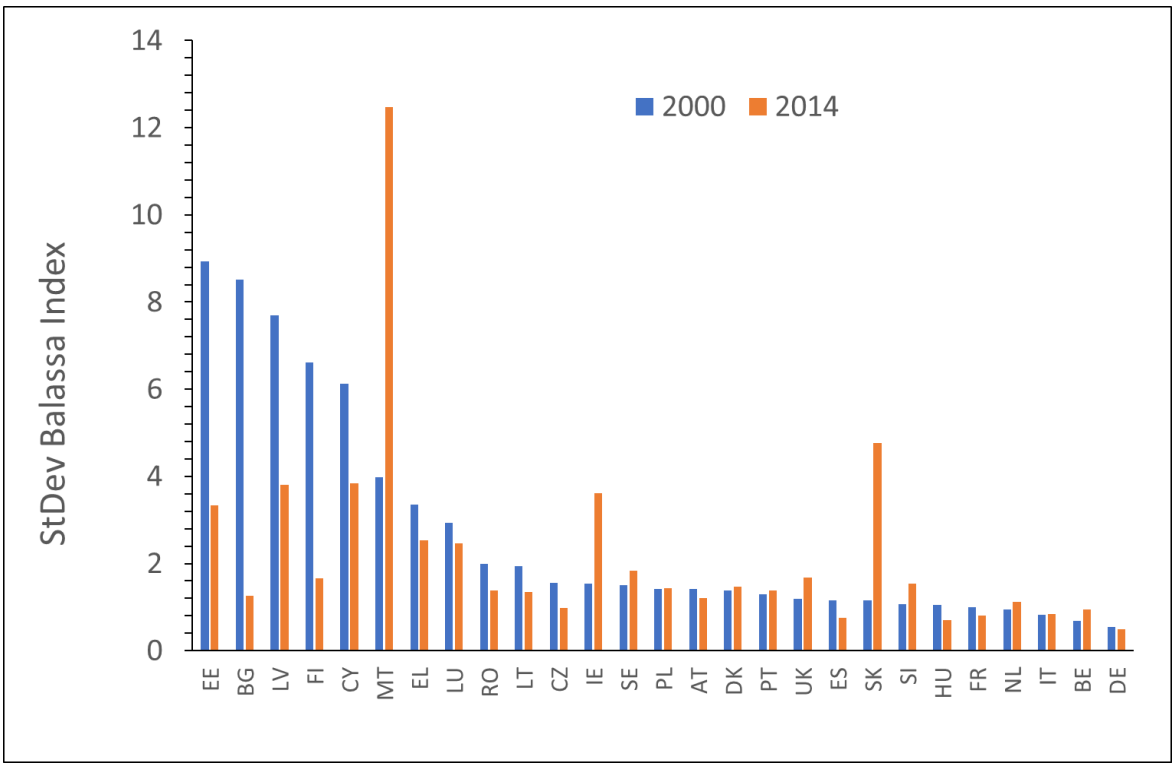
[41] Croatia is not shown as it's Balassa standard deviation decreases from 62.4 to 6.9

Figure 4.2: Balassa Index Average across EU Member States based on STAN data



Note: All sectors included, Balassa Index is calculated as a simple arithmetic average.
Source: STAN export data, CE calculations

Figure 4.3: Balassa Index Standard Deviation across EU Sectors based on WIOD data

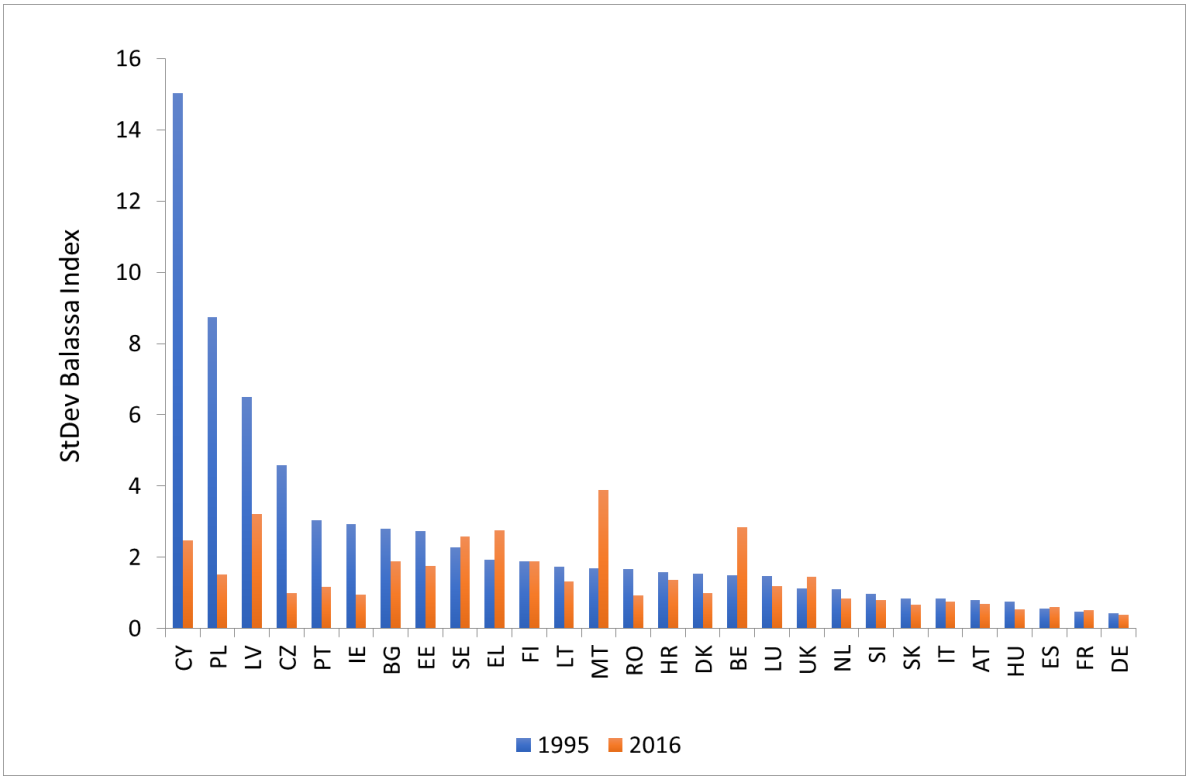


Note: EU27 Member States included in averages (Croatia is excluded)
Source: WIOD export data, CE calculations

The changing pattern across Member States, rather than sectors, is shown in Figures 4.5 and 4.6, as represented by the standard deviation (the average of the Balassa has no meaning when averaged across Member States). On these terms, sectoral specialisations in raw materials and goods across the EU, traditional sectors such as forestry, wood products, and apparel have all become less geographically concentrated between Member States, as have many public services such as health and education.

A few sectors show a marked rise in geographical concentration, including the creative, arts and education (due mostly to the rise in Malta, as mentioned previously) but also printing and recording, and real estate services and energy supply.

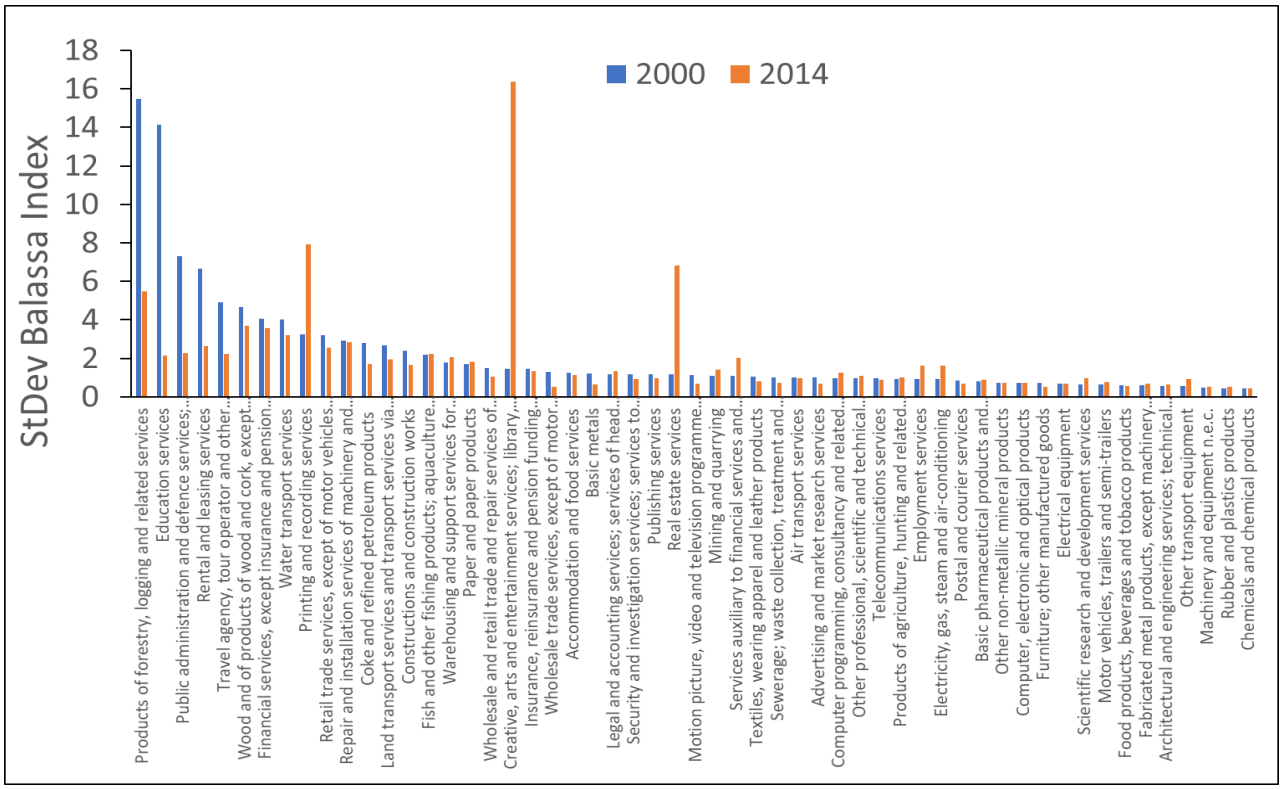
Figure 4.4: Balassa Index Standard Deviation across EU Sectors based on STAN data



Note: EU27 Member States included in averages (Croatia is excluded)
Source: STAN export data, CE calculations

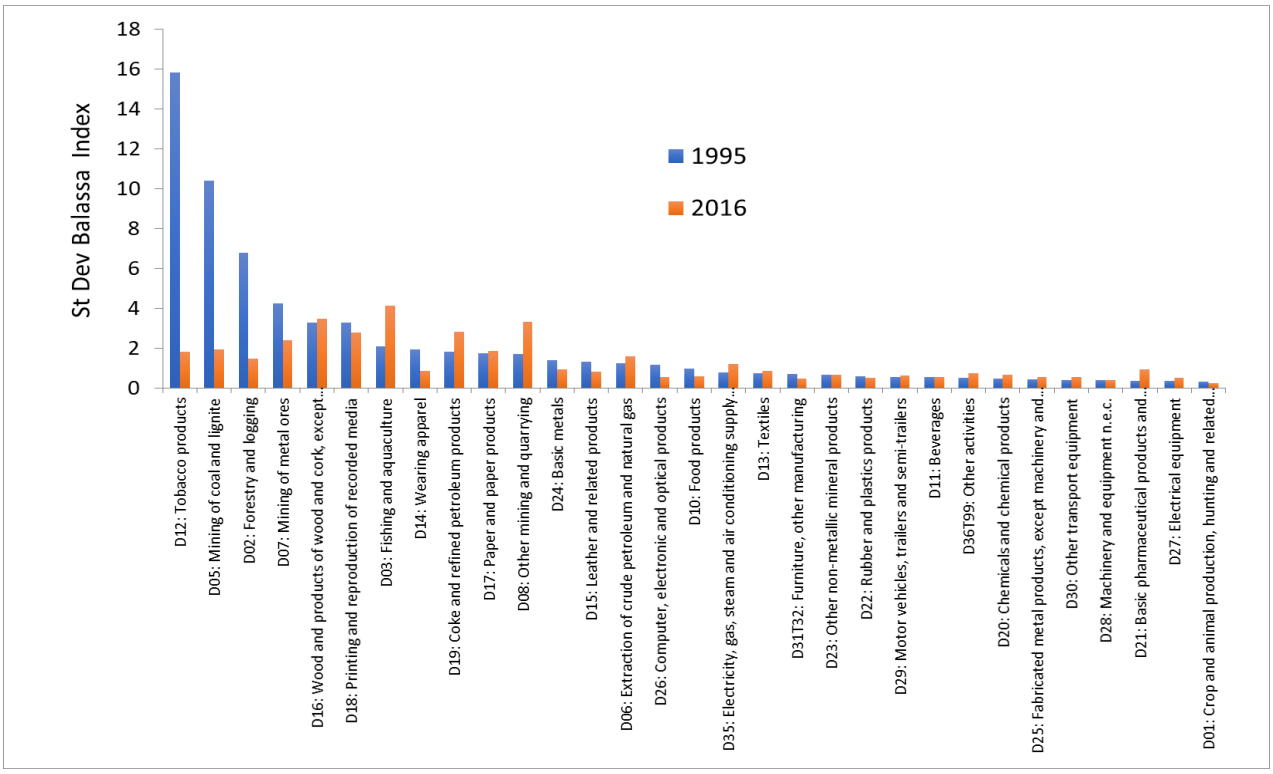
From the tradeable goods focus of the STAN data, extractive sectors such as most of the mining and quarrying sub-sectors have declined along with more traditional manufacturing sectors such as tobacco products, wood products and apparel. Among those showing an increase in concentration are fishing and aquaculture, other mining and quarrying, and coke and petroleum products.

Figure 4.5: Balassa Index Standard Deviation across EU Sectors based on WIOD data



Note: All EU28 Member States included in averages
Source: WIOD export data, CE calculations

Figure 4.6: Balassa Index Standard Deviation across EU Sectors based on STAN data



Note: All EU28 Member States included in averages
Source: STAN export data, CE calculations

Analysis over time (by EU accession)

A final way of looking at the Balassa indices is their evolution over time. Although a comparison has already been done for the beginning and end periods of the data, looking in more detail at the time series is interesting from the perspective of when different Member States acceded to the European Union, and whether any shift in specialisation patterns can be observed / linked to this. Broadly speaking, three cohorts can be identified among Member States:

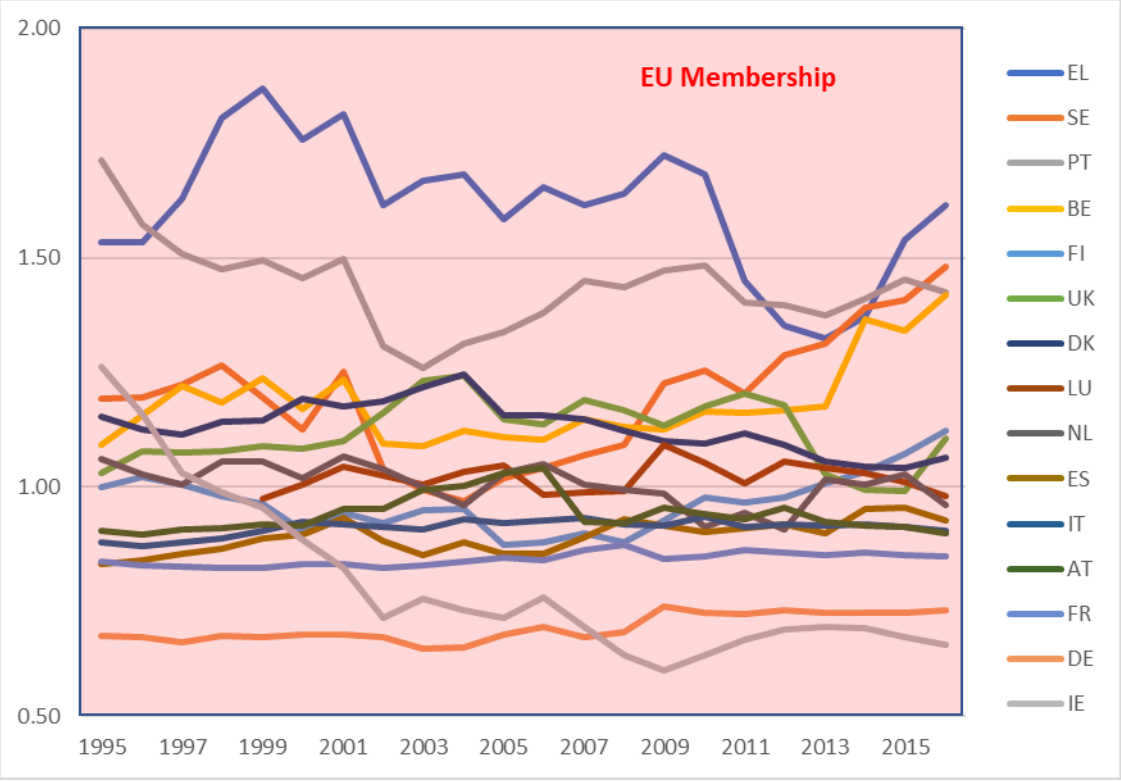
(i) Those which are members for the whole time period: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK.

(ii) Those joining in 2004: the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia.

(iii) Those joining in 2007: Bulgaria and Romania[42].

Figure 4.7 (a-c) shows the movement of the Balassa Index over time for these three cohorts, focussing on the STAN (tradeable goods) database, while Figure 4.8 (a-c) uses the WIOD data (all sectors)

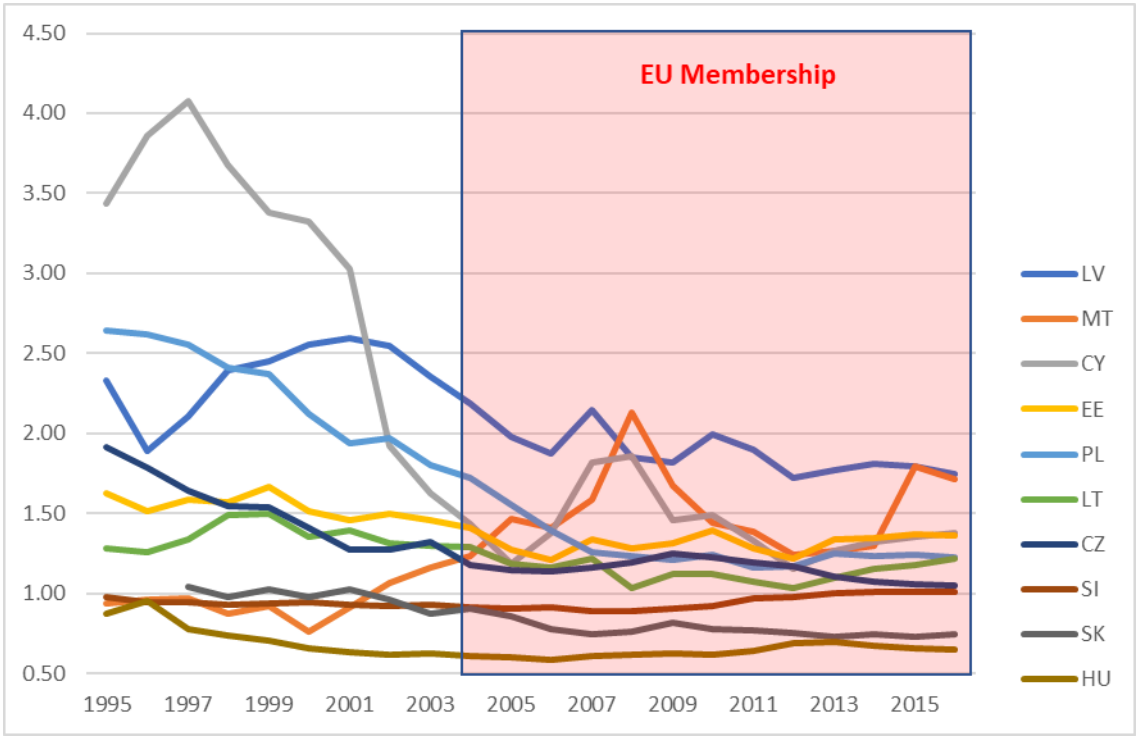
Figure 4.7a: Balassa Index across EU Member States – Cohort 1 (STAN)



Source: STAN export data, CE calculations

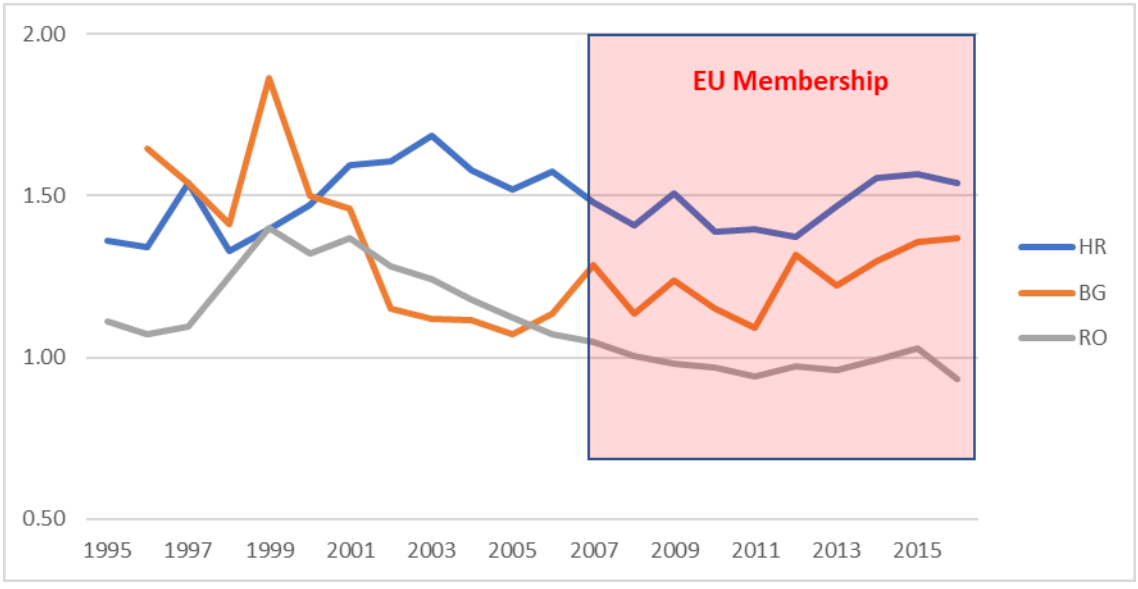
[42] Croatia, although not joining until 2013, is also included in this group.

Figure 4.7b: Balassa Index across EU Member States – Cohort 2 (STAN)



Source: STAN export data, CE calculations

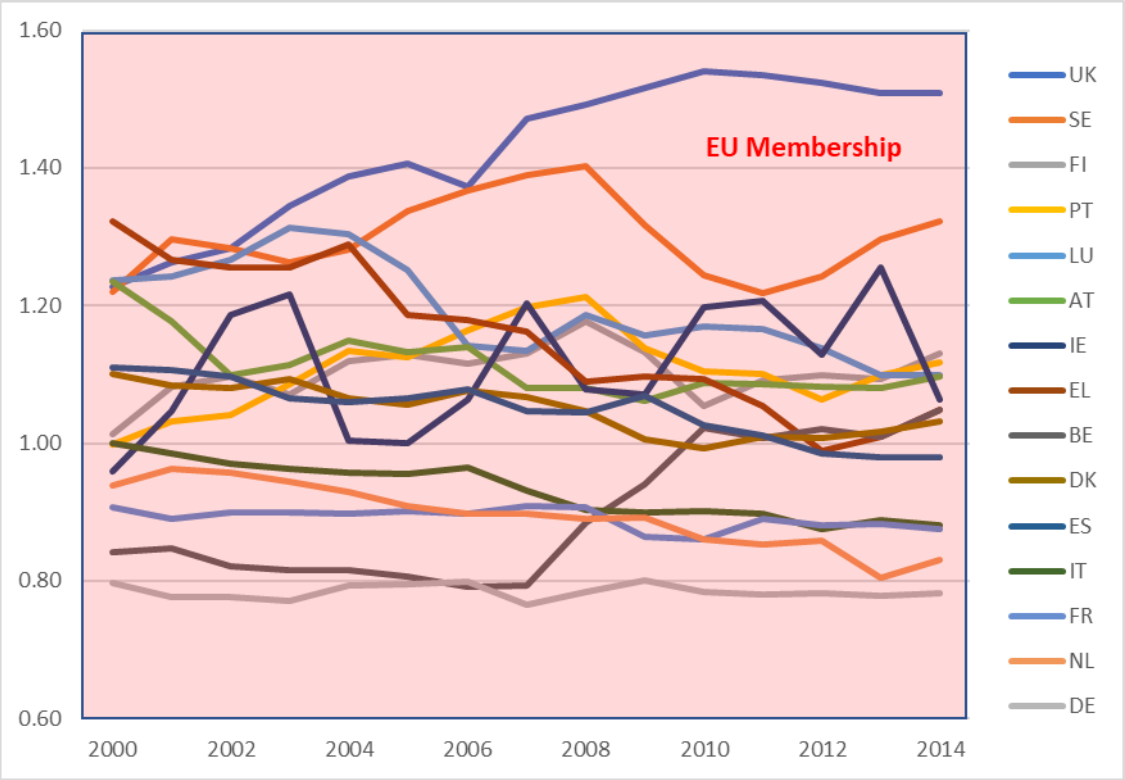
Figure 4.7c: Balassa Index across EU Member States – Cohort 3 (STAN)



Source: STAN export data, CE calculations

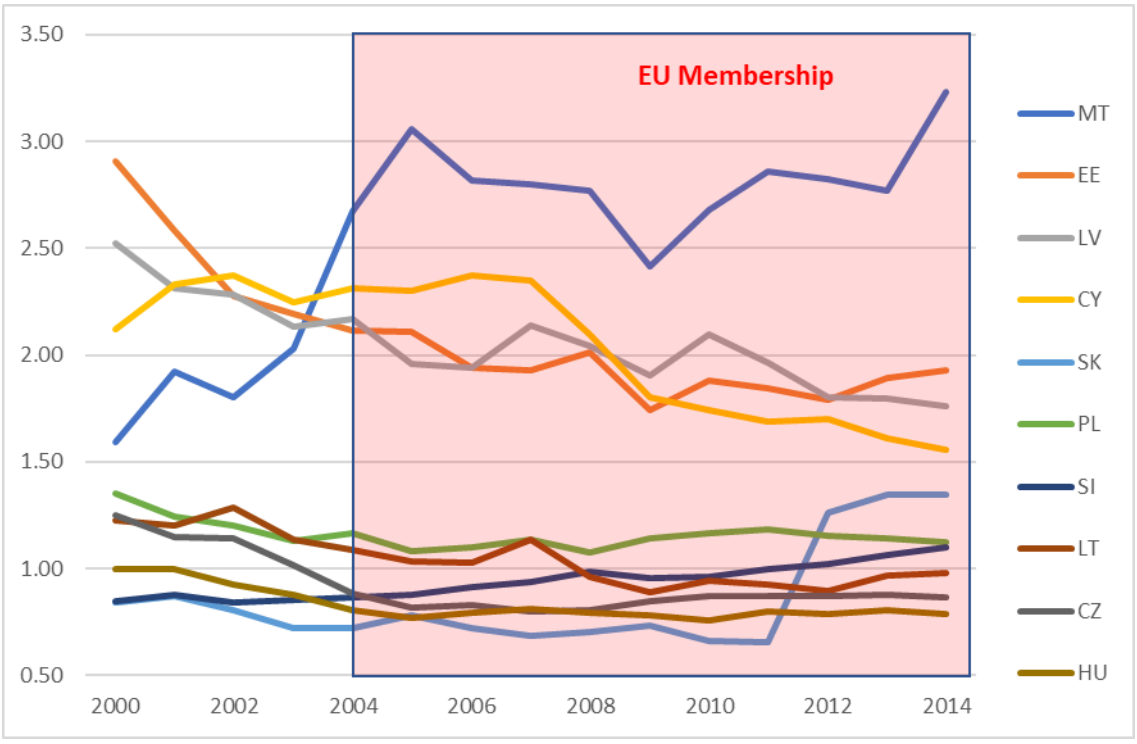
Among the core (EU15) group of Member States, there is a general stability with the exception of Greece and Portugal, for whom the index is quite high and volatile in comparison, while Belgium and Sweden show a marked increase (from 2008 and 2013 respectively).

Figure 4.8a: Balassa Index across EU Member States – Cohort 1 (WIOD)



Source: WIOD export data, CE calculations

Figure 4.8b: Balassa Index across EU Member States – Cohort 2 (WIOD)

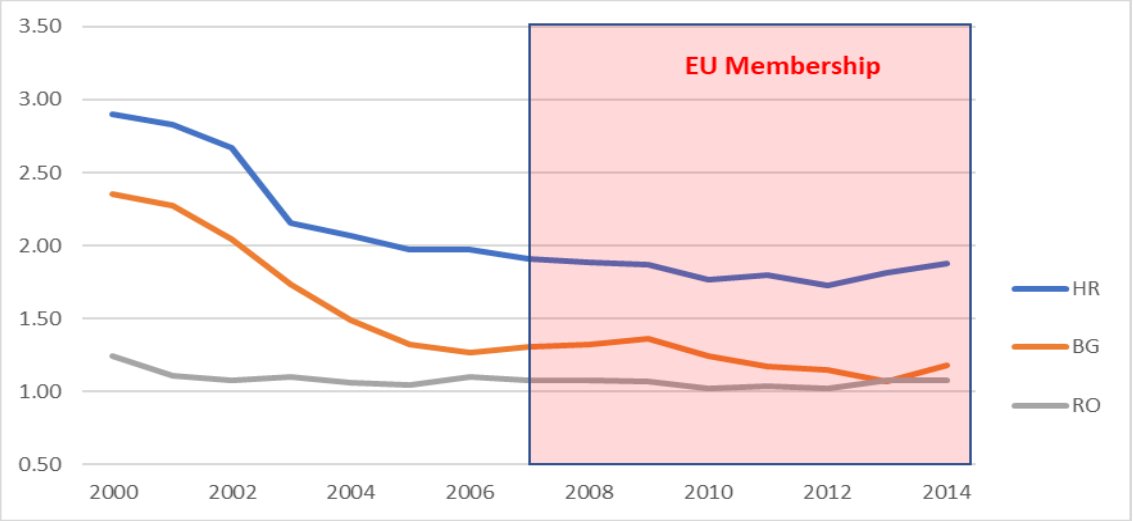


Source: WIOD export data, CE calculations

The 2004 cohort mostly show a decline over time, which is particularly rapid in Cyprus and Poland. Malta is the exception, but its rising trend started before

accession (around 2000). In the final cohort both Bulgaria and Romania show some decrease in the run-up to accession but, with the former reversing this pattern slightly in the following years.

Figure 4.8c: Balassa Index across EU Member States – Cohort 3 (WIOD)



Source: STAN export data, CE calculations

For the WIOD data, among the first cohort of EU15 Member States, again there is mostly stability with the exception of the UK which is rising throughout the period, Greece which is mostly on a downward trend, and Belgium which shows a shift up from 2007 onwards. In the 2004 accession cohort there is more movement, with two groups identified – a lower value Balassa group of Hungary, the Czech Republic, Slovakia[43], Slovenia, Poland and Lithuania; and a higher value group comprising Malta, Estonia, Latvia, and Cyprus which (with the exception of Malta which shows increasing specialisation) all tend to decline over time. Among the final cohort there is a decline in Bulgaria up to 2007 and then little change thereafter, while Romania is relatively stable throughout.

Theil Indices

As discussed in Chapter 2, although several (interrelated) measures of regional sectoral specialisation have been used in the academic literature, one of the most common is the entropy-based Theil Index. As Cutrini (2006, 2009, 2010) has shown, this particular index has the advantage that it is decomposable, and has been the preferred method used in her analyses of regional specialisation across the European Union (as discussed above).

Here we follow Cutrini (2010) and decompose the sectoral (industrial) specialisation of any specific region relative to the European Union as a whole into two parts: the specialisation of that region in the sector concerned relative to the country in which the region is located – the 'within-country' component; and the specialisation of that country relative to the European Union as a whole – the 'between-country' component. Using the notation set out in Chapter 2, we define three 'raw' indices:

First, the specialisation of region j in country i relative to European Union, given by

[43] Slovakia shows a marked increase in 2012 due to a large value in Real Estate Services, which prior to this had been zero throughout. So this may be a spurious result.

$$T_{ij} = \sum_{k=1}^{N} \frac{E_{ijk}}{E_{ij}} ln\left(\frac{E_{ijk}/E_{ij}}{E_k/E}\right)$$

Second, the specialisation of region j in country i relative to that country - the 'within-country' component, given by

$$T_{ij}^{Within} = \sum_{k=1}^{N} \frac{E_{ijk}}{E_{ij}} ln\left(\frac{E_{ijk}/E_{ij}}{E_{ik}/E_i}\right)$$

And third, the national specialisation of country i relative to the European Union – the 'between-country' component - given by

$$T_i^{Between} = \sum_{k=1}^{N} \frac{E_{ik}}{E_i} ln\left(\frac{E_{ik}/E_i}{E_k/E}\right)$$

Each of these can be mapped, for different points in time, although particular interest focuses on the first index.

As Cutrini (2010) points out, the national specialisation relative to Europe, $T_i^{Between}$, can be envisaged as a residual of the average regional specialisation in country *i* relative to Europe once the divergence of regional industrial structures within that country have been accounted for. Thus, if we define

$$aRS_i = \sum_{j=1}^{N} T_{ij} \frac{E_{ij}}{E_i}$$

as the average regional specialisation of all the regions of country *i* relative to the European industrial structure, and

$$aRS_i^{Within} = \sum_{j=1}^{N} T_{ij}^{Within} \frac{E_{ij}}{E_i}$$

as the average regional specialisation of all the regions within country *i* relative to that country's industrial structure, then the average regional specialisation of a country relative to Europe, aRS_i, is composed of two elements: the within country component and the country bias. Both of these average indices can be graphed to indicate trends over time. Finally, it follows that

$$aRS_i = aRS_i^{Within} + T_i^{Between}$$

Re-cap on available data

The database described Chapter 3 was modified in the light of the specialisation analysis. The reason is because the Theil index is a relative measure, and so any findings from the analysis must be made relative to a meaningful benchmark (the denominator). The theoretical construct of the Theil index described in the equations above has the all-sector EU total as the benchmark, but when analysing across sectors and regions the data simply are not available for a full picture. Furthermore, the collection of sectors gathered together in the initial database comprised a mix of manufacturing

and services which, added together, do not add up to anything meaningful to compare against.

To find a way forward, attention has focussed on the manufacturing sector as the most likely benchmark for which employment data would be available across sectors and regions. This links closely to the work of Cutrini (2010), which also focussed on the manufacturing sector for the very same reason. Using the filling-out methods described in Chapter 3, the following dataset was constructed for the empirical analysis:

- Time periods: 2003, 2007, 2011, 2015
- Sectors: 2-digit disaggregation is available. For 2003 and 2007, the NACE 1.1 disaggregation was used[44], while for 2011 and 2015 NACE 2 codes were used[45]. Appendix A contains a full list of sectors.
- Member States: NUTS2 level[46] for AT, BE, DE, EL, ES, FR, HU, IT, NL, PL, PT, SE, SK, and UK.

In terms of coverage, i.e. the proportion of total EU manufacturing employment, the available data accounts for 78% in 2003/07, and 64% in 2011/15. The lower proportion for the NACE Rev2 dataset occurs due to the additional sectors that were omitted for this dataset.

Empirical findings

This section presents the results of the new Theil statistics and puts them in the context of those produced by Cutrini (2010).

- Initial findings and comparability of results

Figure 4.9 shows the initial findings for the overall Theil statistic across all the Member States. Clearly there is step change between the two sets of periods that needs to be resolved because the results are likely to be sensitive to the sample being used, i.e. both the sectoral disaggregation and number of Member States covered by the dataset. This means there are some issues to contend with in how much it is possible to compare the three different sets of results:

(i) Cutrini's (2010) results (for 1985, 1993 and 2001) which are based on NACE1 sectors and a limited number of Member States (BE/LX, DE, EL, ES, FI, FR, IT, NL, and the UK);

(ii) The new set of NACE1 results (for 2004 and 2007) which are based on the same sectors as Cutrini (2010) but which have an expanded set of Member States (see above);

(iii) The new set of NACE2 results (for 2011 and 2015) which have a different sectoral disaggregation but the same countries as in (ii).

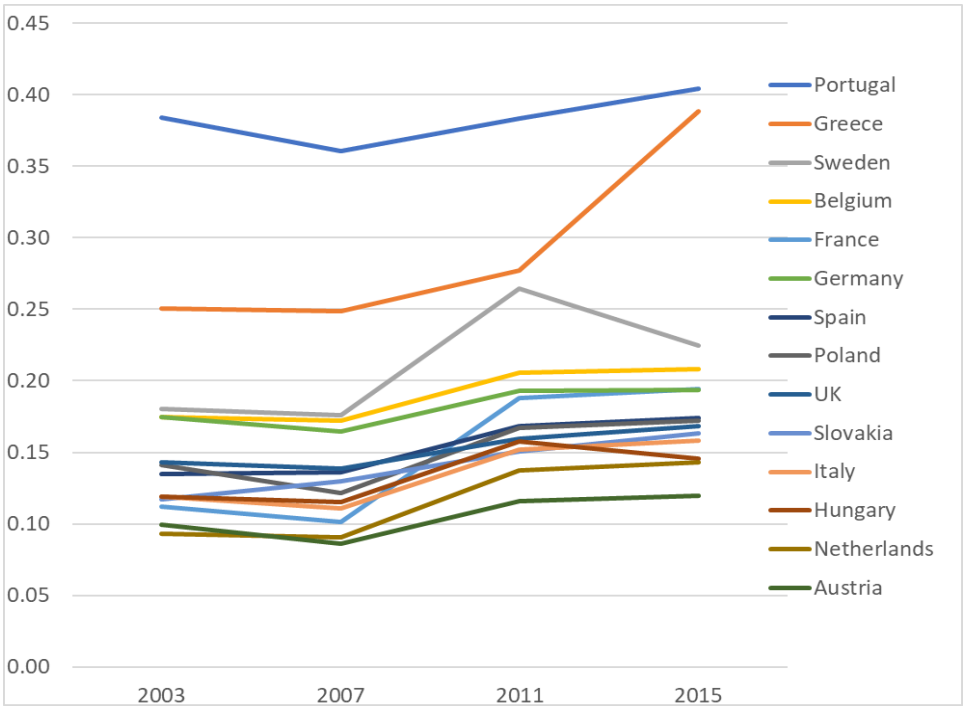
[44] For NACE Rev 1.1, DC - Manufacture of leather and leather products and DF - Manufacture of coke, refined petroleum products and nuclear fuel were excluded from the database because there were too many missing observations that could not be reliably filled.

[45] Similarly, the following sectors were excluded from NACE Rev 2 due to lack of data availability: C12 - Manufacture of tobacco products; C15 - Manufacture of leather and related products; C19 - Manufacture of coke and refined petroleum products; C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations, and C30 - Manufacture of other transport equipment.

[46] NUTS2 regions were used wherever possible. However, data limitations led to some restrictions. The following NUTS 1 are used instead of corresponding NUTS 2 regions: UKM (for 2003 only), ES6 (all years), FR8 (all years), DE7, DE9, DEA, DEB, DED (all years), AT1 (all years). In addition, some regions were excluded from the database due to lack of data, and that they are also non-mainland regions: FR9, PT2 and PT3.

To make sense of the results, a bridging exercise was undertaken to establish a link between (i) and (ii), and (ii) and (iii) – otherwise it would not be possible to know whether changes between these results were being driven by the sample make-up or the actual process of specialisation.

Figure 4.9: Overall Theil Statistic Results – combined NACE1 and NACE2 samples



Source: CE calculations

The bridge between (i) and (ii) was established by reducing the sample of Member States in the new set of results to match Cutrini (2010) as closely as possible. The main difference was that Cutrini's results included Luxembourg and Finland, which are not covered in the update, but as they are relatively small Member States it is hoped that this will not unduly influence the comparability.

The bridge between (ii) and (iii) was established by using detailed results for NL from the LISA database, which allows the NACE2 results to be pushed back across all four periods, and thus any shift in the Theil results for NL (between (ii) and (iii)) should thus be mostly attributable to the change in sectoral disaggregation. If reliable, this shift factor could then be applied to the other Member States to enable a comparison.

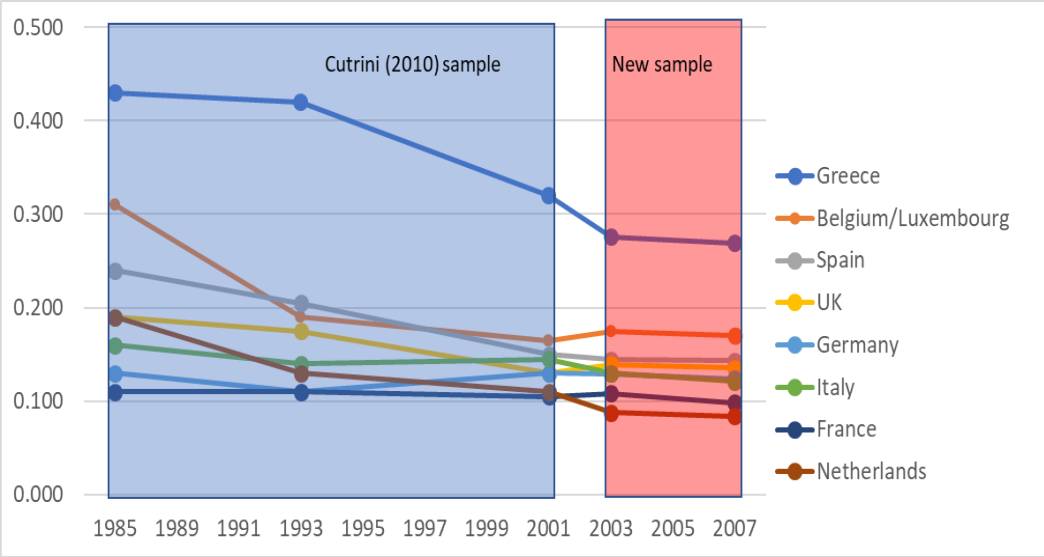
- Cutrini (2010) compared with new data with restricted Member State sample

Figures 4.10a-c show the original Cutrini results alongside the two extra years of results added on using the restricted sample.

In general, the bridging approach seems to be successful. The additional periods also seem to confirm Cutrini's finding that manufacturing specialisation (i.e. degree of dis-similarity relative to the EU benchmark) has been on a decreasing trend, or at best mostly stable, in all the Member States in the sample. Given that all the Member States in the sample are relatively well-established EU members, for which integration within the manufacturing

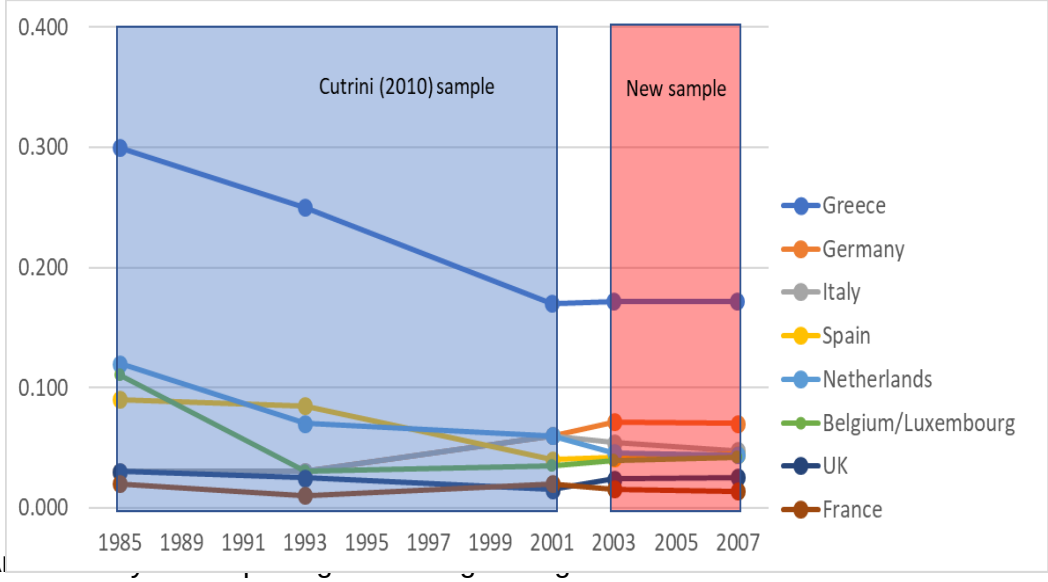
sector is fairly well established with little or no regulatory changes occurring, this is perhaps not surprising.

Figure 4.10a: Overall Theil Index – restricted (Cutrini, 2010) sample



Source: CE calculations

Figure 4.10b: Between Country Theil Index – restricted (Cutrini, 2010) sample

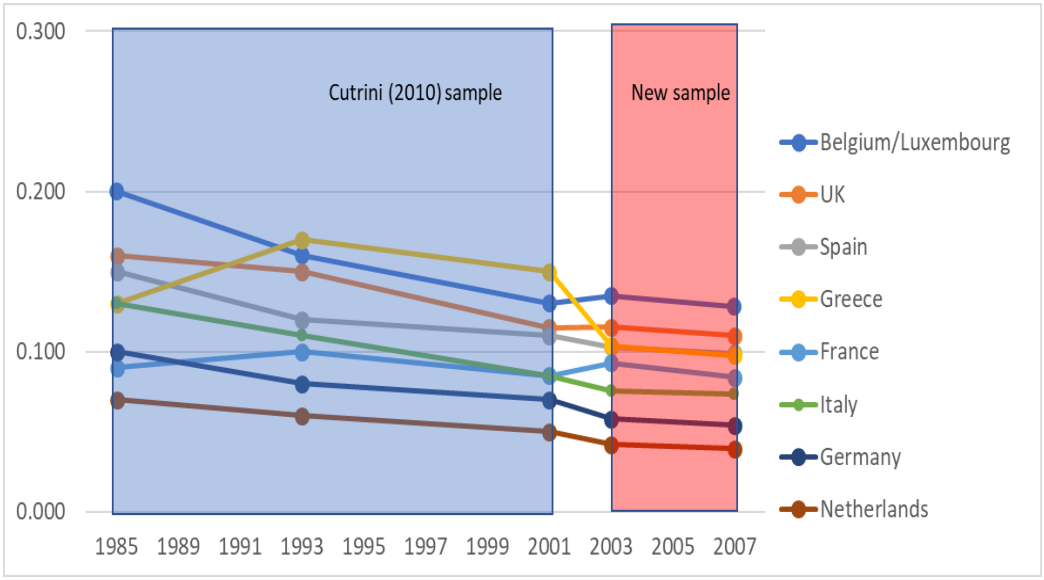


Source: CE calculations

become more similar (though Greece is still more specialised than other states) (Figure 4.7b). This is not overly surprising, perhaps, given that manufacturing employment has been steadily declining across Europe since the early-1980s. That decline has lessened in recent years, and has probably now more or less stabilised. Hence further major reductions in the specialisation of member states is probably not likely.

A somewhat similar story is evident with respect to the degree of specialisation across regions within member states (Figure 4.10c). In almost all member states, regions have become less specialised (more similar) in terms of their manufacturing structures (Figure 4.10c).

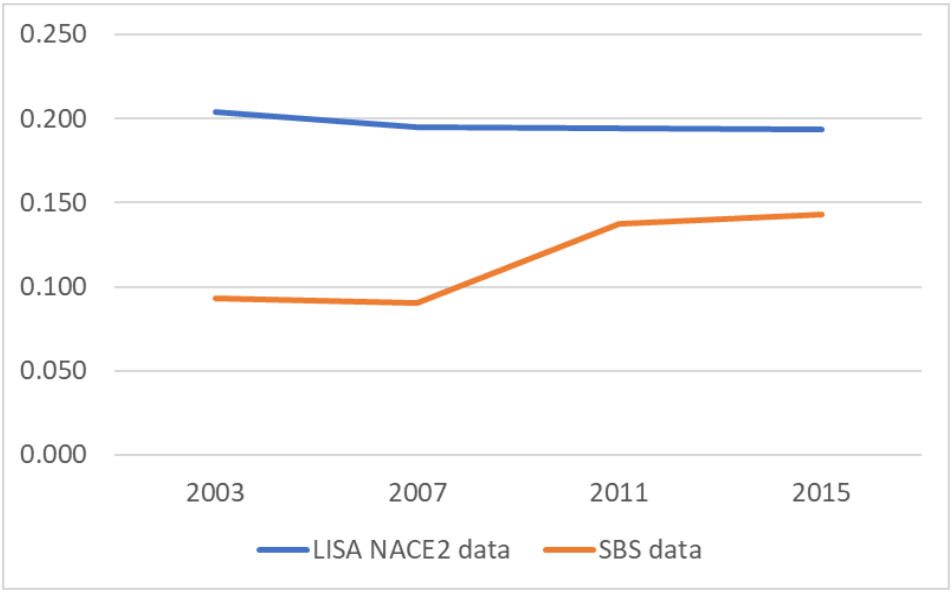
Figure 4.10c: Within Country Theil Index – restricted (Cutrini, 2010) sample



- NL NACE2 results for 2003 and 2007 compared to NACE1 results over full Member State sample

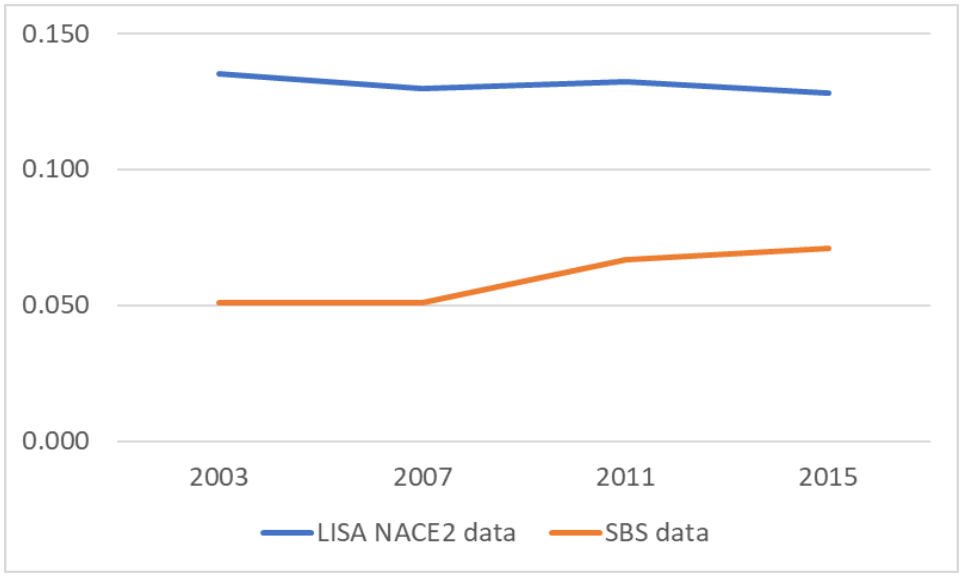
The NL results for NACE2 for all four periods, compared with those using the SBS data (NACE1 and NACE2) are shown in Figures 4.11a-c.

Figure 4.11a: Overall Theil Index – LISA versus SBS data



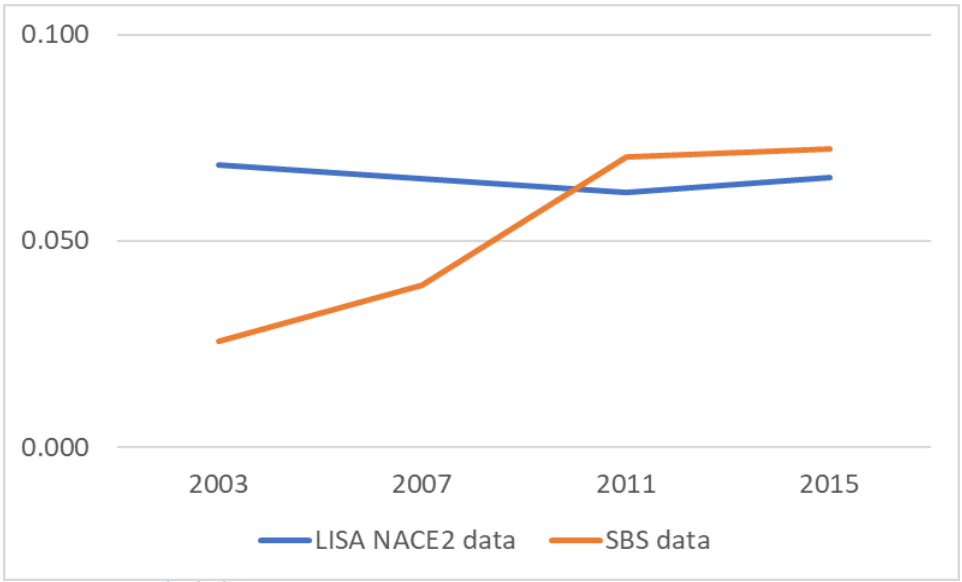
Source: CE calculations

Figure 4.11b: Between Country Theil Index – LISA versus SBS data



Source: CE calculations

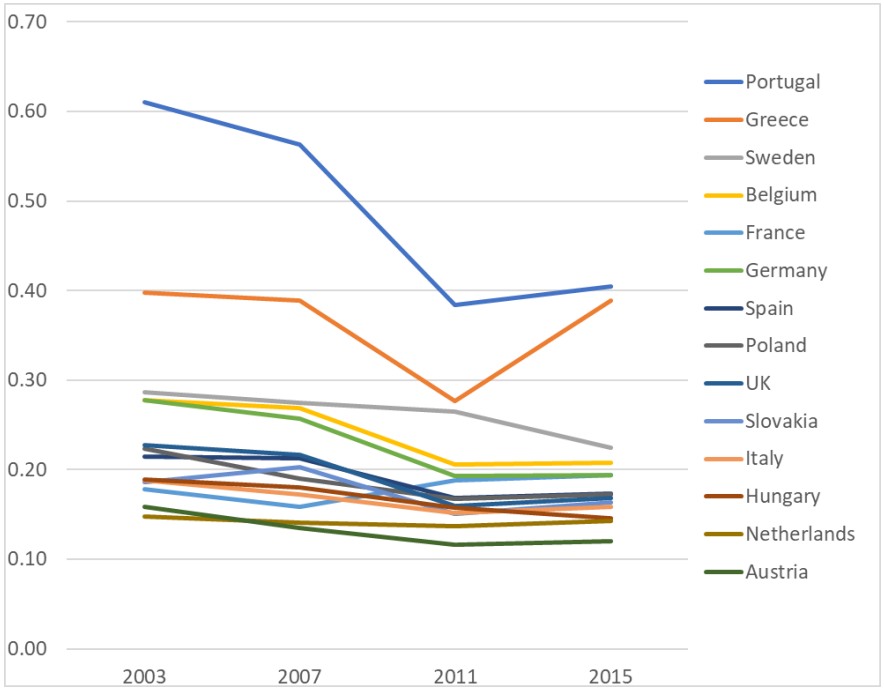
Figure 4.11c: Within Country Theil Index – LISA versus SBS data



Source: CE calculations

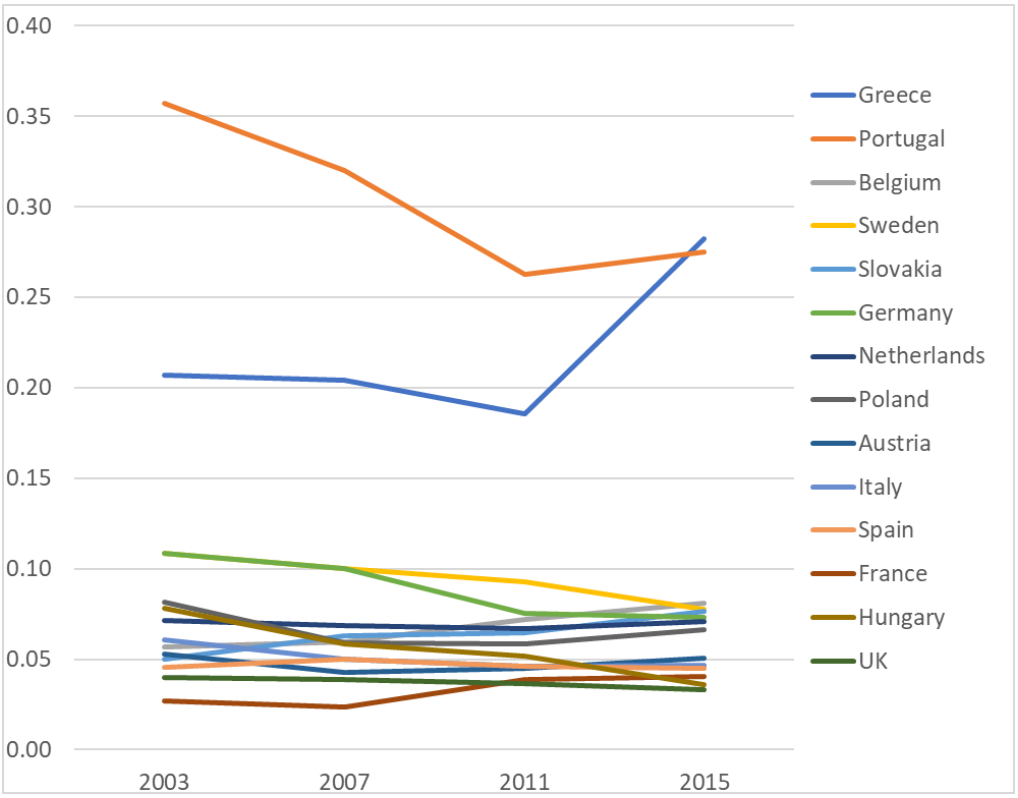
Even with this approach there are differences for the 2011 and 2015 periods, and these are likely to be due to two factors. Firstly, the EU benchmark, created by SBS totals in the original series and EU national accounts for the LISA version (this was required because the SBS totals did not extend back to all periods). Secondly, there was a difference with the sector disaggregation as the EU national accounts data provide aggregations in some cases (e.g. food, beverages and tobacco are grouped as one activity). These two differences are likely to cause a shift for the latter two periods, but beyond this the additional shift for the 2004 and 2007 periods could be caused by the shift to the NACE1 disaggregation.

Figure 4.12a: 'Adjusted' Overall Theil Statistic Results



Source: CE calculations

Figure 4.12b: 'Adjusted' Between Country Theil Statistic Results

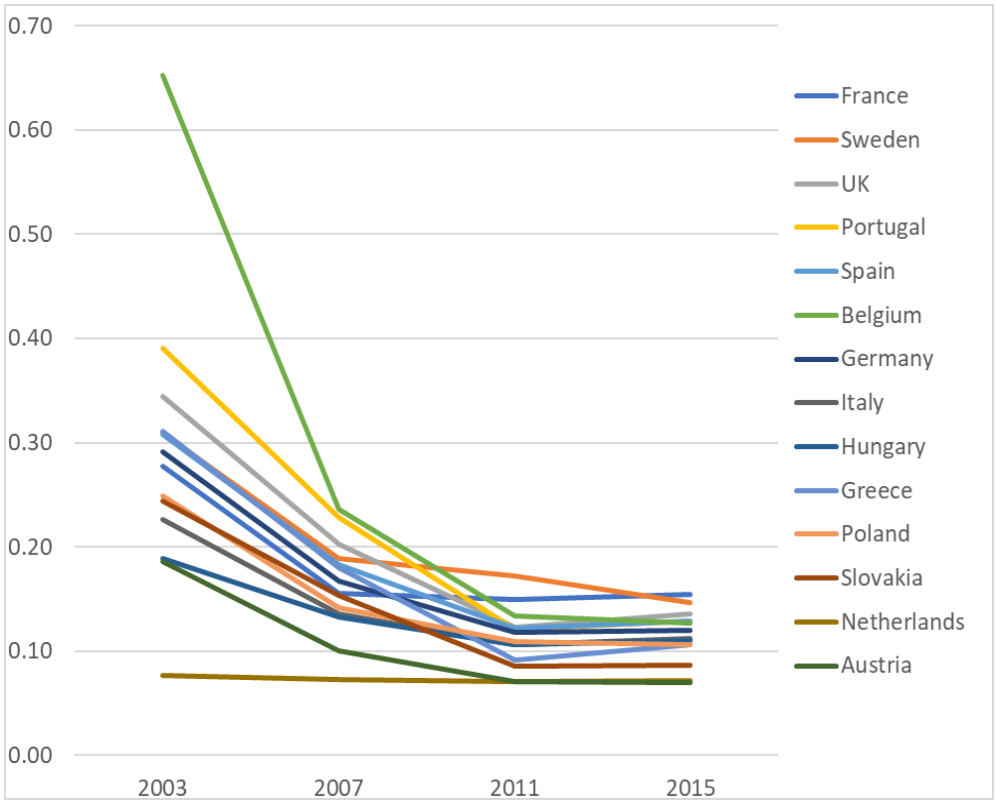


Source: CE calculations

The findings for NL on the LISA data show, as with the extended Cutrini results, a pattern of broad stability / gradual decline across all the Theil components. By adjusting the other Member States by the 'shift factor' between the two lines in Figures 4.11a-c, the resulting patterns are shown in Figures 4.12a-c. These findings should obviously be interpreted with a degree of uncertainty / caution attached to them, as they rely on an adjustment factor derived from the NL data and there is no way of knowing how far this adjustment holds across other Member States. Furthermore, the application of the multiplicative adjustment factor means that the Theil statistics no longer add up.

However, with these caveats in mind, the findings do, again, generally indicate a pattern of declining / stable specialisation patterns, with the exception of the between-country Theil statistic for Greece and Portugal which rises strongly between 2011-2015.

Figure 4.12c: 'Adjusted' Within Country Theil Statistic Results



Source: CE calculations

Summary

There is little evidence to suggest that, as EU integration has progressed over the past two decades or so, Member States have become more export specialised. Rather, overall, the Member States have become more similar in terms of their degree of specialisation, as measured by their export structures over this period. There have only been a few exceptions to this trend, most notably the UK's increase in specialisation in financial services (as seen by comparing Tables A1 and A2).

At the same time, the geographical specialisation of sectors across Member States has tended to become more similar. In other words, it would appear that there is little support at the Member State level for the hypothesis that

integration encourages nations to increase their specialisation in those sectors in which they have a comparative advantage. The Theil statistics used to draw these conclusions are national averages (across regions and sectors), the same as those reported in Cutrini (2010). As they are averages, it is feasible that the average masks changes in specialisation within particular sectors, although the general agreement with findings from the Balassa analysis would tend to support the 'becoming generally more similar in sectoral structure' argument.

In this respect, the findings lend support to Krugman's (2008) general argument that perhaps within advanced economies the era of regional specialisation, whether due to comparative advantage or the increasing returns effects of industrial localisation, has passed. Indeed, there is growing evidence that production processes are fragmenting across borders with countries trading *task*s and *functions* rather than products. That is, regional sectoral ('horizontal') specialisation may be giving way to regional functional ('vertical') specialisation. (Timmer, et al, 2019; see also, for example, Yi, 2003; French, 2017). With cross-border production sharing, countries and regions can specialise in particular stages of the production process – such as R&D, fabrication, marketing, management. Data classified by sector will not necessarily reveal this type of specialisation: different types of data are required (for example, Timmer, 2018, uses occupational labour incomes). Such forces are also linked to the globalisation of production processes, which has been progressing at a rapid rate during the period under analysis, and has encouraged geographically dispersed production networks. It is quite possible, therefore, that the economic forces caused by EU integration are relatively smaller compared to the forces caused by globalization, and thus what is observed reflects more on the latter than the former. It is possible that some degree of regional specialisation of tasks or functions is replacing regional sectoral specialisation, but the detailed data required to investigate this are not available on a consistent basis.

These discussions and arguments are brought together more consistently within the next stage of analysis, which investigates changes in patterns of geographical concentration.

4.4 Results from Measures of Geographical Concentration

Theil Indices of Geographical Concentration

Whereas the Theil index of specialization used above provides a measure of the degree to which each EU region is economically specialized relative to the EU as a whole, the corresponding Theil index of industrial concentration calculates the degree to which any given economic sector is geographically concentrated across the EU. Again, following Cutrini (2010) it is possible to decompose the total relative geographical concentration of any given industry into two sub-components: the within- country relative concentration of an industry, and the between-country relative concentration of that industry. The relevant indices are defined as:

Total relative concentration of industry k

$$T_k = \sum_{i=1}^{m} \sum_{j=1}^{r_i} \frac{E_{ijk}}{E_k} ln \left(\frac{E_{ijk} / E_k}{E_{ij} / E} \right)$$

Within-country relative concentration of industry k

$$T_k^{Within} = \sum_{i=1}^{m} \sum_{j=1}^{r_i} \frac{E_{ijk}}{E_k} ln\left(\frac{E_{ijk}/E_{ik}}{E_{ij}/E_i}\right)$$

Between-country relative concentration of industry k

$$T_k^{Between} = \sum_{i=1}^{m} \frac{E_{ijk}}{E_k} ln\left(\frac{E_{ik}/E_k}{E_i/E}\right)$$

where the notation and definitions of the terms are those used for the Theil specialisation indices above in section 4.3 (*k* refers to industry, *j* to region and *i* to member country).

Recap on available data

As the measure of concentration is sector-specific, the services data created in the original database can also be used alongside the additional manufacturing data from the subsequent data work. What matters most is the consistency of the regional / country coverage to ensure that the indices can be compared over time. Additionally, a reduced regional sample can be used to replicate the results of Cutrini (2010).

This means that the following set of calculations can be performed:

(i) Using the Cutrini sub-sample (of Sectors and Member States), re-produce the numbers for Figs 1 (EU-wide manufacturing), 2 (high vs low tech) and also Fig 3 (EU-wide, particular sectors). This will allow us to add two more observations (2003, 2007) to see whether trends have continued.

(ii) Extend the sample to include our full set of Member States and regions but stick with manufacturing to see how Fig 1 changes. We know that the sectors are different between the Rev 1 and Rev 2 datasets, but there may be an average level of comparability – we'll only know when we do this.

(iii) Again, use the whole sample and the sectors from the originally constructed database from Chapter 3 (where we know there is reasonable two-way consistency in definition) to look how they have changed over all four periods. This will include some service sectors.

Empirical findings

Replication and comparison of Cutrini (2010) results

Figure 4.13 presents a combination of three sets of results.

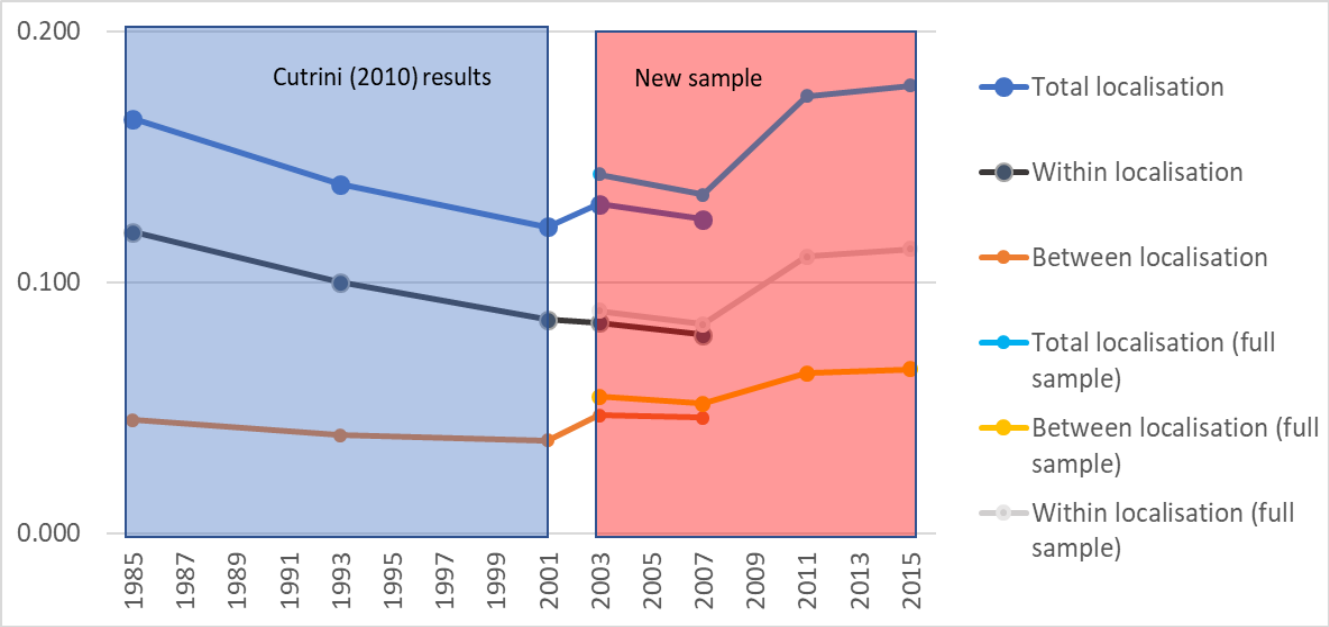
(i) Firstly, it re-creates the Cutriini (2010) results for overall manufacturing.

(ii) Then, it extends this for 2003 and 2007 with the new NACE Rev1 dataset, using the same sectors and Member States as in the original study.

(iii) Finally, the full sample of 13 Member States collected through this project is used to create a revised set of manufacturing results. However, because the 2011 and 2015 data are based on NACE Rev2 sectors it is to be expected that some discontinuity would be observed.

The findings are that, broadly speaking, the manufacturing sector in Europe has continued to decline in its degree of concentration – more or less in line with Cutrini's previous finding. Expanding the coverage of Member States alters the levels of the Theil statistics for 2003 and 2007, but the same rate of decline is observed between the two years. As mentioned above, given the differences in Rev1 and Rev2 sectors it does not make sense to see the increase between 2007 and 2011 as anything meaningful. The movement between 2011 and 2015 can be analysed, however, and shows a slight increase in concentration, although nothing that would reverse the declines seen in previous years. At best it can probably be seen as a stabilisation of previous trend decline.

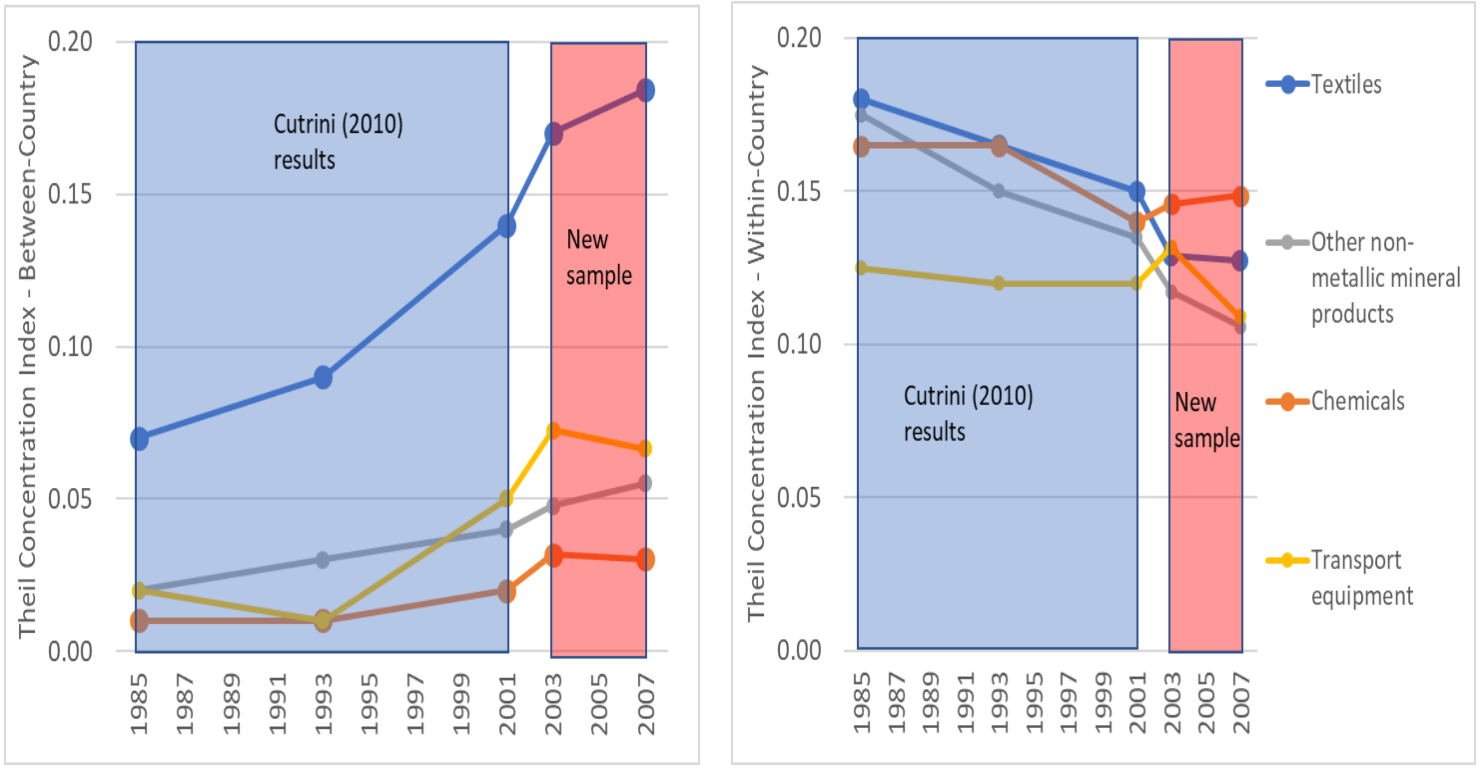
Figure 4.13: Extension of Cutrini (2010) results on geographic concentration - manufacturing



Source: CE calculations

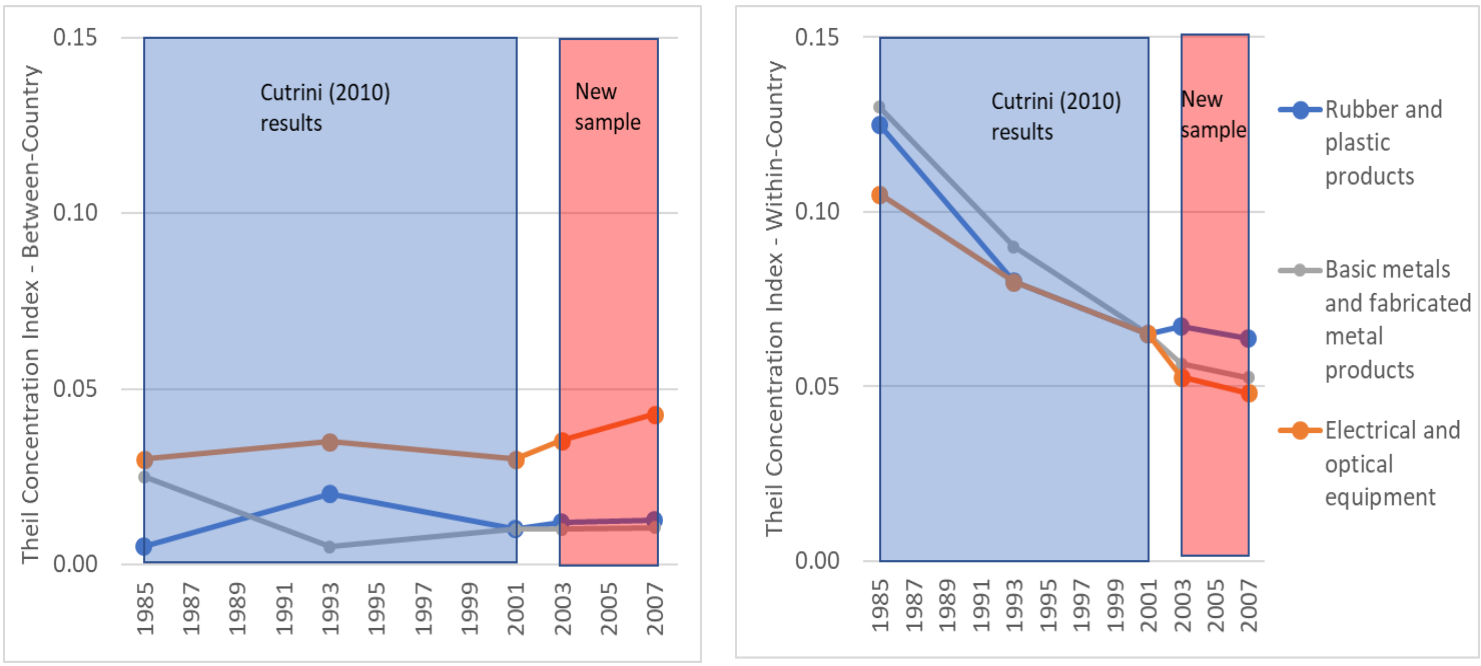
Moving on to look at the individual manufacturing sectors, Figures 4.14a – c replicate Figure 3 from Cutrini (2010) and then extend by two periods (2003 and 2007).

Figure 4.14a: Extension of Cutrini (2010) results on geographic concentration – manufacturing sectors



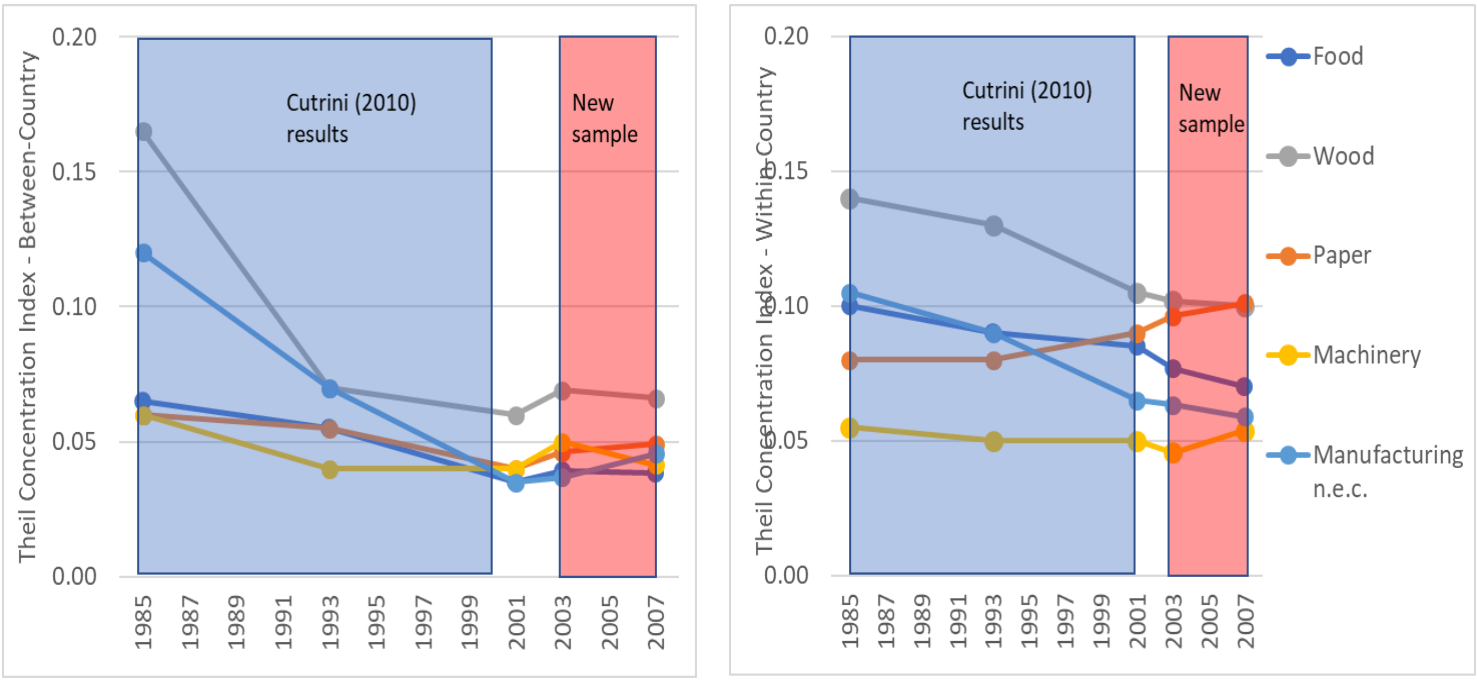
Source: CE calculations

Figure 4.14b: Extension of Cutrini (2010) results on geographic concentration – manufacturing sectors



Source: CE calculations

Figure 4.14c: Extension of Cutrini (2010) results on geographic concentration – manufacturing sectors



Source: CE calculations

Using the database from Chapter 3 with comparable sectors

The work in the database chapter (Chapter 3) established a set of 12 sectors which had sufficient two-way compatibility between them to enable comparison across these classifications, and thus across all four periods. These sectors are outlined in Table 4.1

Table 4.1: Selected sectors from original database

NACE Rev 2 Sector	Share of Rev 1.1 in Rev 2 sector	Share of Rev 2 in Rev 1.1 sector
C10, C11 - Manufacture of food products; Manufacture of beverages	0.96	0.99
C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.89	0.94
C17 - Manufacture of paper and paper products	0.90	0.95
C22 - Manufacture of rubber and plastic products	0.83	0.84
C23 - Manufacture of other non-metallic mineral products	0.91	0.97
C24 - Manufacture of basic metals	0.88	0.97
G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles	0.96	1.00

G46 - Wholesale trade, except of motor vehicles and motorcycles	0.97	1.00
G47 - Retail trade, except of motor vehicles and motorcycles	0.91	0.99
I - Accommodation and food service activities	1.00	1.00
H49 - Land transport and transport via pipelines	0.98	1.00
M72 - Scientific research and development	1.00	1.00

Figures 4.15a and 4.15b report the Theil Concentration Indices (Total, Between and Within) for these sectors. The grouping of the sectors is simply by the scale of their statistics, and not by any economic typology, for ease of viewing their variation over time. Although some care and attention has gone into selecting these sectors, the degree of correspondence as reported in Table 4.1 shows that some caution should still be used in judging the shift between the pre-2007 (Rev 1.1) and post-2011 (Rev 2) periods for certain activities.

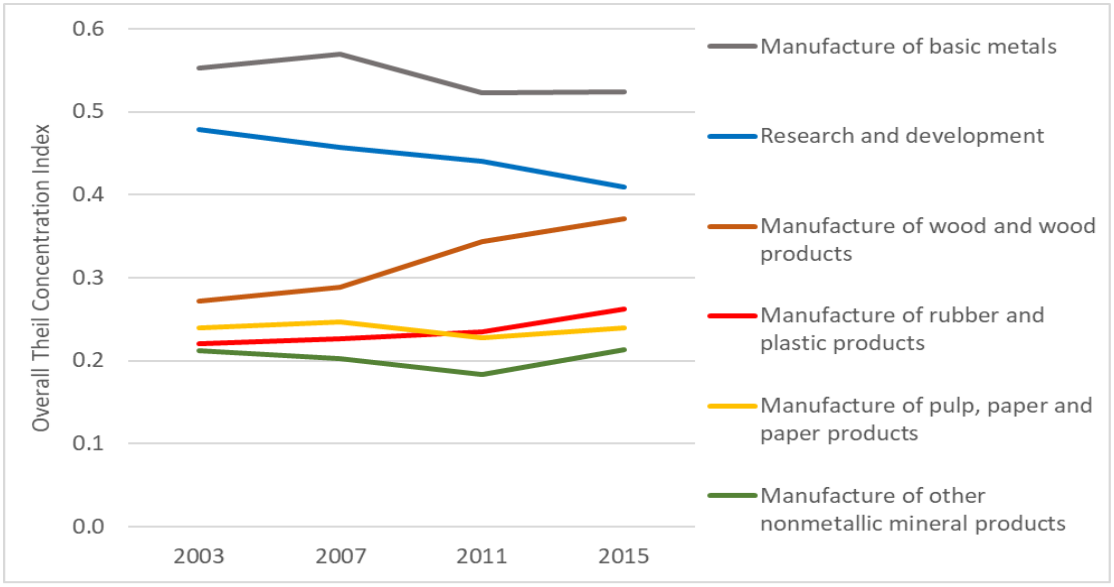
Summary

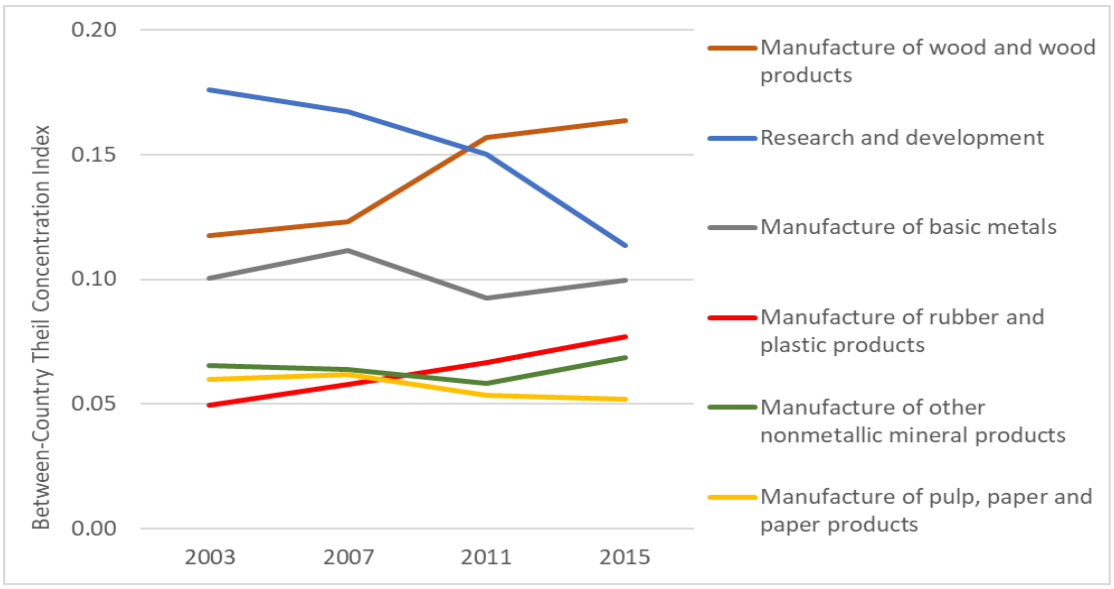
As in the case of specialisation, there is little evidence to suggest that, as EU integration has progressed over the past two decades or so, economic activities – here measured by employment in individual sectors – have become more geographically concentrated, either between or regionally-within Member states. While the limitations of data, discussed here and in the other reports, have to be borne in mind, it does not appear to be the case that agglomeration forces have been sufficient to produce any significant increase in the geographical concentration of employment within industries, at least at the spatial scale for which analysis has been possible. Indeed, our analysis would seem to confirm the trends that Cutrini's earlier studies established, that if anything both economic specialisation and spatial concentration have continued to decline. Of course, a finer spatial lens might well reveal different degrees and trends in local specialisation and spatial concentration. But for the geographical scales studied here, it would be difficult to argue that increasing integration has led to increasing specialisation and agglomeration. It might also be argued that in any case, the process of EU integration itself has slowed or reached limits for some sectors.

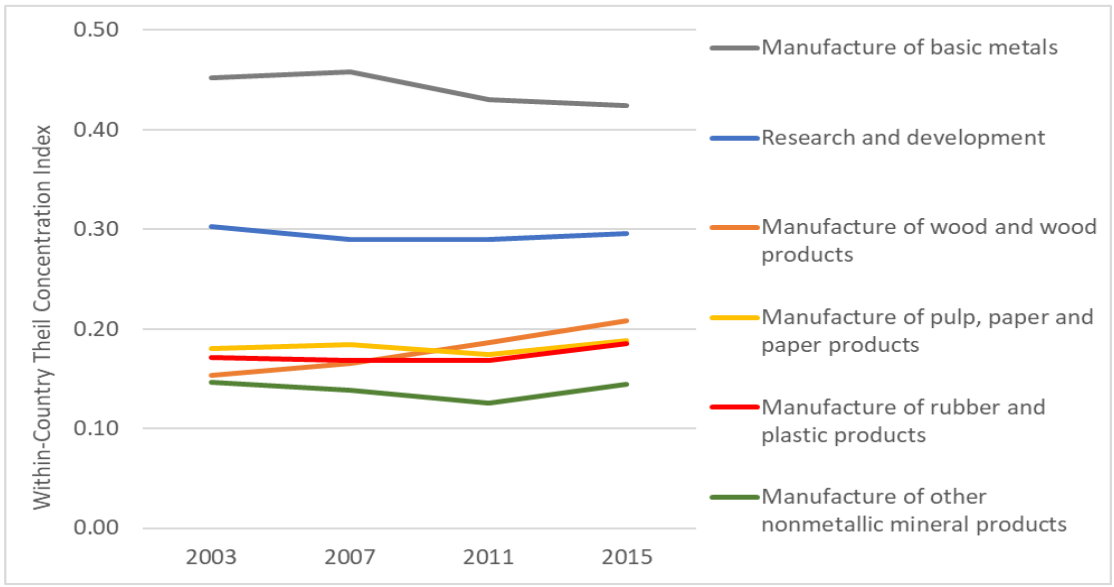
At the same time, as noted above, the theoretical argument that increasing economic integration should lead to both increased geographical concentration (agglomeration) and increased regional specialisation, may no longer be an appropriate view of how the economies of Europe – or indeed in other advanced parts of the global economy – now function. In the case of the European Union, a declining proportion of trade is in fact intra-Union, between Member States, compared to two decades or so ago. The historical shock of the global financial crisis in 2008, and the deep recession this caused, will also have had an impact. Further, dramatic changes in the global economy, in global trade patterns, in technology and in production systems, possibly all render the relationship between national and regional 'openness' and connectivity, on the one hand, and the locational dynamics of economic activity, on the other, much more complex and diffuse than in the past. Finally,

future developments – such as the gathering pace of artificial intelligence and its impact on employment and production, the mounting pressure for shifting to a low-carbon or carbon-neutral economy, and the uncertainty of trade arrangements, for example, between Europe and the United States and China – will all leave some imprint on the economic geography of the European Union.

Figure 4.15a: Full sample results for Rev1 – Rev2 consistent sectors

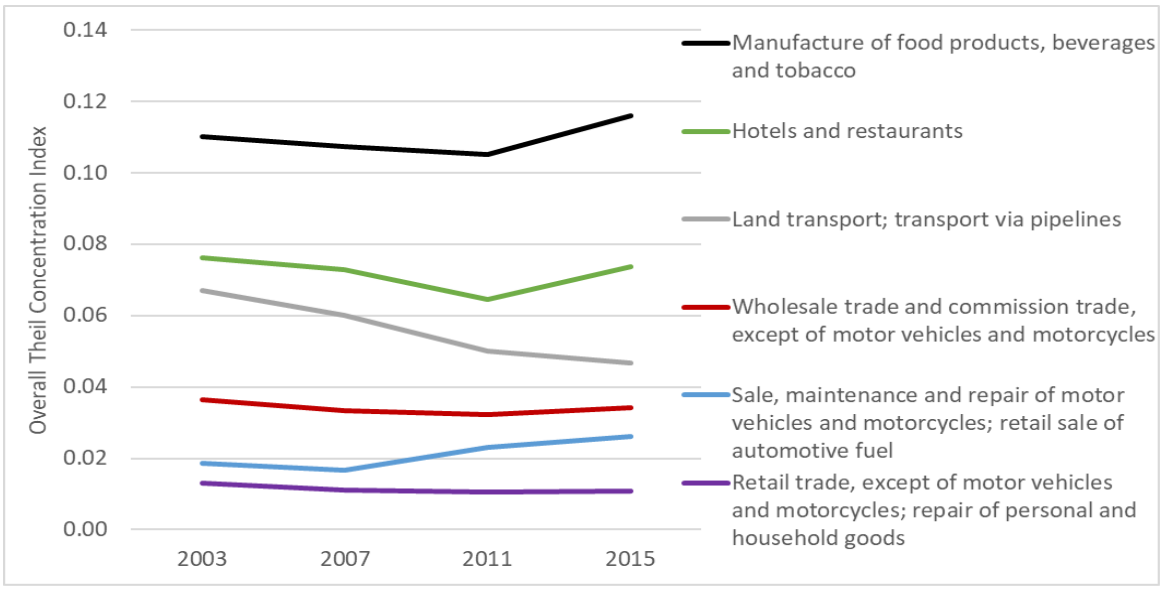


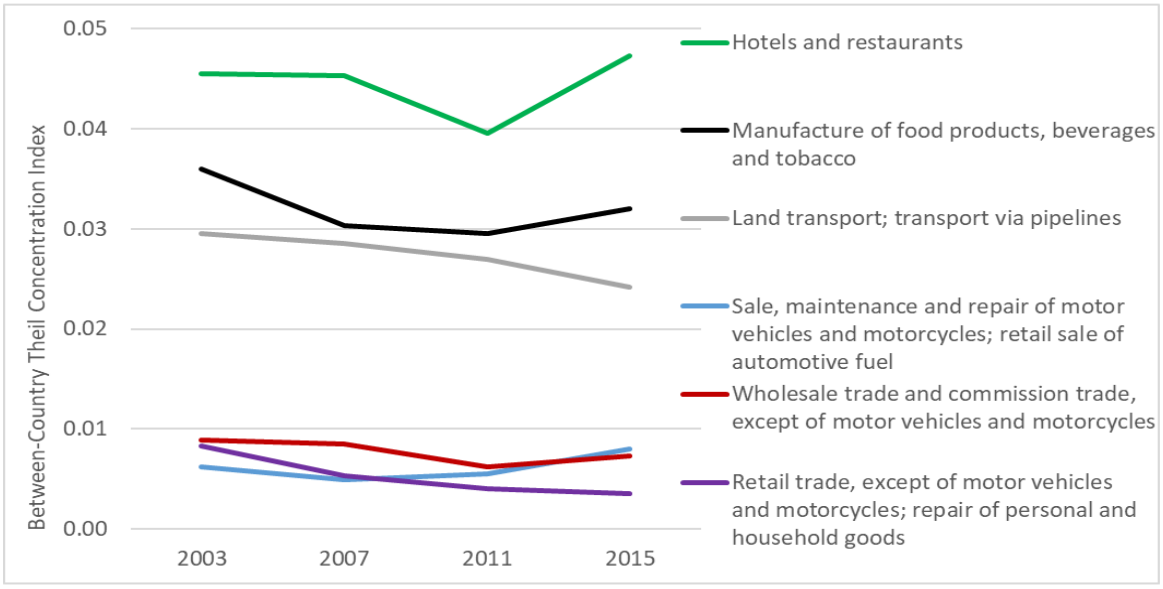


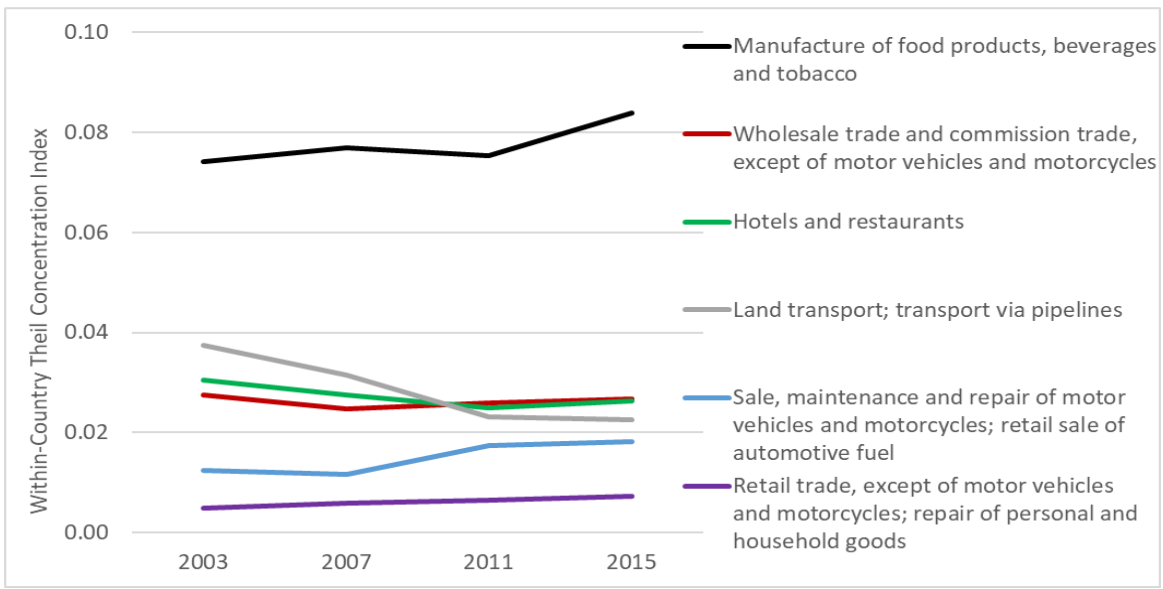


Source: CE calculations

Figure 4.15b: Full sample results for Rev1 – Rev2 consistent sectors







Source: CE calculations

5 Clustering and Agglomeration

5.1 Introduction

This chapter revisits some of the theories relating to clustering and agglomeration, and considers how this inter-relates with the process of economic integration. It also looks back over relevant literature which has studied agglomeration and clustering, and summarises their findings.

5.2 Implications from Theory and Findings of Previous Studies

Re-cap on theory and implications for clustering and agglomeration

Clusters as specialised geographical concentrations

Over the past three decades or so, there has been a veritable flood of academic literature in urban economics, the New Economic Geography, business studies and economic geography, on the topics of clustering and agglomeration. The notion of clustering was strongly promoted by the business economist Michael Porter in the 1980s and 1990s. Porter defines business clusters as

> Geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies, and trade associations) in particular fields that compete but also co-operate (Porter, 1998, p. 197)

Clusters, it is claimed, raise the innovation and productivity of their constituent firms, thereby giving them a competitive advantage in external markets. Indeed, it is frequently argued that a country's most export-competitive sectors of activity often tend to be geographically clustered.

According to Porter, then, key to the existence of a cluster is the spatial co-location - or geographical concentration - of firms *in the same and closely related industries*. Clusters thus imply a degree of local industrial specialisation. In fact, all of the examples of clusters in the academic literature refer to local concentrations of specialised industry. In many respects, the cluster concept is a modern re-incarnation or reworking of Alfred Marshall's (1890) notion of 'industrial district', and Porter's own 'cluster theory' draws heavily on Marshall's 'triad' of localisation economies (a pool of specialised labour, local supporting and ancillary activities, and specialist knowledge accumulation and spillovers among the local firms). These external economies associated with localised specialisation are deemed to raise the innovation and productivity of the firms concerned. It should be noted that Italian economists have also devoted considerable effort in resurrecting

Marshall's notion of 'industrial district', embellishing it in the process, and have used it to describe and analyse the myriad specialised local industrial districts of the so-called 'Third Italy' (for example, see, Gilbert, 2016). The Italian literature rarely uses the term cluster to refer to these modern-day industrial districts, which are also given an explicit social-institutional-cultural dimension (see Sforzi, 2015).

In the Anglophone business economics and economic geography literature, however, it is the cluster notion that is the preferred concept. This is not to say, however, that the cluster concept has become accepted without some reservations, criticisms and caveats (see for example, Martin and Sunley, 2003; Duranton, 2011). For one thing, the geographical scale over which a cluster should be defined, and the mechanisms that underpin its functioning, are often left vague. Just how localised does a cluster have to be to be deemed such? In practice, defining the geographical boundaries of clusters may be highly dependent on the sort of data available, and the areal units on which such data are based. For another, the simple co-location of similar firms, even in close spatial proximity, does not necessarily mean that the group of firms constitute a functioning cluster (as a dense network of interfirm interactions, interdependencies and exchanges). Yet further, the evidence that clustering raises firm productivity, and thence competitive advantage, is far from unequivocal. Nevertheless, the creation and promotion of clusters have become widely accepted policy goals in many European states.

Agglomerations as diversified concentrations

Whilst the modern concept of the cluster has been developed mainly in business economics, the concept of agglomeration derives mainly from the urban economics literature. Although it too is intended to capture the spatial concentration of economic activity, as discussed in Chapter 2 strictly speaking agglomeration refers to the co-location or geographical concentration of a variety of different economic activities together, rather than of firms in the same or interrelated industries. The term agglomeration should really be reserved for geographical concentrations of diverse activities, and is most often used in discussions of externalities of the so-called Jacobsian type (named after the urbanist Jane Jacobs, 1969). These Jacobsian urban or agglomeration externalities include firms' access to a large labour pool, a large 'home' market giving opportunities for new firm entry, access to diverse ancillary activities and services, and various forward and backward linkages between local firms. Typically, such agglomeration economies are discussed in relation to cities, not clusters. Again, the presence of these positive externalities is argued to raise the productivity of local firms.

However, in various writings the terms cluster and agglomeration have come to be used interchangeably, making for some confusion. Whilst spatial co-location of firms is a basic requirement for both concepts, in the case of clusters the co-locating firms are in the same or closely related sectors, whereas in agglomerations the co-locating firms are in diverse activities, which may not be directly or closely related.

The implications of economic integration

To the extent that increasing economic integration across geographic space lowers transport costs and removes the barriers to trade (and frees up the ability of labour to move geographically), then it should encourage the concentration of firms in (specialised) clusters and major agglomerations (large cities and urban regions). And such spatial concentration in turn,

according to assumption, should increase the productivity and competitiveness of firms in such clusters and agglomerations, thereby attracting both more firms and workers. According to theory, then, the overall implication of increasing economic integration - such as across the European Union – should be the increasing concentration (co-location) of firms, both in specialised clusters and in major urban centres and urban regions.

Clusters can rise and fall

It should be noted, however, that economic integration – in the form of reductions in barriers to trade – can also expose existing clusters and urban-regional agglomerations to increased competition from other (including foreign) competition. The economic landscapes across the major advanced economies are littered with the vestiges of once highly-competitive and successful clusters which have since undergone decline in the face of cheaper or more innovative similar clusters elsewhere.

Porter for example, chose the Portuguese footwear clusters as one of his key examples. Yet those clusters have faced intense overseas competition from cheaper production in the Far East, Russia and South America. Clusters (like other forms of sectorally-specialised geographical concentrations, including whole cities), can undergo 'life cycles', rising to prominence but then in some subsequent historical phase slipping into relative or even absolute decline, through a combination of foreign competition and a lack of technological or product upgrading. In fact clusters can experience quite complex evolutionary patterns (see for example, Martin and Sunley, 2003). Little is known about how such evolutionary development paths relate to changes and shifts in trade and economic integration.

5.3 Review of existing literature

European context

Although there has been considerable discussion of cluster policy in the European context, much of it within or associated with the European Commission, there has been surprisingly little detailed empirical analysis that attempts to map actual clusters across the EU. See, for example:

- European Secretariat for Cluster Analysis (ESCA): https://www.cluster-analysis.org;
- European Cluster Policy Forum: Improving Linkages and Synergies in Cluster Policy (https://ec.europa.eu/growth/content/third-european-cluster-policy-forum-improving-linkages-and-synergies-cluster-policy_en;
- Ketels, (2004): The 'mapping tool' that appears on the European Cluster observatory is actually non-functional (European Commission, (https://ec.europa.eu/growth/smes/cluster/observatory/cluster-mapping-services/mapping-tool_en).

One of the few detailed studies is that by Domenech et al (2011), which uses the Amadeus micro database to map clusters of creative industries across Europe. Other studies are usually country specific, for example for the UK (Duranton and Overman, 2005) for Italy and Spain (Lazzeretti et al, 2008), or Germany (Brachert et al, 2011). The resultant findings vary according to the data used and the geographical scales adopted. Not all of the 'clusters' so identified are necessarily functioning clusters. Ideally, mapping clusters requires firm-level data. In the absence of such data, studies often simply revert to the use of location quotients on an industry by industry basis. This

index was discussed in Chapter 2. It does have the virtue of assigning a value of relative local concentration in an industry for each geographic area making up a national economy (or group of such economies, as in the European Union).

Measuring agglomeration

There are different statistical approaches to measuring agglomeration, and those of which are most applicable to the current situation are described below.

Location Quotient (LQ)

As described in Chapter 2, the location quotient for an industry i in region r is the ratio of the region's share of that industry's national employment (subscript N) to that regions share of total national employment, that is:

$$LQ_{ir} = \left(\frac{E_{ir}}{E_{iN}} / \frac{E_r}{E_N}\right) = \left(\frac{E_{ir}}{E_r} / \frac{E_{iN}}{E_N}\right)$$

In the present case, if the reference economy (N) is that of the European Union as a whole, then EU-wide figures would be used instead of the national figures in the above formula.

If the LQ for industry i in region r is greater than unity then the industry in question is generally considered to be more 'localised' or 'clustered' in region r than in other regions: the higher the value of the index the greater the degree of regional localisation or 'clustering'. Thus, mapping the LQs for a given industry i can reveal where and to what extent that industry is geographically 'clustered'.

In addition, since clusters typically involve two or more related or complementary sectors, a further step in the use of location quotients is to examine the correlations between pairs of industries that is:

Corr (LQ_{ir}, LQ_{jr})

across regions. Since these are conventional correlations they can be tested for statistical significance.

The Ellison-Glaeser (EG) statistic

An alternative and arguably more sophisticated approach to identifying co-agglomeration and clustering of industries (and firms) is provided by Ellison and Glaeser (1997, 1999, 2010), who have devised a family of indices of 'geographic concentration' and co-agglomeration. These indices are derived from an underlying theory of firm location under conditions of increasing returns and spillover effects. As such, in all but the simplest co-agglomeration index, their measures require employment data not only for industries but also on the sizes of individual firms in those industries; that is, they require micro-data. Ellison and Glaeser's early work has since attracted a significant body of literature, on refining and extending their original indices, on applying the indices to different empirical contexts, and on identifying the driving forces underpinning local industrial concentration agglomeration (for example, Duranton et al, 2005; Felkner et al, 2011; Howard et al 2015).

In the absence of firm-level data, Ellison-Glaeser (EG) proposed a simple index of industry co-agglomeration requiring only employment data at an industry by industry level, namely:

$$EG_{i,j} = \frac{\sum_{r=1}^{R}(s_{ri} - x_r)(s_{rj} - x_r)}{1 - \sum_{r=1}^{R} x_r^2}$$

where *r* indexes the regions covered in the analysis, s_{ri} is the share of industry *i*'s employment in region *r*, s_{rj} is the share of industry *j*'s in region *r*, and x_r is the mean employment share in region *r* across all industries. As mentioned above, various elaborations of this index have been advanced in the literature, but all require firm-level data.

Summary

One issue with the EG index is that it yields a measure that is in effect the average co-agglomeration of two industries, *i* and *j*, across all regions in the larger geographical area being studied. It does not provide an index of co-agglomeration on a region by region basis. Another issue is that there are no standard statistical tests of the significance of the index. Cassey and Smith (2014) have proposed a simulation method for estimating the significance of the EF index of concentration or agglomeration of a single industry (although this again requires plant level data), but no such corresponding test appears to exist for the co-agglomeration shown above.

The notion and potential benefit of developing clusters remains strong in the agenda of policy makers at all levels of government. The strength of this concept resonates mostly from the seminal work undertaken in the 1980s and 1990s by Michael Porter, and more latterly adopted within the field of new economic geography. While the cluster concept originates in Porter's work on business economics, agglomeration (the benefits that accrue from densification of activity) largely stems from the urban economics literature. Agglomeration benefits are generally divided into two types, urbanisation (the benefits from locating in more densely-populated areas) and localisation (the benefits from locating near firms from similar or related sectors). It is mostly the latter (localisation) agglomeration benefits that are associated with clusters. From the perspective of the study and the interest of how increasing integration across Europe might affecting clustering and agglomeration, the theory would suggest that increasing concentration (co-location) of activity should result.

Within Europe, the European Cluster Observatory represents the main pan-EU focus for analysis. However, exploration of this site has revealed little in the way of detailed regional empirical work, possibly due to the difficulty of obtaining reliable data, an issue which the current study has tried to address. What work does exist is often firm-based, using for example the Amadeus database, or country-specific where access to detailed datasets is more readily available.

For the current study, in terms of measuring agglomeration, lack of firm level data restrict the analysis somewhat, but it is still possible to use location quotient cross-correlations and the simplified version of the Ellison-Glaeser statistic with the regional-sector data to hand. The results of this analysis are presented in the next section.

5.4 Results from Measures of Clustering and Agglomeration

Re-cap on available data

As noted previously, the majority of cluster analysis relies on access to detailed firm-level data, or at least sources that allow for a high detail of sectoral disaggregation. Unfortunately this is not the case with the database that has been established for this study, and this therefore limits the extent to which clusters can be analysed (and identified). This sub-section reviews the available data and analyses which sectors will be included in the cluster analysis.

Chapter 3 and 4 databases

Two sets of sector databases have been developed with different sector/geographical coverage.

- Chapter 3 sectors

For the database constructed in Chapter 3, sectors were chosen which allowed sufficient correspondence between the NACE versions covering the years 2003 / 2007 (Rev 1.1) and 2011 / 2015 (Rev 2). Table 5.1 provides a recap.

Table 5.1: Chapter 3 sector coverage

NACE Rev1.1		NACE Rev2	
Code	**Sector Name**	**Code**	**Sector Name**
DA	Manufacture of food products, beverages and tobacco	C10, C11	Manufacture of food products; Manufacture of beverages
DD	Manufacture of wood and wood products	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
DE21	Manufacture of pulp, paper and paper products	C17	Manufacture of paper and paper products
DH	Manufacture of rubber and plastic products	C22	Manufacture of rubber and plastic products
DI	Manufacture of other non-metallic mineral products	C23	Manufacture of other non-metallic mineral products
DJ27	Manufacture of basic metals	C24	Manufacture of basic metals
G50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	G46	Wholesale trade, except of motor vehicles and motorcycles
G52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	G47	Retail trade, except of motor vehicles and motorcycles
H	Hotels and restaurants	I	Accommodation and food service activities

NACE Rev1.1		NACE Rev2	
Code	**Sector Name**	**Code**	**Sector Name**
I60	Land transport; transport via pipelines	H49	Land transport and transport via pipelines
K73	Research and development	M72	Scientific research and development

- Chapter 4 manufacturing sectors

For the analysis of specialisation and geographical concentration, attention also focussed on the manufacturing sector as the work attempted to replicate and extend the analysis of Cutrini (2010). Table 5.2 shows the sector coverage available.

Table 5.2: Chapter 4 manufacturing sector coverage

NACE Rev1.1		NACE Rev2	
Code	Sector Name	Code	Sector Name
DA	Manufacture of food products, beverages and tobacco	C10	Manufacture of food products
		C11	Manufacture of beverages
DB	Manufacture of textiles and textile products	C13	Manufacture of textiles
		C14	Manufacture of wearing apparel
DD	Manufacture of wood and wood products	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
DE	Manufacture of pulp, paper and paper products; publishing and printing	C17	Manufacture of paper and paper products
		C18	Printing and reproduction of recorded media
DG	Manufacture of chemicals, chemical products and man-made fibres	C20	Manufacture of chemicals and chemical products
DH	Manufacture of rubber and plastic products	C22	Manufacture of rubber and plastic products
DI	Manufacture of other non-metallic mineral products	C23	Manufacture of other non-metallic mineral products
DJ	Manufacture of basic metals and fabricated metal products	C24	Manufacture of basic metals
		C25	Manufacture of fabricated metal products, except machinery and equipment
DK	Manufacture of machinery and equipment n.e.c.	C28	Manufacture of machinery and equipment n.e.c.
DL	Manufacture of electrical and	C26	Manufacture of computer, electronic and

NACE Rev1.1		NACE Rev2	
Code	Sector Name	Code	Sector Name
	optical equipment	C27	optical products Manufacture of electrical equipment
DM	Manufacture of transport equipment	C29	Manufacture of motor vehicles, trailers and semi-trailers
DN	Manufacturing n.e.c.	C31 C32 C33	Manufacture of furniture Other manufacturing Repair and installation of machinery and equipment

- Geographical coverage

The additional manufacturing detail provided for the Chapter 4 analysis came at the cost of reducing the regional coverage of the data. Table 5.3 provides the detail.

Table 5.3: Geographical coverage of the datasets from Chapter 3 and Chapter 4

Member State	Number of NUTS regions	
	Original database in Chapter 3	Manufacturing only database in Chapter 4
Austria	7	7
Belgium	11	11
France	22	20
Germany	38	19
Greece	13	13
Hungary	7	7
Italy	21	21
Netherlands	12	12
Poland	16	16
Slovakia	4	4
Spain	17	16
Sweden	8	8
United Kingdom	37	34
Portugal	N/A	5
Total	**213**	**193**

Choice of sectors and geography for cluster analysis

Both the LQ and EG co-agglomeration statistics are largely atheoretical, in that they will generate a set of average pairwise correlations for all sectors in the analysis regardless of whether they are likely to be directly connected. However, a priori reasoning can be used to judge which sector combinations are more likely to provide promising results, which can also help to narrow down the analysis to those considered more meaningful.

Use of input-output linkages

In particular, input-output (IO) tables can be used to establish the strongest sector supply linkages for those in the sample, and therefore provide a justification for co-location. Using IO tables from Eurostat, Table 5.4 lists the strongest[47] supply-chain (intermediate demand) relationships for each of the sectors in Tables 5.2 and 5.3, highlighting any that are available in the current sample.

Table 5.4: Sector supply-chain linkages

Sector	Supply-Chain Sectors
Food products, beverages and tobacco products	
Textiles, wearing apparel and leather products	Chemicals and chemical products Wholesale trade services, except of motor vehicles and motorcycles
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	Wholesale trade services, except of motor vehicles and motorcycles
Paper and paper products	Wholesale trade services, except of motor vehicles and motorcycles
Printing and recording services	Paper and paper products Wholesale trade services, except of motor vehicles and motorcycles
Chemicals and chemical products	
Rubber and plastics products	Chemicals and chemical products
Other non-metallic mineral products	Chemicals and chemical products
Basic metals	
Fabricated metal products, except machinery and equipment	Basic metals Wholesale trade services, except of motor vehicles and motorcycles
Computer, electronic and optical products	Electrical equipment Wholesale trade services, except of motor vehicles and motorcycles
Electrical equipment	Basic metals Fabricated metal products, except machinery and

[47] To define what we mean by strong supply-chain linkages, the combined use matrix was analysed for a selection of the larger Member States (DE, ES, FR, PL, and the UK) and the proportions of intermediate demand that each sector supplies to the other was analysed. Proportions of 10% and above are listed in Table 3.4, aside from the own-sector demand which is typically the dominant proportion.

Sector	Supply-Chain Sectors
	equipment Computer, electronic and optical products
Machinery and equipment n.e.c.	Basic metals Fabricated metal products, except machinery and equipment Wholesale trade services, except of motor vehicles and motorcycles
Motor vehicles, trailers and semi-trailers	Basic metals Fabricated metal products, except machinery and equipment
Furniture; other manufactured goods	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials Wholesale trade services, except of motor vehicles and motorcycles
Repair and installation services of machinery and equipment	Fabricated metal products, except machinery and equipment Machinery and equipment n.e.c. Wholesale trade services, except of motor vehicles and motorcycles Motor vehicles, trailers and semi-trailers
Wholesale and retail trade and repair services of motor vehicles and motorcycles	Motor vehicles, trailers and semi-trailers
Wholesale trade services, except of motor vehicles and motorcycles	Land transport services and transport services via pipelines
Retail trade services, except of motor vehicles and motorcycles	
Land transport services and transport services via pipelines	Wholesale trade services, except of motor vehicles and motorcycles
Accommodation and food services	Food products, beverages and tobacco products Wholesale trade services, except of motor vehicles and motorcycles
Scientific research and development services	Chemicals and chemical products

A few points emerge from Table 5.4:

- Clearly the wholesale trade services sector is linked with many of the sectors, but this is unlikely to mean that the activities would be located near to one another. Indeed, the main link in the other direction is with land transport services, where co-location could possibly occur due to the

presence of strong infrastructure linkages or a central location (for distributional purposes).

- Similarly, accommodation and food services is linked with food, beverages and tobacco most likely due to a third factor, namely urbanisation or tourism locations.
- Some traditional manufacturing linkages emerge (e.g. rubber and plastics with chemicals, motor vehicles with basic metals) and it is possibly here that co-location is more likely.

Geography of analysis

The EG statistic provides an average (across the geography being analysed) of location correlations. In a similar way, the LQ statistic (which is by industry and region) can be correlated across regions for pairwise industry combinations.

For this reason, outside of an overall EU average, only countries with a large enough number of regions can be analysed, otherwise the power of the statistics calculated will not be robust. Based on Table 5.3, the following Member States could possibly be analysed individually, alongside a pan-European calculation: Germany, France, Spain, Italy, Poland, and the UK.

Location quotient analysis

The industry location quotients have been calculated for each of the region-industry combinations in the sample, using the formula described in the previous chapter, with the correlation coefficients (and associated significance) calculated from this, i.e. for each industry, the correlation takes places across the regions in the sample. The location quotients are calculated over each of the four years of data.

Pan-EU results

- Nace Rev1 sectors

Tables 5.5a-d show the cross-correlation coefficients for all the sectors in the sample, with coefficients coloured red if they are significant at 95% confidence limits (i.e. p-value <= 0.05), with the top-10% (highest) of correlations also shaded red. The tables are presented as triangular matrices[48], because the results are symmetric, and the two-letter abbreviations are the industry codes as described in Tables 5.1 and 5.2.

The combinations that stand out as being particularly strong (across both years) and which are justified by potential supply-chain relationships, are as follows:

- DK (Manufacture of basic metals and fabricated metal products) and DJ (Manufacture of machinery and equipment n.e.c.).
- DN (Manufacturing n.e.c.) with DD (Manufacture of wood and wood product), particularly as DN contains furniture manufacturing;
- Retail service sectors (G50, G52) and H (Hotels and restaurants) which have more to do with demand-side linkages related to co-incidental factors such as urbanisation.

Generally speaking, there is little evidence, at EU level, that the LQ values have increased over the two periods. Table 5.6a shows the difference, with

[48] The leading diagonal has been removed as all these correlations are equal to 1.

red numbers highlighting changes from significant correlations (though not necessarily significant changes) while the yellow highlights signify those sectors for which supply-chain linkages might be expected. The average change across the significant correlations is -0.007.

- Nace Rev2 sectors

For the periods 2011 and 2015 which use Nace Rev2 sector definitions, there is more variation of significance. Tables 5.5c and 5.5d show the results, with the significant (positive) values highlighted in red, while the top 10% (highest correlations) are shaded in red, as with the Rev1 tables.

Rather than go through all the top combinations (some of which might be spurious and not worth reporting) the combinations which are justified by the supply-chain linkages mentioned in Table 5.4 are as follows:

- Manufacture of furniture (C31), and Wood and of products of wood (C16);
- Computer, electronic and optical products (C26) and Electrical equipment (C27);
- Machinery and equipment n.e.c. (C28) and Fabricated metal products, except machinery and equipment (C25);
- Chemicals and chemical products (C20), Rubber and plastic products (C22), and Other non-metallic mineral products (C23);
- Basic metals (C24) with Fabricated metal products, except machinery and equipment (C25);
- Manufacture of machinery and equipment n.e.c. (C28) and Manufacture of motor vehicles, trailers and semi-trailers (C29).

Unlike the Rev1 differences, the change between 2015 and 2011 for those sector combinations of interest is generally positive, implying increasing co-location activity. The changes are quite small, however, and are likely a reflection of both the short time period between the observations and also the generally limited progress of integration across the whole of the EU sample. Table 5.6b shows the period change, using the same colour coding as described for Table 3.6a above. The average change for significant cross-sector correlations is 0.009.

- Changes across sectors in all four periods

There are a few sectors where the definitions transcend the change from Rev1 to Rev2, and even less where supply-chain linkages can be used to judge whether a meaningful concentration measure has strengthened over the whole period. Possibly the only combination that meets these criteria is between the manufacturing of wood and wood products (DD/C16), with that of pulp, paper and paper products (DE/C17). Here there is evidence of increasing concentration, with the LQ correlation increasing from 0.103, to 0.159, 0.429 and 0.468 in the four periods.

Table 5.5a: Location Quotient Correlation Coefficients (EU Sample, 2003)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.320	0.319	-0.084	-0.067	0.350	0.260	0.162	0.030	0.058	-0.017	0.299	-0.035	-0.068	-0.100	-0.236	0.233	-0.350
DB			0.233	-0.081	-0.093	0.163	0.343	0.230	0.187	0.209	-0.070	0.372	-0.112	0.041	-0.118	-0.188	0.062	-0.295
DD				0.103	-0.236	0.187	0.319	0.313	0.285	0.092	-0.050	0.614	-0.034	-0.107	-0.187	-0.065	0.121	-0.351
DE					0.253	0.166	-0.209	0.123	0.296	0.258	0.134	0.166	0.132	0.282	0.072	-0.079	0.173	0.334
DG						0.229	-0.012	0.111	0.134	0.201	0.090	-0.049	0.024	0.190	-0.061	-0.168	0.046	0.196
DH							0.159	0.518	0.419	0.394	0.268	0.385	-0.023	-0.117	-0.128	-0.226	0.030	-0.097
DI								0.349	0.211	0.030	-0.030	0.309	-0.025	-0.059	-0.161	-0.107	0.141	-0.363
DJ									0.602	0.357	0.264	0.390	-0.064	-0.120	-0.308	-0.216	0.076	-0.244
DK										0.600	0.385	0.440	-0.164	-0.024	-0.325	-0.271	-0.058	-0.019
DL											0.321	0.203	-0.210	-0.129	-0.259	-0.305	0.043	0.076
DM												0.134	-0.117	-0.035	-0.150	-0.208	-0.039	0.038
DN													0.026	0.091	-0.052	-0.166	0.036	-0.207
G50														0.154	0.548	0.393	0.004	0.088
G51															0.190	0.065	0.267	0.287
G52																0.575	-0.035	0.183
H																	-0.083	0.044
I60																		-0.119
K73																		

Table 5.5b: Location Quotient Correlation Coefficients (EU Sample, 2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.293	0.301	-0.137	-0.094	0.416	0.283	0.164	0.009	0.035	0.034	0.301	0.001	-0.024	-0.218	-0.222	0.173	-0.359
DB			0.208	-0.098	-0.105	0.224	0.296	0.206	0.170	0.194	-0.007	0.431	-0.013	0.072	-0.156	-0.157	0.040	-0.305
DD				0.159	-0.206	0.266	0.349	0.382	0.297	0.147	0.061	0.639	0.058	-0.095	-0.204	-0.068	0.201	-0.365
DE					0.213	0.138	-0.207	0.166	0.292	0.185	0.065	0.153	0.148	0.204	0.007	-0.109	0.186	0.261
DG						0.179	-0.007	0.063	0.129	0.135	0.046	-0.087	0.103	0.148	-0.080	-0.184	0.028	0.139
DH							0.230	0.506	0.448	0.487	0.367	0.451	-0.025	-0.149	-0.242	-0.350	0.194	-0.149
DI								0.350	0.184	0.077	0.072	0.348	-0.005	-0.039	-0.168	-0.123	0.144	-0.379
DJ									0.600	0.415	0.308	0.413	-0.067	-0.165	-0.336	-0.261	0.149	-0.290
DK										0.611	0.435	0.421	-0.126	-0.060	-0.383	-0.294	0.061	-0.015
DL											0.417	0.260	-0.174	-0.132	-0.293	-0.322	0.138	0.046
DM												0.165	-0.107	-0.118	-0.204	-0.269	0.044	-0.040
DN													0.012	0.083	-0.128	-0.203	0.148	-0.282
G50														0.114	0.471	0.312	0.025	0.100
G51															0.242	0.042	0.185	0.186
G52																0.512	-0.130	0.146
H																	-0.139	0.004
I60																		-0.128
K73																		

Table 5.5c: Location Quotient Correlation Coefficients (EU Sample, 2011)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.262	0.209	0.235	0.209	0.046	-0.063	0.028	0.329	0.244	-0.041	0.178	-0.065	0.040	-0.029	0.043	0.266	-0.028	0.102	0.019	-0.099	-0.068	-0.254	0.147	-0.327
C11			0.075	0.069	0.109	-0.022	-0.068	-0.007	0.198	0.202	-0.001	0.182	0.036	0.070	0.001	0.077	0.084	-0.060	-0.081	-0.054	0.047	-0.110	0.042	0.079	-0.157
C13				0.357	0.124	0.167	0.241	0.066	0.273	0.261	0.031	0.401	0.106	0.218	0.225	0.082	0.283	0.225	0.010	-0.052	0.082	-0.083	-0.100	0.009	-0.209
C14					0.252	0.041	-0.054	-0.122	0.165	0.320	-0.026	0.266	0.066	0.193	0.106	0.079	0.331	0.198	0.103	-0.187	0.038	-0.065	-0.157	0.095	-0.245
C16						0.429	-0.097	-0.142	0.251	0.365	0.260	0.436	0.034	0.220	0.232	0.093	0.551	0.125	0.192	-0.069	-0.127	-0.237	-0.119	0.334	-0.360
C17							0.132	0.222	0.232	0.102	0.480	0.377	0.143	0.321	0.354	0.164	0.181	0.144	0.149	0.168	-0.077	-0.207	-0.236	0.265	-0.096
C18								0.134	0.060	-0.123	-0.111	0.063	0.117	0.128	0.150	-0.044	0.076	0.290	-0.107	0.275	0.262	0.092	0.013	0.060	0.194
C20									0.201	0.105	0.095	0.178	0.144	0.153	0.188	0.147	-0.029	0.068	0.113	0.216	0.143	-0.086	-0.185	0.066	0.111
C22										0.234	0.124	0.554	0.318	0.457	0.367	0.336	0.379	0.364	0.216	0.106	-0.127	-0.287	-0.353	0.092	-0.194
C23											0.138	0.373	0.099	0.220	0.191	0.238	0.385	0.065	0.091	-0.023	-0.057	-0.097	-0.107	0.205	-0.367
C24												0.372	0.077	0.222	0.274	0.200	-0.009	0.011	0.146	0.049	-0.104	-0.083	-0.069	0.152	-0.125
C25													0.329	0.615	0.628	0.361	0.415	0.427	0.272	0.052	-0.085	-0.285	-0.282	0.153	-0.248
C26														0.521	0.438	0.449	0.065	0.464	0.227	0.069	-0.046	-0.089	-0.137	0.154	0.142
C27															0.677	0.442	0.278	0.497	0.243	0.054	0.004	-0.228	-0.213	0.084	-0.019
C28																0.504	0.230	0.535	0.174	0.119	0.068	-0.219	-0.166	-0.034	0.010
C29																	0.125	0.172	0.205	0.007	0.032	-0.197	-0.257	0.194	-0.012
C31																		0.237	0.163	-0.057	0.025	-0.130	-0.241	0.145	-0.256
C32																			0.223	0.274	0.085	-0.045	-0.054	-0.006	0.001
C33																				-0.028	0.062	-0.230	-0.342	0.300	-0.124
G45																					0.098	0.283	0.053	-0.031	0.128
G46																						0.156	0.008	0.219	0.196
G47																							0.478	-0.039	0.183
I																								-0.093	0.104
H49																									-0.160
M72																									

Table 5.5d: Location Quotient Correlation Coefficients (EU Sample, 2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.218	0.272	0.209	0.202	0.072	0.032	0.000	0.242	0.251	-0.051	0.145	-0.097	0.022	-0.015	-0.001	0.258	0.007	0.047	-0.048	-0.024	-0.023	-0.098	0.110	-0.282
C11			0.087	0.059	0.071	0.014	-0.042	-0.005	0.107	0.109	0.005	0.124	-0.027	0.029	-0.012	0.042	0.031	-0.015	-0.098	-0.097	-0.013	-0.137	0.044	0.053	-0.052
C13				0.411	0.163	0.200	0.290	0.078	0.336	0.289	0.016	0.425	0.165	0.278	0.251	0.126	0.330	0.268	0.057	-0.036	0.104	-0.046	-0.123	0.062	-0.211
C14					0.207	0.075	0.048	-0.104	0.179	0.334	-0.003	0.253	0.047	0.199	0.128	0.084	0.308	0.269	0.117	-0.188	0.041	-0.153	-0.151	0.119	-0.224
C16						0.468	0.030	-0.085	0.304	0.373	0.247	0.471	0.083	0.285	0.228	0.127	0.621	0.131	0.193	0.086	-0.090	-0.238	-0.178	0.335	-0.374
C17							0.115	0.197	0.251	0.163	0.377	0.399	0.155	0.369	0.323	0.119	0.223	0.173	0.122	0.214	-0.067	-0.122	-0.238	0.210	-0.174
C18								0.117	0.152	-0.001	-0.102	0.174	0.075	0.187	0.139	-0.020	0.188	0.244	-0.015	0.307	0.287	0.179	-0.130	0.017	0.023
C20									0.205	0.201	0.091	0.189	0.162	0.155	0.206	0.122	0.010	0.100	0.222	0.172	0.118	-0.020	-0.214	0.071	-0.001
C22										0.322	0.195	0.574	0.345	0.481	0.389	0.356	0.423	0.400	0.200	0.176	-0.059	-0.177	-0.319	0.124	-0.225
C23											0.173	0.388	0.173	0.304	0.266	0.261	0.388	0.143	0.205	0.037	-0.035	-0.165	-0.159	0.234	-0.328
C24												0.403	0.100	0.273	0.295	0.222	0.026	0.079	0.217	0.087	-0.126	-0.052	-0.081	0.110	-0.162
C25													0.421	0.637	0.633	0.365	0.418	0.490	0.271	0.114	0.004	-0.178	-0.302	0.152	-0.275
C26														0.516	0.517	0.410	0.083	0.553	0.157	0.169	-0.035	-0.046	-0.168	0.119	0.058
C27															0.669	0.453	0.327	0.521	0.195	0.100	-0.016	-0.170	-0.254	0.161	-0.081
C28																0.492	0.227	0.524	0.152	0.163	0.111	-0.120	-0.182	0.014	-0.069
C29																	0.124	0.238	0.203	0.066	0.067	-0.120	-0.222	0.292	-0.086
C31																		0.241	0.179	0.036	0.084	-0.077	-0.197	0.215	-0.267
C32																			0.170	0.142	0.064	-0.036	-0.157	0.040	-0.076
C33																				0.057	0.144	-0.108	-0.290	0.290	-0.193
G45																					0.078	0.360	-0.095	-0.077	0.110
G46																						0.249	-0.041	0.234	0.117
G47																							0.374	-0.119	0.172
I																								-0.088	0.148
H49																									-0.168
M72																									

Table 5.6a: EU Location Quotient Correlation Coefficients Changes (2003-2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		-0.027	-0.017	-0.053	-0.027	0.066	0.024	0.002	-0.021	-0.023	0.051	0.002	0.036	0.045	-0.118	0.014	-0.060	-0.009
DB			-0.025	-0.017	-0.012	0.061	-0.047	-0.024	-0.016	-0.014	0.064	0.059	0.099	0.031	-0.038	0.030	-0.022	-0.010
DD				0.056	0.031	0.079	0.030	0.069	0.013	0.055	0.111	0.025	0.092	0.012	-0.017	-0.003	0.080	-0.015
DE					-0.040	-0.027	0.001	0.043	-0.005	-0.072	-0.069	-0.012	0.016	-0.079	-0.066	-0.030	0.013	-0.073
DG						-0.050	0.005	-0.048	-0.006	-0.065	-0.043	-0.038	0.080	-0.041	-0.020	-0.016	-0.018	-0.057
DH							0.072	-0.012	0.029	0.094	0.099	0.066	-0.002	-0.033	-0.115	-0.123	0.163	-0.051
DI								0.002	-0.027	0.047	0.102	0.039	0.020	0.020	-0.008	-0.017	0.003	-0.016
DJ									-0.002	0.058	0.044	0.023	-0.003	-0.044	-0.028	-0.045	0.073	-0.045
DK										0.011	0.050	-0.019	0.038	-0.037	-0.057	-0.023	0.119	0.004
DL											0.096	0.057	0.036	-0.003	-0.034	-0.017	0.095	-0.030
DM												0.031	0.009	-0.083	-0.054	-0.061	0.084	-0.078
DN													-0.014	-0.008	-0.076	-0.037	0.112	-0.075
G50														-0.039	-0.077	-0.080	0.021	0.012
G51															0.051	-0.023	-0.083	-0.101
G52																-0.063	-0.096	-0.037
H																	-0.056	-0.040
I60																		-0.009
K73																		

Table 5.6b: EU Location Quotient Correlation Coefficients Changes (2011-2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		-0.044	0.063	-0.027	-0.008	0.026	0.095	-0.028	-0.088	0.007	-0.010	-0.033	-0.032	-0.018	0.014	-0.044	-0.008	0.035	-0.055	-0.067	0.075	0.045	0.156	-0.038	0.045
C11			0.012	-0.010	-0.037	0.036	0.026	0.001	-0.091	-0.093	0.006	-0.059	-0.062	-0.042	-0.013	-0.035	-0.053	0.045	-0.016	-0.042	-0.059	-0.027	0.002	-0.026	0.104
C13				0.054	0.038	0.033	0.049	0.013	0.063	0.028	-0.015	0.024	0.059	0.059	0.025	0.044	0.046	0.043	0.048	0.016	0.022	0.037	-0.023	0.053	-0.002
C14					-0.045	0.033	0.102	0.018	0.014	0.014	0.023	-0.013	-0.018	0.006	0.022	0.005	-0.024	0.072	0.015	-0.001	0.002	-0.088	0.006	0.024	0.021
C16						0.039	0.127	0.056	0.053	0.008	-0.013	0.035	0.049	0.065	-0.004	0.034	0.070	0.007	0.001	0.155	0.037	-0.001	-0.059	0.001	-0.014
C17							-0.018	-0.025	0.018	0.062	-0.103	0.022	0.012	0.048	-0.031	-0.045	0.043	0.030	-0.028	0.046	0.010	0.085	-0.002	-0.055	-0.077
C18								-0.017	0.091	0.122	0.009	0.111	-0.042	0.059	-0.011	0.024	0.111	-0.045	0.091	0.031	0.025	0.087	-0.143	-0.043	-0.171
C20									0.004	0.096	-0.004	0.011	0.018	0.002	0.018	-0.025	0.040	0.031	0.110	-0.044	-0.025	0.066	-0.030	0.005	-0.113
C22										0.088	0.071	0.021	0.027	0.024	0.022	0.020	0.044	0.036	-0.015	0.070	0.068	0.110	0.034	0.032	-0.031
C23											0.035	0.015	0.074	0.083	0.075	0.023	0.002	0.078	0.114	0.060	0.022	-0.068	-0.052	0.029	0.039
C24												0.031	0.023	0.050	0.021	0.022	0.035	0.068	0.071	0.038	-0.023	0.031	-0.012	-0.042	-0.037
C25													0.092	0.022	0.005	0.004	0.002	0.063	0.000	0.061	0.088	0.106	-0.020	-0.002	-0.027
C26														-0.005	0.078	-0.039	0.018	0.089	-0.069	0.100	0.011	0.043	-0.031	-0.035	-0.084
C27															-0.008	0.011	0.049	0.024	-0.049	0.046	-0.020	0.058	-0.042	0.077	-0.062
C28																-0.012	-0.003	-0.011	-0.022	0.044	0.043	0.100	-0.017	0.048	-0.079
C29																	-0.001	0.066	-0.002	0.059	0.035	0.077	0.035	0.098	-0.074
C31																		0.004	0.017	0.092	0.059	0.053	0.043	0.070	-0.011
C32																			-0.053	-0.131	-0.020	0.009	-0.104	0.046	-0.078
C33																				0.085	0.081	0.122	0.052	-0.010	-0.069
G45																					-0.020	0.077	-0.148	-0.045	-0.018
G46																						0.093	-0.048	0.015	-0.080
G47																							-0.104	-0.080	-0.011
I																								0.005	0.044
H49																									-0.009
M72																									

Individual Member States

As noted previously, part of the reason behind limited change in the LQ correlations could be because they are calculated across an average of all EU regions in the sample, where a range of EU Member States at different stages of integration are present, thus potentially obscuring results. By analysing individual Member States the degree of heterogeneity would be reduced. With this in mind, the LQ correlation coefficients were reproduced for some of the larger Member States in the sample (Poland and the UK).

Poland

Of the larger countries, all except Poland are well-established (and therefore well-integrated) EU members and this would point to using Poland as an example of where change over time might be most easily observed. The disadvantage of using Poland is that it only has 16 regions over which to average the LQ coefficient correlations.

The results of the analysis (see Tables 5.7a-d) do not generally yield much evidence either way. There is no more evidence of increases in the LQ correlations for Poland than there is for the EU sample data. Most of the strong correlations occur among the service sectors, which could be related to the strong urbanisation forces and development of the capital city region over this time. It could also be that the loss of observations from moving to Member State level offsets the greater focus obtained by looking at individual countries. Tables 5.8a-b show the changes in the correlation coefficients, using colours in the same way as for the EU equivalents in Tables 5.6a and b. The average changes of significant coefficients over the two periods are -0.040 and -0.061.

UK

For reasons stated above, while Poland is an interesting example from an integration perspective, it is less promising in terms of the number of regions. For this reason, the UK was also selected as it has the largest number of NUTS2 regions of any Member State in the sample (see Table 5.3). Tables 5.9a-d thus show the equivalent LQ correlations for the UK over the four available periods from the SBS database, while Tables 3.10a and b show the coefficient changes across the two sets of periods.

Compared to Poland, the significant correlations in the UK are located mostly amongst the manufacturing sectors and less in services, but on the whole there are few combinations where a significant correlation also coincides with a strong supply-chain linkage which is also positive. In fact, the only combination for the 2003-07 change which meets these criteria is DI (Manufacture of other non-metallic mineral products) and DH (Manufacture of rubber and plastic products), while for the 2011-15 period change no such coincidence occurs. Overall, the average changes of significant coefficients over the two periods are -0.036 and -0.084.

Table 5.7a: Location Quotient Correlation Coefficients (Poland, 2003)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		-0.027	0.214	0.138	-0.149	0.116	-0.626	-0.316	-0.344	-0.128	-0.135	0.389	-0.052	-0.092	-0.238	-0.152	-0.100	-0.172
DB			-0.191	-0.043	0.009	0.035	0.136	-0.132	-0.056	0.142	-0.194	0.069	0.062	0.010	-0.210	-0.150	-0.195	-0.123
DD				-0.320	-0.436	0.225	-0.184	-0.286	-0.415	-0.053	0.154	0.638	-0.195	-0.393	-0.177	0.220	-0.368	-0.481
DE					0.693	0.099	-0.291	0.073	-0.257	0.498	0.022	-0.107	0.550	0.770	0.599	0.175	0.759	0.704
DG						-0.033	-0.125	0.159	0.003	0.478	0.031	-0.231	0.377	0.498	0.381	0.169	0.470	0.444
DH							-0.212	0.096	0.084	0.215	0.430	0.448	0.274	0.326	0.041	0.130	-0.022	0.021
DI								0.383	0.633	-0.040	0.030	-0.173	-0.129	-0.197	-0.066	-0.226	-0.165	-0.195
DJ									0.677	0.513	0.248	-0.057	0.483	0.332	0.361	0.282	-0.066	0.136
DK										0.240	0.302	-0.087	0.258	0.108	0.022	-0.049	-0.162	-0.018
DL											0.415	0.291	0.815	0.709	0.610	0.557	0.330	0.515
DM												0.094	0.321	0.361	0.217	0.571	-0.057	0.115
DN													0.124	-0.137	-0.099	0.138	-0.281	-0.289
G50														0.840	0.747	0.582	0.439	0.557
G51															0.801	0.468	0.711	0.846
G52																0.694	0.672	0.756
H																	0.116	0.276
I60																		0.890
K73																		

Table 5.7b: Location Quotient Correlation Coefficients (Poland, 2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.063	0.416	0.334	0.040	0.351	-0.625	-0.191	-0.261	-0.129	-0.194	0.435	0.289	0.200	0.160	0.069	-0.097	-0.158
DB			-0.223	0.047	-0.003	0.151	0.079	-0.118	-0.081	0.155	-0.113	0.061	-0.027	0.062	-0.133	-0.168	-0.212	-0.129
DD				-0.155	-0.305	0.313	-0.174	-0.114	-0.271	0.017	0.218	0.658	0.000	-0.265	-0.126	0.360	-0.291	-0.414
DE					0.640	0.171	-0.361	0.164	-0.227	0.420	-0.015	0.098	0.703	0.838	0.792	0.253	0.683	0.541
DG						0.125	-0.197	0.243	0.124	0.412	0.079	-0.022	0.503	0.591	0.558	0.265	0.439	0.401
DH							-0.141	0.210	0.325	0.213	0.407	0.609	0.312	0.325	0.106	0.134	-0.147	-0.104
DI								0.387	0.520	0.049	0.214	-0.067	-0.216	-0.324	-0.289	-0.264	-0.258	-0.255
DJ									0.615	0.566	0.472	0.130	0.573	0.334	0.246	0.355	-0.094	0.136
DK										0.333	0.492	0.139	0.248	0.107	-0.036	-0.110	-0.241	0.025
DL											0.565	0.305	0.703	0.594	0.427	0.469	0.275	0.459
DM												0.230	0.440	0.334	0.206	0.483	-0.046	0.139
DN													0.303	-0.001	0.001	0.051	-0.250	-0.247
G50														0.823	0.783	0.557	0.401	0.456
G51															0.856	0.439	0.670	0.734
G52																0.572	0.655	0.729
H																	0.175	0.346
I60																		0.712
K73																		

Table 5.7c: Location Quotient Correlation Coefficients (Poland, 2011)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.335	0.002	0.007	0.408	0.319	0.301	0.193	0.212	-0.466	-0.423	0.080	-0.292	-0.057	0.126	-0.328	0.479	0.187	0.090	0.245	0.177	0.173	0.033	0.061	-0.257
C11			-0.130	-0.059	-0.185	-0.199	0.674	0.205	-0.150	-0.475	0.041	-0.284	-0.257	-0.027	-0.109	-0.120	-0.138	0.268	0.011	0.475	0.558	0.653	0.203	0.458	0.505
C13				0.753	-0.184	0.310	0.005	-0.106	0.372	0.213	-0.045	0.064	0.287	0.646	0.179	0.289	0.193	0.475	-0.072	0.076	0.168	0.058	-0.137	-0.054	-0.129
C14					-0.254	0.067	0.033	-0.167	0.162	0.069	-0.225	-0.221	0.059	0.190	-0.347	-0.207	-0.042	0.138	-0.153	-0.249	0.025	-0.106	-0.187	-0.139	-0.095
C16						0.059	-0.339	-0.140	0.193	-0.026	-0.315	0.178	-0.054	-0.234	0.163	0.026	0.693	-0.009	0.112	0.123	-0.291	-0.064	0.314	-0.076	-0.447
C17							0.311	0.464	0.324	-0.137	-0.223	0.452	0.386	0.174	0.199	0.057	0.296	0.383	0.142	0.275	0.352	0.228	-0.021	0.244	-0.100
C18								0.306	0.046	-0.413	-0.095	-0.090	0.002	0.018	-0.221	-0.293	-0.066	0.243	-0.004	0.480	0.801	0.785	0.208	0.612	0.632
C20									0.125	-0.243	0.109	0.424	0.179	0.243	-0.102	0.098	-0.143	0.205	0.370	0.466	0.423	0.394	0.350	0.473	0.224
C22										-0.074	-0.004	0.276	0.286	0.450	0.390	0.136	0.518	0.461	0.140	0.227	0.278	0.150	0.145	-0.035	-0.088
C23											0.362	0.384	0.014	0.374	0.347	0.509	0.021	-0.158	-0.110	-0.177	-0.388	-0.256	-0.253	-0.322	-0.258
C24												0.483	-0.113	0.488	0.278	0.690	-0.306	0.021	0.221	0.155	0.018	-0.036	0.066	-0.056	0.129
C25													0.301	0.513	0.435	0.564	0.122	0.381	0.648	0.484	0.170	0.115	0.326	0.151	-0.096
C26														0.310	0.152	0.146	-0.035	0.646	0.560	0.400	0.367	0.256	0.435	0.372	0.390
C27															0.527	0.662	0.152	0.523	0.267	0.429	0.272	0.229	0.119	0.062	0.075
C28																0.614	0.417	0.428	0.079	0.227	-0.051	-0.056	-0.254	-0.228	-0.263
C29																	0.104	0.321	0.232	0.375	0.039	0.030	0.041	0.088	-0.036
C31																		0.112	-0.140	0.149	-0.101	0.087	-0.010	-0.123	-0.364
C32																			0.594	0.720	0.643	0.524	0.395	0.417	0.293
C33																				0.663	0.431	0.268	0.695	0.496	0.361
G45																					0.792	0.820	0.693	0.790	0.548
G46																						0.837	0.474	0.841	0.754
G47																							0.586	0.745	0.645
I																								0.598	0.450
H49																									0.793
M72																									

Table 5.7d: Location Quotient Correlation Coefficients (Poland, 2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.564	0.152	0.090	0.472	0.280	0.516	-0.042	0.184	-0.365	-0.333	0.075	-0.383	0.012	0.247	-0.332	0.502	0.346	-0.128	0.368	0.319	0.460	0.131	0.278	-0.177
C11			0.001	0.023	-0.054	-0.153	0.543	0.231	-0.013	-0.273	0.131	-0.120	-0.348	0.152	0.283	0.040	0.025	0.281	0.074	0.399	0.461	0.532	0.062	0.357	0.186
C13				0.727	-0.069	0.369	0.087	-0.057	0.433	0.168	-0.045	0.096	0.234	0.674	0.179	0.304	0.338	0.669	-0.045	0.219	0.240	0.297	-0.069	0.306	-0.075
C14					-0.231	0.014	0.089	-0.159	0.045	0.145	-0.151	-0.236	-0.019	0.237	-0.227	-0.141	-0.033	0.257	-0.280	-0.193	0.029	0.026	-0.186	-0.019	-0.081
C16						0.126	-0.170	-0.042	0.236	-0.051	-0.279	0.230	-0.009	-0.049	0.238	-0.005	0.629	0.010	-0.014	0.274	-0.230	0.043	0.373	0.095	-0.380
C17							0.237	0.280	0.241	-0.067	-0.162	0.511	0.245	0.261	0.236	0.106	0.345	0.369	-0.026	0.283	0.228	0.242	-0.085	0.447	-0.157
C18								0.126	0.059	-0.332	0.088	0.006	-0.075	0.057	-0.083	-0.164	0.098	0.363	-0.078	0.553	0.817	0.819	0.256	0.592	0.601
C20									0.228	-0.098	0.176	0.424	0.109	0.287	0.000	0.233	-0.176	0.180	0.426	0.336	0.239	0.217	0.381	0.379	0.169
C22										0.102	0.258	0.479	0.184	0.467	0.495	0.394	0.510	0.648	0.122	0.375	0.264	0.274	0.135	0.139	-0.103
C23											0.425	0.349	-0.050	0.402	0.319	0.532	0.025	-0.157	-0.167	-0.099	-0.292	-0.158	-0.285	-0.222	-0.346
C24												0.475	-0.020	0.441	0.364	0.693	-0.255	0.137	0.301	0.337	0.179	0.139	0.148	0.082	0.184
C25													0.236	0.468	0.493	0.553	0.172	0.394	0.518	0.538	0.192	0.189	0.281	0.327	-0.119
C26														0.139	0.016	0.287	-0.025	0.446	0.475	0.255	0.216	0.147	0.314	0.368	0.432
C27															0.342	0.674	0.274	0.528	0.326	0.468	0.249	0.335	0.172	0.378	0.021
C28																0.610	0.255	0.457	0.087	0.346	0.100	0.153	-0.182	0.144	-0.389
C29																	0.085	0.363	0.358	0.515	0.183	0.221	0.095	0.372	0.026
C31																		0.262	-0.236	0.307	0.041	0.330	-0.034	0.160	-0.278
C32																			0.409	0.635	0.622	0.620	0.297	0.541	0.233
C33																				0.493	0.284	0.141	0.616	0.365	0.381
G45																					0.756	0.825	0.628	0.851	0.461
G46																						0.824	0.348	0.812	0.725
G47																							0.421	0.738	0.551
I																								0.463	0.508
H49																									0.562
M72																									

Table 5.8a: Poland Location Quotient Correlation Coefficients Changes (2003-2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.090	0.203	0.196	0.189	0.235	0.001	0.125	0.083	-0.001	-0.059	0.046	0.341	0.293	0.398	0.220	0.004	0.014
DB			-0.033	0.090	-0.013	0.116	-0.057	0.014	-0.025	0.013	0.081	-0.008	-0.089	0.052	0.076	-0.017	-0.018	-0.006
DD				0.165	0.130	0.088	0.010	0.171	0.144	0.070	0.064	0.020	0.195	0.128	0.052	0.140	0.077	0.066
DE					-0.053	0.071	-0.070	0.091	0.030	-0.078	-0.037	0.205	0.153	0.068	0.192	0.078	-0.076	-0.162
DG						0.158	-0.072	0.084	0.121	-0.066	0.048	0.209	0.125	0.093	0.177	0.096	-0.031	-0.042
DH							0.072	0.114	0.241	-0.003	-0.023	0.161	0.037	0.000	0.066	0.004	-0.125	-0.125
DI									-0.114	0.089	0.184	0.106	-0.086	-0.127	-0.223	-0.038	-0.093	-0.059
DJ									-0.062	0.053	0.224	0.187	0.090	0.002	-0.116	0.073	-0.028	0.000
DK										0.093	0.190	0.227	-0.009	-0.001	-0.058	-0.061	-0.080	0.043
DL											0.150	0.014	-0.111	-0.115	-0.183	-0.089	-0.055	-0.057
DM												0.135	0.119	-0.027	-0.010	-0.087	0.011	0.024
DN													0.178	0.136	0.100	-0.087	0.031	0.042
G50														-0.017	0.036	-0.025	-0.038	-0.101
G51															0.055	-0.029	-0.041	-0.112
G52																-0.122	-0.016	-0.026
H																	0.058	0.070
I60																		-0.178
K73																		

Table 5.8b: Poland Location Quotient Correlation Coefficients Changes (2011-2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.230	0.150	0.083	0.064	-0.038	0.215	-0.235	-0.028	0.101	0.090	-0.004	-0.091	0.069	0.121	-0.004	0.024	0.159	-0.219	0.123	0.141	0.287	0.098	0.217	0.079
C11			0.131	0.082	0.131	0.046	-0.131	0.026	0.137	0.202	0.090	0.164	-0.091	0.179	0.392	0.159	0.163	0.013	0.063	-0.077	-0.097	-0.121	-0.141	-0.100	-0.319
C13				-0.027	0.115	0.059	0.081	0.048	0.061	-0.045	0.000	0.032	-0.053	0.028	0.000	0.015	0.145	0.194	0.027	0.144	0.071	0.240	0.068	0.360	0.054
C14					0.023	-0.052	0.056	0.009	-0.117	0.076	0.074	-0.015	-0.078	0.047	0.120	0.066	0.009	0.119	-0.127	0.057	0.004	0.132	0.001	0.120	0.014
C16						0.067	0.169	0.098	0.043	-0.025	0.036	0.052	0.045	0.185	0.076	-0.031	-0.064	0.019	-0.125	0.151	0.060	0.107	0.059	0.171	0.068
C17							-0.074	-0.184	-0.083	0.071	0.061	0.059	-0.141	0.087	0.036	0.049	0.049	-0.014	-0.168	0.008	-0.125	0.013	-0.064	0.203	-0.057
C18								-0.180	0.012	0.081	0.182	0.096	-0.077	0.039	0.138	0.129	0.165	0.119	-0.074	0.073	0.016	0.033	0.048	-0.020	-0.031
C20									0.103	0.145	0.067	0.000	-0.070	0.045	0.102	0.136	-0.033	-0.024	0.056	-0.129	-0.185	-0.176	0.031	-0.095	-0.055
C22										0.176	0.262	0.203	-0.102	0.017	0.105	0.259	-0.008	0.187	-0.017	0.147	-0.014	0.124	-0.010	0.174	-0.015
C23											0.063	-0.036	-0.064	0.028	-0.029	0.023	0.004	0.001	-0.057	0.079	0.097	0.098	-0.032	0.100	-0.088
C24												-0.008	0.093	-0.047	0.085	0.003	0.051	0.116	0.080	0.182	0.161	0.174	0.082	0.138	0.054
C25													-0.065	-0.044	0.057	-0.011	0.050	0.013	-0.130	0.054	0.022	0.074	-0.045	0.176	-0.024
C26														-0.171	-0.137	0.141	0.010	-0.199	-0.085	-0.144	-0.151	-0.109	-0.121	-0.004	0.042
C27															-0.185	0.012	0.122	0.005	0.059	0.039	-0.023	0.106	0.053	0.316	-0.054
C28																-0.003	-0.162	0.030	0.008	0.119	0.151	0.209	0.072	0.372	-0.126
C29																	-0.019	0.042	0.126	0.139	0.145	0.191	0.054	0.284	0.061
C31																		0.150	-0.096	0.157	0.141	0.243	-0.024	0.283	0.086
C32																			-0.185	-0.086	-0.021	0.096	-0.098	0.124	-0.060
C33																				-0.171	-0.147	-0.127	-0.080	-0.131	0.020
G45																					-0.036	0.005	-0.066	0.061	-0.087
G46																						-0.013	-0.127	-0.029	-0.029
G47																							-0.165	-0.008	-0.094
I																								-0.136	0.058
H49																									-0.231
M72																									

Table 5.9a: Location Quotient Correlation Coefficients (UK, 2003)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.229	0.814	-0.038	0.036	0.436	0.212	0.136	0.179	-0.301	-0.040	0.361	0.347	-0.042	0.118	0.102	0.623	-0.286
DB			0.202	0.252	0.162	0.434	0.202	0.100	0.196	-0.084	0.260	0.437	-0.039	0.227	-0.119	-0.184	0.217	-0.380
DD				-0.076	0.085	0.613	0.276	0.276	0.341	-0.156	0.127	0.471	0.441	-0.026	0.325	0.102	0.442	-0.233
DE					0.042	-0.198	-0.269	-0.399	-0.174	-0.285	-0.299	0.042	-0.152	0.364	-0.220	-0.164	-0.010	0.202
DG						0.202	0.009	0.033	-0.051	-0.164	0.204	0.270	0.148	0.076	0.233	-0.137	0.287	-0.023
DH							0.473	0.653	0.648	0.093	0.451	0.723	0.287	0.093	0.116	-0.151	0.460	-0.229
DI								0.413	0.520	0.079	0.131	0.201	0.239	0.089	0.051	-0.096	0.266	-0.309
DJ									0.589	0.101	0.504	0.562	0.125	0.050	-0.078	-0.217	0.436	-0.274
DK										0.400	0.278	0.431	0.287	0.285	-0.088	-0.426	0.086	-0.021
DL											0.178	-0.040	0.199	0.097	0.090	-0.357	-0.382	0.178
DM												0.472	0.202	-0.013	0.074	-0.112	0.038	-0.309
DN													0.207	0.058	0.120	-0.192	0.312	-0.277
G50														0.232	0.576	0.105	0.117	0.030
G51															-0.112	-0.446	0.148	0.398
G52																0.372	-0.029	-0.032
H																	-0.027	0.037
I60																		-0.145
K73																		

Table 5.9b: Location Quotient Correlation Coefficients (UK, 2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.193	0.616	-0.021	0.038	0.422	0.305	0.139	0.229	-0.279	0.065	0.167	0.354	-0.051	0.167	0.248	0.443	-0.334
DB			0.038	0.247	0.136	0.495	0.238	0.116	0.250	-0.145	0.251	0.634	0.022	0.247	-0.094	-0.198	0.156	-0.381
DD				-0.310	0.072	0.549	0.473	0.418	0.259	-0.078	0.273	0.230	0.512	-0.247	0.397	0.172	0.320	-0.416
DE					-0.042	-0.281	-0.253	-0.390	-0.255	-0.158	-0.331	-0.067	-0.315	0.192	-0.267	-0.044	0.132	0.258
DG						0.249	0.067	0.120	0.058	-0.153	0.233	0.099	0.290	0.092	0.321	-0.129	0.472	-0.015
DH							0.544	0.607	0.561	0.002	0.523	0.684	0.538	0.029	0.254	-0.020	0.375	-0.386
DI								0.512	0.581	-0.107	0.205	0.339	0.315	0.043	0.059	-0.204	0.368	-0.389
DJ									0.487	0.009	0.493	0.590	0.275	-0.034	0.024	-0.208	0.260	-0.392
DK										0.317	0.306	0.424	0.464	0.334	-0.039	-0.297	0.129	-0.094
DL											0.087	0.046	0.458	0.349	0.229	-0.279	-0.351	0.473
DM												0.574	0.360	-0.051	0.120	0.043	0.021	-0.318
DN													0.274	0.066	0.110	-0.208	0.028	-0.462
G50														0.346	0.693	0.055	0.319	0.069
G51															0.006	-0.428	0.137	0.311
G52																0.217	0.257	-0.140
H																	-0.008	-0.103
I60																		-0.114
K73																		

Table 5.9c: Location Quotient Correlation Coefficients (UK, 2011)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.241	0.210	0.236	0.609	0.580	0.052	0.261	0.510	0.319	0.239	0.125	-0.303	0.168	0.104	-0.099	0.189	-0.162	0.110	0.308	0.093	0.247	0.091	0.521	-0.329
C11			0.159	0.105	0.245	0.109	-0.109	-0.149	0.031	0.139	-0.101	0.102	0.095	0.130	0.266	-0.067	-0.029	-0.130	0.108	0.097	0.130	-0.029	-0.045	0.098	-0.013
C13				0.581	0.139	0.372	0.481	0.241	0.312	0.215	0.003	0.150	-0.234	0.215	0.201	-0.076	0.668	-0.012	-0.184	-0.043	0.163	-0.167	-0.265	-0.015	-0.369
C14					0.096	0.288	0.394	0.082	0.267	0.153	-0.064	0.204	-0.219	-0.051	0.234	-0.030	0.371	0.026	-0.149	0.025	0.317	-0.210	-0.194	-0.079	-0.329
C16						0.649	0.027	0.161	0.663	0.370	0.642	0.320	-0.094	0.415	0.228	0.016	0.127	0.016	0.005	0.280	-0.170	0.371	0.215	0.330	-0.436
C17							0.361	0.406	0.565	0.186	0.449	0.064	-0.092	0.192	0.039	-0.034	0.276	-0.100	-0.078	0.177	0.098	0.126	-0.001	0.307	-0.254
C18								0.242	0.049	0.043	-0.272	-0.087	0.156	0.165	0.258	0.058	0.412	0.041	-0.038	0.110	0.292	0.045	-0.263	-0.031	-0.002
C20									0.278	0.316	0.179	0.260	-0.131	-0.052	0.122	0.394	0.298	-0.259	0.005	0.080	0.128	0.033	-0.247	0.251	0.226
C22										0.519	0.616	0.569	-0.117	0.386	0.416	0.278	0.405	0.254	-0.047	0.483	0.154	0.174	-0.077	0.218	-0.405
C23											0.300	0.385	-0.223	0.217	0.380	0.226	0.403	-0.043	-0.177	0.277	0.083	0.220	-0.307	0.259	-0.256
C24												0.368	-0.262	0.083	-0.083	0.099	0.125	0.062	-0.009	0.108	-0.184	0.131	0.266	0.399	-0.300
C25													-0.184	0.347	0.587	0.638	0.373	0.258	0.071	0.389	0.079	-0.080	-0.344	0.121	-0.293
C26														0.378	0.158	-0.142	-0.190	0.395	0.360	0.303	0.295	0.150	-0.020	-0.452	0.417
C27															0.526	0.144	0.193	0.318	0.096	0.381	-0.155	0.147	-0.053	-0.002	-0.289
C28																0.530	0.328	0.214	-0.108	0.515	0.180	-0.113	-0.268	-0.086	-0.108
C29																	0.138	0.052	-0.027	0.239	0.035	-0.126	-0.311	0.054	0.025
C31																		0.224	-0.098	0.262	0.326	0.014	-0.471	0.128	-0.295
C32																			0.472	0.575	0.253	0.123	-0.016	-0.360	-0.170
C33																				0.292	0.029	0.297	0.193	0.060	-0.028
G45																					0.406	0.408	-0.017	0.125	-0.046
G46																						-0.088	-0.479	-0.299	0.221
G47																							0.284	0.369	-0.136
I																								0.224	-0.001
H49																									-0.158
M72																									

Table 5.9d: Location Quotient Correlation Coefficients (UK, 2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.339	0.223	0.003	0.657	0.513	0.202	0.120	0.580	0.210	0.185	0.142	0.073	0.160	0.326	-0.064	0.392	-0.282	0.405	0.183	0.124	0.383	0.099	0.419	-0.344
C11			0.081	-0.048	0.152	0.037	-0.089	-0.154	-0.010	0.036	-0.113	-0.047	0.167	0.011	0.189	-0.045	-0.113	-0.219	0.204	0.099	0.097	-0.073	0.264	0.055	0.150
C13				0.173	0.019	0.455	0.345	0.285	0.393	0.138	-0.002	0.125	-0.067	0.185	0.301	-0.088	0.507	-0.131	-0.073	-0.177	0.189	0.004	-0.194	-0.067	-0.305
C14					-0.070	0.115	0.246	-0.147	0.116	0.095	-0.116	0.003	-0.025	-0.234	0.086	-0.087	0.205	-0.253	-0.162	-0.322	0.034	-0.285	-0.271	-0.041	-0.139
C16						0.237	0.278	0.375	0.651	0.486	0.309	0.429	-0.041	0.168	0.375	0.149	0.595	-0.104	0.552	0.326	0.098	0.122	-0.118	0.535	-0.295
C17							0.252	0.245	0.576	0.054	0.512	0.155	0.107	0.323	0.244	-0.041	0.361	-0.054	0.036	0.012	-0.010	0.312	0.094	0.282	-0.270
C18								0.315	0.288	0.194	-0.209	0.204	-0.066	0.255	0.444	0.177	0.538	0.232	0.292	0.017	0.079	-0.135	-0.394	0.059	-0.101
C20									0.311	0.247	0.038	0.277	-0.235	0.272	0.204	0.212	0.540	0.037	0.265	-0.058	-0.069	0.047	-0.260	0.217	-0.062
C22										0.496	0.428	0.636	0.034	0.332	0.448	0.256	0.673	-0.065	0.309	0.331	0.200	0.291	-0.174	0.464	-0.338
C23											0.135	0.498	0.026	0.162	0.399	0.240	0.332	-0.052	0.243	0.148	0.260	0.069	-0.292	0.403	-0.279
C24												0.278	-0.119	0.253	-0.192	-0.018	0.085	0.108	0.074	0.027	-0.250	0.147	0.366	0.464	-0.271
C25													0.000	0.413	0.501	0.616	0.453	0.287	0.405	0.316	0.259	-0.090	-0.381	0.322	-0.230
C26														0.316	0.359	-0.184	-0.149	0.217	0.167	0.505	0.248	0.197	-0.182	-0.272	0.290
C27															0.398	0.235	0.196	0.398	0.315	0.278	-0.221	0.172	0.077	0.077	-0.244
C28																0.336	0.392	-0.078	0.298	0.443	0.360	-0.015	-0.386	0.109	-0.042
C29																	0.041	0.099	0.039	0.107	0.183	-0.198	-0.246	0.222	-0.149
C31																		-0.011	0.287	0.173	0.092	0.019	-0.409	0.258	-0.236
C32																			0.384	0.199	-0.223	0.004	-0.113	-0.179	0.085
C33																				0.389	-0.002	0.096	-0.024	0.141	-0.196
G45																					0.298	0.373	-0.088	0.065	0.102
G46																						-0.169	-0.483	-0.057	0.139
G47																							0.211	0.298	-0.252
I																								-0.133	-0.108
H49																									-0.384
M72																									

Table 5.10a: UK Location Quotient Correlation Coefficients Changes (2003-2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		-0.036	-0.198	0.017	0.002	-0.014	0.093	0.003	0.051	0.023	0.106	-0.194	0.007	-0.009	0.049	0.146	-0.179	-0.048
DB			-0.164	-0.004	-0.027	0.061	0.036	0.016	0.054	-0.061	-0.009	0.197	0.061	0.020	0.025	-0.014	-0.061	-0.001
DD				-0.233	-0.013	-0.065	0.197	0.141	-0.082	0.078	0.145	-0.241	0.071	-0.222	0.072	0.070	-0.121	-0.183
DE					-0.084	-0.083	0.016	0.009	-0.081	0.127	-0.032	-0.108	-0.164	-0.172	-0.048	0.120	0.142	0.056
DG						0.047	0.057	0.087	0.109	0.011	0.029	-0.171	0.142	0.016	0.088	0.008	0.185	0.008
DH							0.071	-0.047	-0.087	-0.092	0.073	-0.038	0.250	-0.064	0.139	0.131	-0.085	-0.158
DI								0.099	0.060	-0.186	0.074	0.138	0.076	-0.046	0.008	-0.108	0.102	-0.080
DJ									-0.102	-0.092	-0.012	0.028	0.151	-0.084	0.102	0.009	-0.176	-0.119
DK										-0.082	0.029	-0.007	0.177	0.049	0.050	0.129	0.043	-0.073
DL											-0.091	0.086	0.259	0.252	0.140	0.077	0.032	0.295
DM												0.102	0.158	-0.038	0.045	0.155	-0.017	-0.009
DN													0.067	0.009	-0.010	-0.015	-0.284	-0.185
G50														0.114	0.118	-0.050	0.203	0.038
G51															0.119	0.018	-0.010	-0.087
G52																-0.155	0.286	-0.108
H																	0.019	-0.139
I60																		0.031
K73																		

Table 5.10b: UK Location Quotient Correlation Coefficients Changes (2011-2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.098	0.013	-0.233	0.047	-0.067	0.149	-0.142	0.070	-0.109	-0.055	0.017	0.376	-0.008	0.222	0.035	0.203	-0.120	0.296	-0.125	0.031	0.136	0.009	-0.103	-0.015
C11			-0.078	-0.152	-0.093	-0.071	0.020	-0.005	-0.041	-0.103	-0.012	-0.149	0.071	-0.118	-0.077	0.022	-0.083	-0.090	0.096	0.001	-0.033	-0.044	0.309	-0.043	0.163
C13				-0.408	-0.120	0.083	-0.136	0.044	0.081	-0.078	-0.005	-0.025	0.166	-0.031	0.099	-0.011	-0.161	-0.119	0.112	-0.134	0.026	0.171	0.071	-0.052	0.063
C14					-0.166	-0.173	-0.148	-0.230	-0.151	-0.058	-0.052	-0.201	0.194	-0.183	-0.148	-0.057	-0.166	-0.279	-0.013	-0.347	-0.283	-0.075	-0.078	0.038	0.190
C16						-0.412	0.251	0.214	-0.012	0.116	-0.333	0.109	0.053	-0.247	0.147	0.134	0.468	-0.120	0.546	0.046	0.268	-0.249	-0.333	0.205	0.141
C17							-0.109	-0.160	0.011	-0.132	0.063	0.091	0.199	0.132	0.205	-0.007	0.085	0.045	0.114	-0.165	-0.108	0.186	0.096	-0.025	-0.016
C18								0.074	0.239	0.150	0.063	0.291	-0.222	0.090	0.186	0.119	0.126	0.192	0.330	-0.094	-0.213	-0.180	-0.131	0.090	-0.099
C20									0.032	-0.069	-0.140	0.018	-0.104	0.324	0.083	-0.182	0.242	0.296	0.260	-0.138	-0.196	0.015	-0.013	-0.034	-0.288
C22										-0.023	-0.188	0.067	0.151	-0.054	0.032	-0.021	0.268	-0.319	0.356	-0.153	0.046	0.117	-0.097	0.246	0.067
C23											-0.166	0.112	0.249	-0.056	0.019	0.014	-0.070	-0.010	0.420	-0.128	0.176	-0.151	0.015	0.145	-0.023
C24												-0.090	0.143	0.170	-0.108	-0.117	-0.041	0.047	0.083	-0.082	-0.067	0.015	0.101	0.065	0.029
C25													0.185	0.066	-0.086	-0.022	0.080	0.030	0.334	-0.073	0.180	-0.010	-0.037	0.201	0.063
C26														-0.062	0.200	-0.042	0.040	-0.178	-0.193	0.203	-0.047	0.047	-0.162	0.179	-0.126
C27															-0.129	0.092	0.004	0.080	0.220	-0.103	-0.066	0.025	0.130	0.079	0.044
C28																-0.194	0.064	-0.291	0.406	-0.071	0.180	0.098	-0.118	0.195	0.066
C29																	-0.097	0.047	0.066	-0.131	0.148	-0.072	0.065	0.168	-0.174
C31																		-0.235	0.385	-0.090	-0.234	0.005	0.062	0.131	0.059
C32																			-0.087	-0.376	-0.476	-0.119	-0.098	0.181	0.255
C33																				0.097	-0.031	-0.201	-0.217	0.081	-0.169
G45																					-0.108	-0.035	-0.071	-0.060	0.148
G46																						-0.081	-0.005	0.242	-0.081
G47																							-0.073	-0.071	-0.116
I																								-0.357	-0.107
H49																									-0.226
M72																									

EG co-agglomeration statistic

EU-level results

Table 5.6a-d provides a list of the highest (top-10) pairwise co-agglomerations according to the EG statistic calculated for all European regions in the sample, over each of the four years for which data are available (2003, 2007, 2011, and 2015). The first two years use NACE 1.1 sector classifications, while the final two years are defined on NACE 2 classifications.

These top-10 lists do not include those pairwise relationships identified in the previous section which are likely to occur for reasons other than supply-chain reasons, e.g. most wholesale trade services linkages. Full details of the tables, including those statistics omitted from the top-10 list, are provided in Appendix C.

Table 5.6a: Highest EU-wide Pairwise Co-agglomerations (2003)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of machinery and equipment n.e.c.	Manufacture of electrical and optical equipment	0.0032
2	Manufacture of textiles and textile products	Manufacturing n.e.c.	0.0030
3	Manufacture of basic metals and fabricated metal products	Manufacture of machinery and equipment n.e.c.	0.0030
4	Manufacture of electrical and optical equipment	Manufacture of transport equipment	0.0029
5	Manufacture of textiles and textile products	Manufacture of wood and wood products	0.0029
6	Manufacture of textiles and textile products	Manufacture of basic metals and fabricated metal products	0.0026
7	Manufacture of rubber and plastic products	Manufacture of machinery and equipment n.e.c.	0.0025
8	Manufacture of machinery and equipment n.e.c.	Manufacture of transport equipment	0.0025
9	Manufacture of wood and wood products	Manufacturing n.e.c.	0.0024
10	Manufacture of chemicals, chemical products and man-made fibres	Manufacture of machinery and equipment n.e.c.	0.0021

Table 5.6b: Highest EU-wide Pairwise Co-agglomerations (2007)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of machinery and equipment n.e.c.	Manufacture of electrical and optical equipment	0.0034
2	Manufacture of textiles and textile products	Manufacturing n.e.c.	0.0034

Rank	Industry 1	Industry 2	EG Stat
3	Manufacture of textiles and textile products	Manufacture of wood and wood products	0.0030
4	Manufacture of machinery and equipment n.e.c.	Manufacture of transport equipment	0.0030
5	Manufacture of electrical and optical equipment	Manufacture of transport equipment	0.0029
6	Manufacture of textiles and textile products	Manufacture of basic metals and fabricated metal products	0.0027
7	Manufacture of wood and wood products	Manufacturing n.e.c.	0.0026
8	Manufacture of basic metals and fabricated metal products	Manufacture of machinery and equipment n.e.c.	0.0023
9	Manufacture of rubber and plastic products	Manufacture of transport equipment	0.0021
10	Manufacture of electrical and optical equipment	Research and development	0.0020

Table 5.6c: Highest EU-wide Pairwise Co-agglomerations (2011)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of textiles	Manufacture of wearing apparel	0.0097
2	Manufacture of electrical equipment	Manufacture of machinery and equipment n.e.c.	0.0072
3	Manufacture of machinery and equipment n.e.c.	Manufacture of motor vehicles, trailers and semi-trailers	0.0059
4	Manufacture of computer, electronic and optical products	Manufacture of motor vehicles, trailers and semi-trailers	0.0054
5	Manufacture of electrical equipment	Manufacture of motor vehicles, trailers and semi-trailers	0.0053
6	Manufacture of chemicals and chemical products	Manufacture of basic metals	0.0051
7	Manufacture of wearing apparel	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.0050
8	Manufacture of wearing apparel	Manufacture of furniture	0.0047
9	Manufacture of basic metals	Manufacture of machinery and equipment n.e.c.	0.0046
10	Manufacture of basic metals	Manufacture of electrical equipment	0.0039

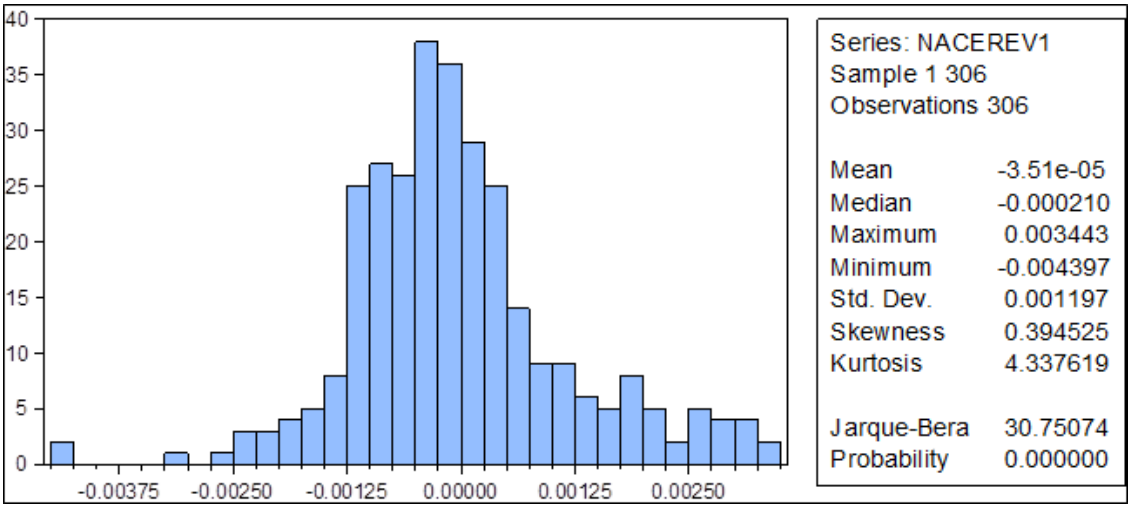
Table 5.6d: Highest EU-wide Pairwise Co-agglomerations (2015)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of textiles	Manufacture of wearing apparel	0.0093
2	Manufacture of electrical equipment	Manufacture of machinery and equipment n.e.c.	0.0079
3	Manufacture of machinery and equipment n.e.c.	Manufacture of motor vehicles, trailers and semi-trailers	0.0065
4	Manufacture of computer, electronic and optical products	Manufacture of motor vehicles, trailers and semi-trailers	0.0062
5	Manufacture of chemicals and chemical products	Manufacture of basic metals	0.0060
6	Manufacture of electrical equipment	Manufacture of motor vehicles, trailers and semi-trailers	0.0058
7	Manufacture of basic metals	Manufacture of machinery and equipment n.e.c.	0.0050
8	Manufacture of computer, electronic and optical products	Manufacture of electrical equipment	0.0047
9	Manufacture of wearing apparel	Manufacture of furniture	0.0047
10	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Manufacture of furniture	0.0044

Tests of significance

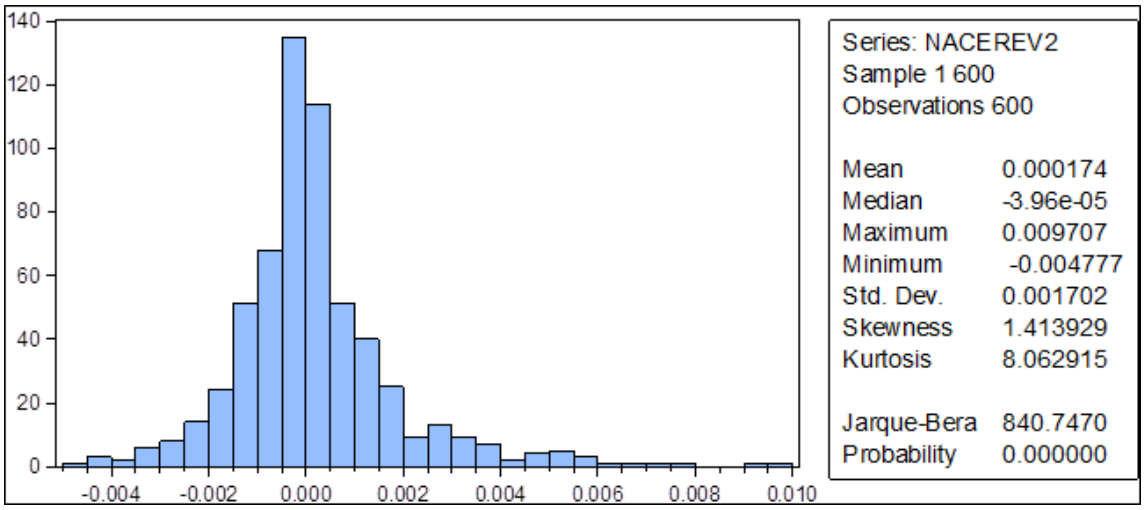
The calculation and ranking of the EG statistics does not tell us very much unless we can establish the results are significant or not.

Figure 5.11: Histogram from combined 2003/2007 EG statistics



Figures 5.11 and 5.12 show the histograms of the combined 2003/2007 and 2011/2015 EG statistics, alongside distributional characteristics and a Jarque-Bera test for normality. Both distributions are shown to be non-normal which means we cannot use +/- 2 standard deviations as a method for determining significance.

Figure 5.12: Histogram from combined 2011/2015 EG statistics



Instead we can attempt bootstrapping to work out the statistical properties of a distribution, whereby we undertake repeated random sampling to allow for a more rigorous estimation of variance and, ultimately, significance.

Bootstrapping results

We undertook repeated (1000) random sampling of the regional-sector employment and reproduced the equivalent histograms for the ones shown in Figures 5.11 and 5.12. These are shown in Figures 5.13 and 5.14 respectively.

Figure 5.13: Bootstrapped EG statistic histogram for 2003/2007

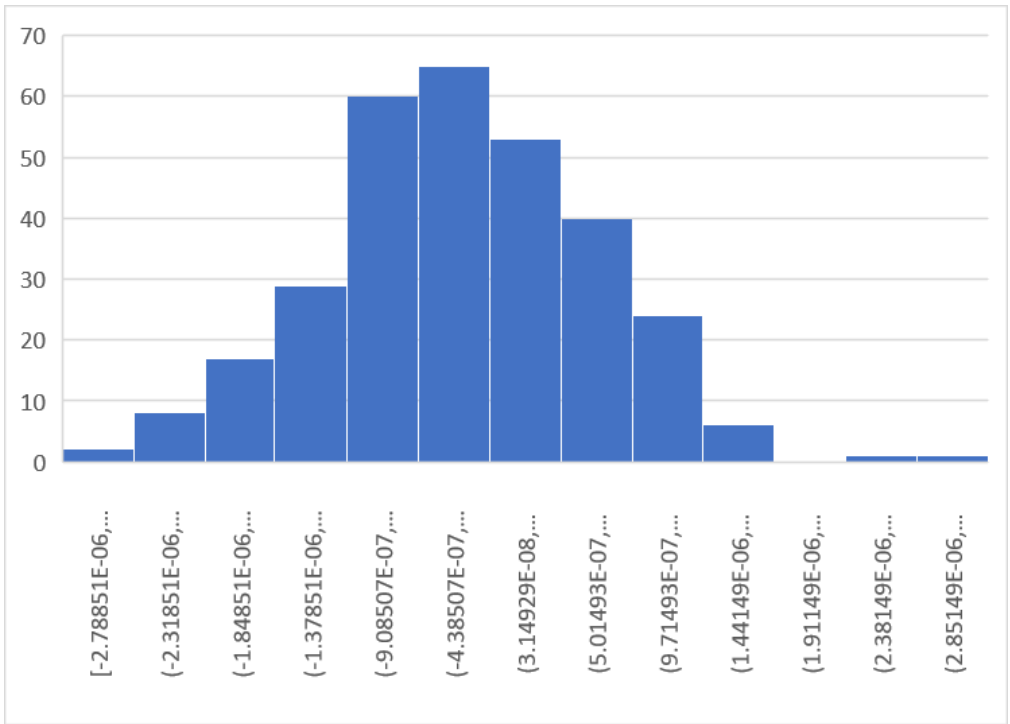
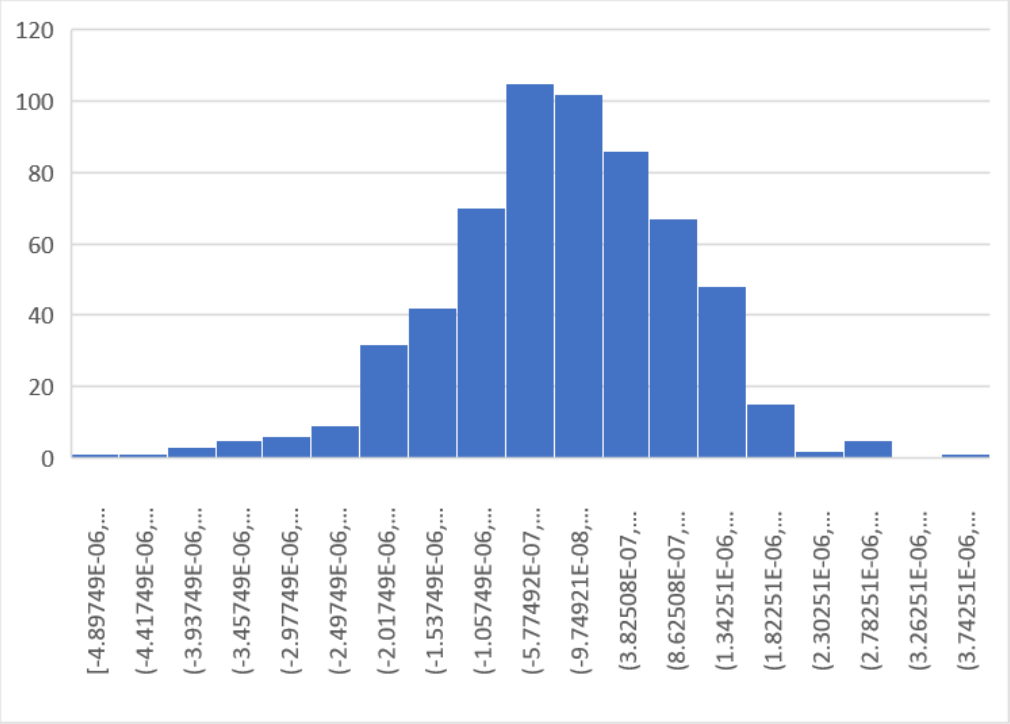


Figure 5.14: Bootstrapped EG statistic histogram for 2011/2015



The histograms generated by the bootstrapping method show that the top-10 EG statistic values reported in Tables 5.6a-d are all significant[49] and can then be compared with the significant LQ correlations, although there is little indication that the extent of co-agglomeration has increased over the periods.

As with the LQ statistic, the sector combination that is most comparable across the NACE revisions (the manufacturing of wood and wood products, with that of pulp, paper and paper products) does not appear in any of the top-10 lists in Tables 5.6a-d, but examination of the EG statistic for this does reveal again a gradual increase over the whole period[50].

Comparing LQ and EG results

The degree of correspondence between the LQ correlations and the EG statistics was assessed by undertaking a correlation for each year. The results showed little change across the two sets of period, with a correlation of around 0.7 for the Rev1 periods (2003 and 2007) and 0.6 for the Rev2 period (2011 and 2015). The lower correlation in the Rev2 periods can most likely be explained by the greater sectoral disaggregation.

Country-specific analysis

To round off the analysis, an individual Member State was selected to see how a single country differed from the averaged EU results. This time the focus was only on the UK, as the LQ analysis of Poland was limited by the number of regions available. The UK results are at two levels, firstly at NUTS2 using the SBS data as previously, and secondly using CE's local area database which extends the number of areas to around 400. The point of doing this is firstly to see what difference adding an order of magnitude to the spatial disaggregation has on the EG statistic results, and also because the local area data are available for a much longer and consistent time series

[49] The thresholds for significance at the 95% level of confidence are 0.000099 for the Rev1 periods and 0.00031 for the Rev2 periods.

[50] The values for this combination are -0.001, -0.0008, 0.0006, and 0.001 for the 2003, 2007, 2011 and 2015 periods, respectively.

(1981-2017) and so the evolution of the EG statistics over the period when the UK was integrating as part of the EU.

NUTS2 level analysis

As noted in Table 5.3, among the other Member States in the sample, the UK contains a high number of NUTS2 regions, and so in theory should provide a more robust set of results than most other countries. Tables 5.7a-d report the top-10 combinations[51], replicating the EU results from Tables 5.6a-d. The degree of correspondence (correlation) between the Rev1 periods is much higher 0.97) compared to the later Rev2 periods (0.69), possibly due to the smaller number of sectors in the Rev1 classification. Both are strongly positive and suggestive of persistence in co-location patterns, however.

Table 5.7a: Highest UK Pairwise Co-agglomerations (2003)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of basic metals and fabricated metal products	Manufacture of transport equipment	0.0150
2	Manufacture of rubber and plastic products	Manufacture of transport equipment	0.0075
3	Manufacture of rubber and plastic products	Manufacture of basic metals and fabricated metal products	0.0072
4	Manufacture of other non-metallic mineral products	Manufacture of basic metals and fabricated metal products	0.0069
5	Manufacture of basic metals and fabricated metal products	Manufacture of machinery and equipment n.e.c.	0.0067
6	Manufacture of rubber and plastic products	Manufacture of other non-metallic mineral products	0.0066
7	Manufacture of other non-metallic mineral products	Manufacture of machinery and equipment n.e.c.	0.0066
8	Manufacture of transport equipment	Manufacturing n.e.c.	0.0061
9	Manufacture of textiles and textile products	Manufacture of other non-metallic mineral products	0.0060
10	Manufacture of machinery and equipment n.e.c.	Manufacture of transport equipment	0.0060

Table 5.7b: Highest UK Pairwise Co-agglomerations (2007)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of basic metals and fabricated metal products	Manufacture of transport equipment	0.0102
2	Manufacture of other non-metallic mineral products	Manufacture of basic metals and fabricated metal products	0.0081
3	Manufacture of rubber and plastic products	Manufacture of other non-metallic mineral products	0.0078

[51] The 95% confidence limit for the Rev1 periods is calculated to be 0.00072 while for the Rev2 periods it is 0.00172.

Rank	Industry 1	Industry 2	EG Stat
4	Manufacture of textiles and textile products	Manufacture of other non-metallic mineral products	0.0066
5	Manufacture of other non-metallic mineral products	Manufacture of machinery and equipment n.e.c.	0.0066
6	Manufacture of rubber and plastic products	Manufacture of transport equipment	0.0066
7	Manufacture of rubber and plastic products	Manufacture of basic metals and fabricated metal products	0.0065
8	Manufacture of other non-metallic mineral products	Manufacture of transport equipment	0.0065
9	Manufacture of textiles and textile products	Manufacturing n.e.c.	0.0064
10	Manufacture of basic metals and fabricated metal products	Manufacturing n.e.c.	0.0061

Table 5.7c: Highest UK Pairwise Co-agglomerations (2011)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of textiles	Manufacture of wearing apparel	0.0213
2	Manufacture of basic metals	Manufacture of motor vehicles, trailers and semi-trailers	0.0207
3	Manufacture of textiles	Manufacture of furniture	0.0169
4	Manufacture of beverages	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.0139
5	Manufacture of textiles	Manufacture of paper and paper products	0.0138
6	Manufacture of fabricated metal products, except machinery and equipment	Manufacture of motor vehicles, trailers and semi-trailers	0.0138
7	Manufacture of basic metals	Manufacture of fabricated metal products, except machinery and equipment	0.0132
8	Manufacture of beverages	Manufacture of textiles	0.0114
9	Manufacture of machinery and equipment n.e.c.	Manufacture of motor vehicles, trailers and semi-trailers	0.0113
10	Manufacture of textiles	Manufacture of chemicals and chemical products	0.0110

Table 5.7d: Highest UK Pairwise Co-agglomerations (2015)

Rank	Industry 1	Industry 2	EG Stat
1	Manufacture of basic metals	Manufacture of motor vehicles, trailers and semi-trailers	0.0231
2	Manufacture of fabricated metal products, except machinery and equipment	Manufacture of motor vehicles, trailers and semi-trailers	0.0167
3	Manufacture of basic metals	Manufacture of fabricated metal products, except machinery and equipment	0.0149
4	Manufacture of textiles	Manufacture of paper and paper products	0.0144
5	Manufacture of beverages	Repair and installation of machinery and equipment	0.0133
6	Manufacture of textiles	Manufacture of furniture	0.0129
7	Manufacture of textiles	Manufacture of chemicals and chemical products	0.0126
8	Manufacture of rubber and plastic products	Manufacture of basic metals	0.0113
9	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Manufacture of basic metals	0.0107
10	Manufacture of other non-metallic mineral products	Manufacture of basic metals	0.0106

Local area analysis

The sector classification for the CE database follows the Rev2 system, and as many of the corresponding sectors[52] that are covered there are included in the co-location analysis. Tables 5.8a-d show the equivalent results using local areas instead of NUTS2 regions[53]. These generally tend to show co-location is strongest among the manufacturing sectors (where IO linkages might be expected to be strongest), and is highly persistent with correlations of 0.97, 0.96, and 0.94 between the years of between the EG results for 2003-07, 2007-11, and 2011-15, respectively.

Table 5.8a: Highest UK Local Area Pairwise Co-agglomerations (2003)

Rank	Industry 1	Industry 2	EG Stat
1	Accommodation	Other professional services[54]	0.0018
2	Metals & metal prods.	Motor vehicles, etc	0.0017
3	Machinery, etc	Motor vehicles, etc	0.0013
4	Electrical equipment	Machinery, etc	0.0012

[52] The correspondence is not exact, as the sector disaggregation in CE's local area database is a mix of two-digit activities, and aggregates thereof.
[53] The relevant 95% confidence limits are 0.00008, 0.00012, 0.00018, and 0.00019 for the respective years.
[54] This sector is included because it contains R&D services, as part of a wider aggregation of activities.

Rank	Industry 1	Industry 2	EG Stat
5	Electrical equipment	Motor vehicles, etc	0.0012
6	Wood & paper	Chemicals, etc	0.0011
7	Non-metallic min. prods.	Metals & metal prods.	0.0011
8	Non-metallic min. prods.	Machinery, etc	0.0011
9	Non-metallic min. prods.	Motor vehicles, etc	0.0011
10	Metals & metal prods.	Machinery, etc	0.0011

Table 5.8b: Highest UK Local Area Pairwise Co-agglomerations (2007)

Rank	Industry 1	Industry 2	EG Stat
1	Accommodation	Other professional services	0.0014
2	Metals & metal prods.	Motor vehicles, etc	0.0014
3	Electrical equipment	Motor vehicles, etc	0.0013
4	Wood & paper	Chemicals, etc	0.0011
5	Wood & paper	Non-metallic min. prods.	0.0011
6	Chemicals, etc	Non-metallic min. prods.	0.0011
7	Metals & metal prods.	Machinery, etc	0.0011
8	Electrical equipment	Machinery, etc	0.0011
9	Textiles, etc	Chemicals, etc	0.0010
10	Non-metallic min. prods.	Machinery, etc	0.0010

Table 5.8c: Highest UK Local Area Pairwise Co-agglomerations (2011)

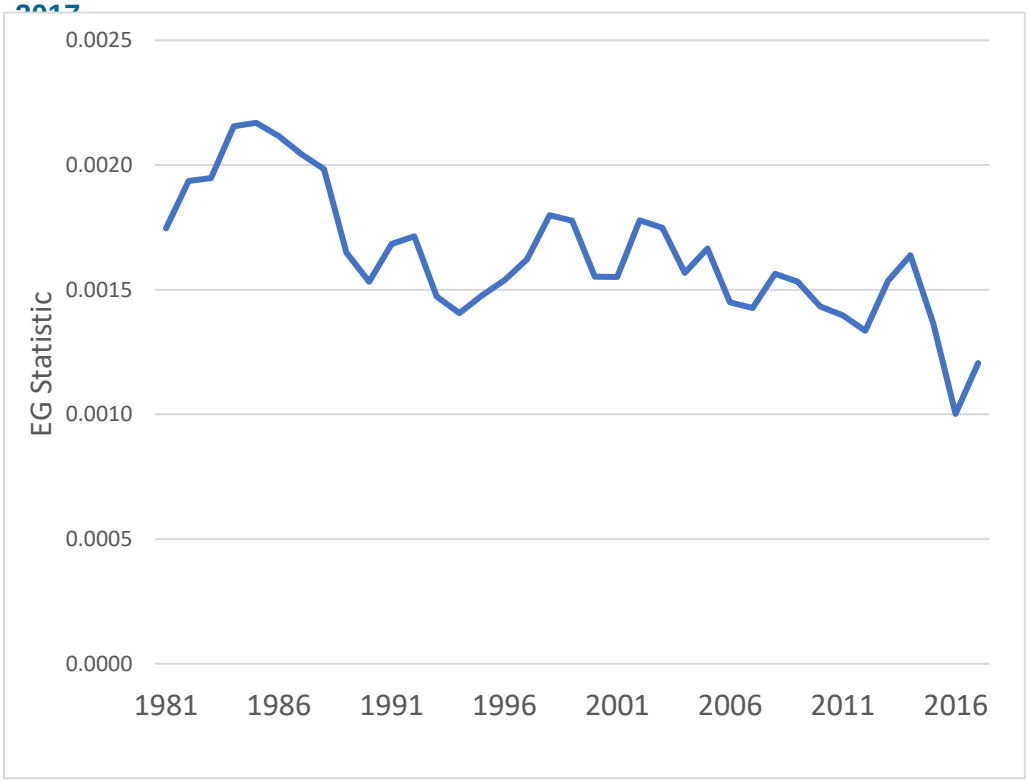
Rank	Industry 1	Industry 2	EG Stat
1	Machinery, etc	Motor vehicles, etc	0.0017
2	Textiles, etc	Chemicals, etc	0.0014
3	Metals & metal prods.	Motor vehicles, etc	0.0014
4	Wood & paper	Chemicals, etc	0.0013
5	Metals & metal prods.	Machinery, etc	0.0013
6	Electrical equipment	Machinery, etc	0.0013
7	Food, drink & tobacco	Wood & paper	0.0012
8	Chemicals, etc	Non-metallic min. prods.	0.0012
9	Accommodation	Other professional services	0.0012
10	Wood & paper	Non-metallic min. prods.	0.0011

Table 5.8d: Highest UK Local Area Pairwise Co-agglomerations (2015)

Rank	Industry 1	Industry 2	EG Stat
1	Wood & paper	Non-metallic min. prods.	0.0015
2	Metals & metal prods.	Motor vehicles, etc	0.0014
3	Wood & paper	Chemicals, etc	0.0013
4	Electrical equipment	Motor vehicles, etc	0.0013
5	Food, drink & tobacco	Wood & paper	0.0012
6	Chemicals, etc	Non-metallic min. prods.	0.0012
7	Non-metallic min. prods.	Metals & metal prods.	0.0012
8	Wood & paper	Electrical equipment	0.0012
9	Electrical equipment	Machinery, etc	0.0012
10	Wood & paper	Metals & metal prods.	0.0011

To review all the EG statistics over time would be a task well beyond the remit of this study, and so a single co-location (Metals & metal products – Motor vehicles, etc) has been chosen as one which is consistently strong in the tables, as well as having a prior expectation from the IO analysis. Figure 5.15 charts the evolution of this co-location statistic from 1981-2017. The downward trend is suggestive of a gradual weakening of ties between the location outcomes of the sector, possibly caused by the increasing importance of global supply chain linkages.

Figure 5.15: Metals & Metal Prods – Motor Vehicles EG statistic 1981-2017



General input-output analysis

As a final exploration of the link between the co-location statistics and input-output linkages, correlation analysis was attempted between the EG results

and the IO tables, firstly to see if such correlations recorded positive results and secondly whether there was evidence of changing strength in the correlation over time. This line of research broadly follows the analysis undertaken by Diodato et al (2018)[55], whereby the strength of supply-chain linkages as a driver of co-location was assessed relative to other factors such as access to skilled labour.

Unfortunately, the correspondence between the input-output table sectors (which are only available at Nace Rev2 classification, covering two of the years 2011 and 2015) and those from the SBS is not complete[56] and so only a partial analysis could be undertaken. Another limitation of this analysis is that the EG statistic matrix is symmetric, i.e. the co-location takes no account of the expected direction of the supply-side linkage, which is relevant for the input-output table.

With this in mind, the limitations of the data are too great to prove anything substantial when compared to the data available for the Diodato study, and so this part of the analysis was not undertaken.

Summary

Testing for the degree of geographical co-location, agglomeration and clustering of economic activities across the EU, and how far and in what ways such spatial phenomena have varied over time is far from straightforward. Previous studies using data from the 1980s and 1990s have yielded mixed results, some finding evidence of increasing geographical concentration and agglomeration, others finding little or no evidence of such trends.

Our analyses, focussing on the period since 2003, was constrained by data issues that have imposed limitations on all aspects of the project, as presented in previous reports and chapters. The lack of detailed consistent firm-level data severely constrains any attempt to identify clusters, which functionally consist of numerous co-located firms in related sectors, linked in complex supply chains, input-output structures, knowledge exchange relationships, innovation networks and shared labour pools. Using sectoral data, as was the case here, input-output tables can be used to suggest possible supply-chain linkages that can generate expected co-location patterns of industries, but such patterns may not necessarily be functioning clusters in the strict Porterian sense.

Even with our sectoral data there are other limitations, including the break in series as between NACE Rev 1.1 and NACE Rev 2, gaps in regional coverage, the restricted information on services, and the short overall time period for which analysis was conducted (2003-2015).

Notwithstanding these issues, and using location quotients and the basic Ellison-Glaeser statistic, our analyses find some evidence of pairwise co-location or geographical concentration of certain activities. The findings are strongest for pairs of industries for which there are clear supply-chain, input-output linkages, such as textiles and apparel; electrical equipment and computer, electronic and optical products; chemicals and chemical products; rubber and plastic products and other non-metallic mineral products; and basic

[55] It should be noted that the Diodato (2018) study was based on US and Mexico data, with access to over 1000 metropolitan areas (the preferred geographical unit of analysis) and 120 (traded) industries. Such level of detail is important when contrasted against the limitations of the available EU data.

[56] In particular, in the IO tables food, beverages and tobacco are combined, as are textiles and wearing apparel. Finally, furniture is combined as part of other manufacturing.

metals with fabricated metal products, except machinery and equipment; and manufacturing of wood and wood products, with that of pulp, paper and paper products. There is also limited evidence that some of these co-location concentrations have increased over the period of the study. Overall, however, the findings do not suggest that there has been any substantial increase in geographical agglomeration and co-location across sectors since the early-2000s.

How then do our findings relate to what theory would lead us to expect? The dominant view (for example in the New Economic Geography) is that increasing economic integration promotes trade, which in turn promotes increasing returns from greater regional specialisation and geographical concentration of activities. Thus, increasing economic integration in the EU, to the extent that it leads to increased intra-EU trade, and assuming other things being equal, should tend to promote greater geographical specialisation, agglomeration and clustering of industries, as both member states and their regions are able to take advantage of the increasing returns effects associated with scale of production among localised interrelated and linked firms and industries. In a classic paper, Krugman (1993) used the case of the United States to demonstrate this argument, and moreover to argue that as the EU became more integrated (especially in terms of monetary union), so economic activity there would become more geographical agglomerated and specialised. However, interestingly, by the time of his Nobel Prize lecture in 2008, Krugman had changed his mind, and argued that the process of regional specialisation and agglomeration in the advanced economies of the world had actually probably peaked in the 1930s, long before the New Economic Theory of agglomeration was developed (in large part by Krugman himself in the 1990s) - and long before the EU was formed. In Krugman's view, the phenomenon of increasing spatial agglomeration of industry is now largely confined to younger and emerging economies (such as China).

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Appendices

The contents of the appendices is as follows:

- Appendix A: Balassa Index Heat Maps
- Appendix B: Manufacturing Sector Coverage for the Theil Indices
- Appendix C: Detailed Ellison-Glaeser Statistics

Appendix A Balassa Index Heat Maps

This Appendix contains sector-based heat maps across each Member State for the periods 2000 and 2014 for the WIOD database, and for 1995 and 2016 for the STAN database.

Figure A1: Balassa Index heat map across Member State Sectors based on WIOD database, 2000

CPA	Product	AT	BE	DE	DK	EL	ES	FI	FR	IE	IT	LU	NL	PT	SE	UK	CY	CZ	EE	HU	LT	LV	MT	PL	SI	SK	BG	RO	HR	Average
CPA_A01	Products of agriculture, hunting and related s	0.31	1.01	0.45	1.18	3.63	2.77	0.33	1.38	0.71	0.84	0.14	2.59	0.34	0.16	0.33	0.85	0.69	0.98	1.12	1.28	0.19	0.12	0.85	0.24	0.49	3.21	1.59	0.85	1.02
CPA_A02	Products of forestry, logging and related serv	1.23	1.05	0.94	0.78	0.35	0.76	1.53	0.99	0.00	0.50	0.88	0.87	2.88	1.03	0.16	0.02	4.41	65.89	2.70	4.38	54.40	3.55	1.48	2.08	5.65	1.45	11.41	5.89	6.33
CPA_A03	Fish and other fishing products; aquaculture	0.02	0.31	0.41	5.41	1.44	2.47	0.04	1.13	0.00	0.60	0.03	1.14	1.11	2.41	1.24	1.95	0.69	10.77	0.15	0.05	1.79	1.68	0.34	0.01	0.05	0.11	0.08	2.58	1.36
CPA_B	Mining and quarrying	0.07	0.83	0.17	1.41	0.50	0.12	0.09	0.05	0.02	0.06	0.01	5.53	0.33	0.20	2.06	0.06	0.34	0.25	0.14	0.16	0.25	0.39	0.98	0.01	0.06	1.03	0.11	0.06	0.55
CPA_C10-C12	Food products, beverages and tobacco produ	0.72	1.55	0.63	2.50	0.01	1.15	0.29	1.21	2.41	0.84	0.08	1.57	0.69	0.30	0.75	0.52	0.49	0.83	0.82	1.22	0.69	0.27	1.14	0.37	0.31	0.65	0.25	0.74	0.82
CPA_C13-C15	Textiles, wearing apparel and leather product	0.89	0.91	0.72	0.79	1.10	1.04	0.24	0.86	0.19	2.86	0.22	0.49	4.09	0.29	0.77	0.08	0.96	2.14	1.38	3.94	1.70	1.36	2.52	1.54	1.30	1.73	2.69	1.07	1.35
CPA_C16	Wood and of products of wood and cork, exc	3.44	1.15	0.65	1.04	0.12	0.67	5.47	0.53	0.32	0.59	0.43	0.33	5.59	3.28	0.16	0.03	2.03	14.37	1.04	5.37	21.32	0.01	4.41	4.46	1.80	1.46	4.23	3.48	3.13
CPA_C17	Paper and paper products	1.95	0.78	0.95	0.43	0.20	0.69	8.57	0.77	0.14	0.68	0.20	0.61	2.59	3.59	0.40	0.05	0.79	0.91	0.44	0.20	0.32	0.03	1.11	2.36	1.97	0.29	0.38	0.61	1.14
CPA_C18	Printing and recording services	8.97	0.36	1.75	0.09	0.05	0.03	0.74	0.07	6.38	0.33	1.28	0.41	0.13	0.04	0.11	0.00	0.82	14.00	0.13	0.04	0.03	4.41	0.06	0.10	0.05	0.03	0.00	0.06	1.44
CPA_C19	Coke and refined petroleum products	0.26	2.01	0.47	0.78	3.49	1.56	1.43	0.77	0.01	0.80	0.35	1.92	0.53	1.27	0.97	14.25	0.50	0.17	0.49	5.83	0.24	0.02	0.75	0.12	1.85	3.30	3.05	2.47	1.77
CPA_C20	Chemicals and chemical products	0.45	1.80	1.21	0.42	0.24	0.80	0.45	1.16	1.63	0.75	0.13	1.07	0.40	0.48	0.96	0.02	0.63	0.58	0.49	0.20	0.17	0.16	0.70	0.82	0.77	0.92	0.67	0.73	0.67
CPA_C21	Basic pharmaceutical products and pharmace	0.66	0.50	0.80	2.65	0.22	0.56	0.20	1.01	3.16	0.98	0.02	1.22	0.18	1.44	1.16	0.20	0.28	0.20	0.44	0.29	0.66	0.51	0.16	2.16	0.17	0.38	0.09	1.47	0.78
CPA_C22	Rubber and plastics products	1.08	1.41	1.24	0.79	0.35	1.04	0.69	0.98	0.30	1.35	1.07	0.65	1.24	0.78	0.74	0.06	1.47	0.63	0.82	0.29	0.24	1.21	1.23	1.74	1.29	0.23	0.27	0.47	0.85
CPA_C23	Other non-metallic mineral products	1.27	1.42	0.88	0.75	0.64	1.75	0.58	0.81	0.30	2.24	0.88	0.40	2.23	0.49	0.56	0.23	2.83	1.28	0.81	0.12	0.44	0.21	1.43	1.88	1.77	1.16	2.05	1.58	1.11
CPA_C24	Basic metals	1.58	1.78	1.11	0.28	1.38	0.83	1.47	1.05	0.22	0.87	1.56	0.62	0.72	1.27	0.69	0.09	1.07	0.41	0.59	0.13	1.76	0.08	1.66	1.92	4.04	5.55	3.17	0.35	1.30
CPA_C25	Fabricated metal products, except machinery	1.54	0.90	1.27	0.72	0.16	0.93	0.88	0.81	0.20	1.61	1.02	0.63	1.42	1.08	0.66	0.06	2.42	1.91	0.85	0.38	0.47	0.53	1.64	2.03	1.20	0.67	0.40	0.64	0.97
CPA_C26	Computer, electronic and optical products	0.51	0.53	0.90	0.53	0.00	0.35	2.21	0.90	2.66	0.42	0.26	1.75	0.44	1.42	1.33	0.02	0.38	0.47	1.88	0.34	0.13	1.78	0.32	0.28	0.38	0.07	0.47	0.12	0.74
CPA_C27	Electrical equipment	1.30	0.66	1.31	0.64	0.26	0.78	1.16	1.00	0.85	1.27	0.22	0.52	0.99	1.06	0.79	0.02	2.03	0.82	2.10	0.35	0.19	1.22	1.22	3.22	1.45	0.25	1.60	0.65	1.00
CPA_C28	Machinery and equipment n.e.c.	1.21	0.65	1.63	0.92	0.06	0.53	1.10	0.81	0.23	1.81	0.22	0.34	0.32	1.18	0.82	0.05	0.99	0.35	0.51	0.21	0.22	0.24	0.56	0.97	0.81	0.39	0.56	0.08	0.63
CPA_C29	Motor vehicles, trailers and semi-trailers	1.09	1.32	1.66	0.14	0.00	1.76	0.29	1.16	0.09	0.65	0.07	0.31	1.23	1.04	0.65	0.03	1.41	0.29	1.48	0.36	0.06	0.03	1.16	1.02	1.94	0.02	0.11	0.05	0.70
CPA_C30	Other transport equipment	1.88	0.19	1.18	0.31	0.53	0.56	0.70	2.17	0.07	0.91	0.05	0.28	0.24	0.58	1.37	0.41	0.28	0.49	0.13	0.60	0.19	0.01	1.00	0.33	0.42	0.06	0.68	1.07	0.60
CPA_C31_C32	Furniture; other manufactured goods	1.05	1.85	0.84	1.38	0.11	0.69	0.34	0.63	1.29	2.43	0.06	0.50	0.31	0.82	0.70	0.13	0.89	1.82	0.56	1.18	1.16	1.85	2.18	2.64	0.51	0.13	1.51	0.93	1.02
CPA_C33	Repair and installation services of machinery	4.45	0.38	1.21	2.42	0.00	0.00	4.75	1.40	0.00	0.09	0.08	1.45	4.01	0.94	0.00	0.66	0.00	2.58	0.72	0.00	1.40	13.90	1.31	0.92	0.00	1.02	0.36	6.42	1.80
CPA_D35	Electricity, gas, steam and air-conditioning	1.18	2.80	2.17	0.75	0.14	0.65	0.96	0.74	0.01	0.27	0.15	0.54	0.09	0.65	0.05	0.00	2.66	1.86	2.27	0.19	0.79	0.01	0.54	1.41	0.11	3.15	0.32	0.57	0.89
CPA_E37-E39	Sewerage; waste collection, treatment and di	0.86	0.02	0.80	0.40	0.67	0.79	0.32	1.57	0.00	1.41	1.28	1.26	0.83	0.46	1.24	0.24	3.42	1.93	0.32	2.44	4.30	0.16	1.48	0.99	1.82	1.89	0.48	2.28	1.20
CPA_F	Constructions and construction works	3.23	1.51	0.24	4.74	9.15	0.02	0.36	0.00	0.00	0.48	0.71	2.50	2.12	0.00	0.49	0.54	2.75	3.32	3.48	2.00	1.53	0.43	7.61	1.31	1.16	4.96	0.73	5.93	2.19
CPA_G45	Wholesale and retail trade and repair services	1.57	0.01	0.28	1.45	0.00	0.12	0.84	4.22	0.00	0.05	0.76	0.00	0.00	5.84	0.12	0.00	0.06	1.59	3.75	0.00	0.00	0.06	0.00	0.00	0.00	0.40	0.02	0.00	0.76
CPA_G46	Wholesale trade services, except of motor ve	1.69	0.48	1.63	2.51	2.02	0.26	0.50	1.93	0.86	0.49	0.78	0.38	3.75	1.03	0.06	0.69	0.19	1.30	1.37	6.04	1.04	0.46	0.00	0.92	1.58	2.12	1.43	0.00	1.27
CPA_G47	Retail trade services, except of motor vehicle	0.00	0.00	0.02	0.00	13.15	0.00	0.46	5.48	0.00	0.00	3.78	0.00	0.00	3.26	0.00	5.81	0.00	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.19	6.22	3.01	1.85
CPA_H49	Land transport services and transport service	2.05	0.89	0.16	1.38	0.21	3.03	0.70	1.46	0.10	0.90	1.78	1.01	0.93	0.21	0.29	0.24	5.04	1.77	3.46	3.94	12.61	0.02	3.71	2.97	4.25	3.03	5.12	6.01	2.40
CPA_H50	Water transport services	0.11	0.50	0.94	7.75	20.43	0.37	0.56	0.76	0.06	0.78	0.01	0.70	0.15	1.19	0.83	2.77	0.05	1.97	0.03	0.22	2.07	0.35	0.17	0.15	0.00	0.10	0.17	3.95	1.68
CPA_H51	Air transport services	0.48	0.28	0.49	1.58	0.61	2.72	0.85	1.28	0.90	0.70	2.29	1.64	3.26	0.45	0.89	2.84	1.78	0.72	1.49	0.43	1.31	3.61	0.49	0.46	0.03	2.91	0.61	2.29	1.33
CPA_H52	Warehousing and support services for transp	0.69	2.47	0.33	0.96	0.84	2.22	0.30	0.58	0.17	1.85	0.54	1.35	0.70	2.30	0.39	3.75	0.62	7.03	1.77	2.01	5.70	4.39	0.94	0.54	0.38	0.73	0.70	4.27	1.73
CPA_H53	Postal and courier services	2.39	1.88	0.48	1.88	0.31	0.43	0.98	0.58	3.26	0.24	0.81	2.68	0.34	0.00	0.79	0.62	0.50	0.26	0.35	0.82	0.91	0.04	2.02	0.02	0.69	1.16	0.24	0.54	0.90
CPA_I	Accommodation and food services	3.04	1.09	1.24	0.14	0.00	0.00	0.58	0.00	3.47	0.00	0.02	0.00	1.88	0.00	2.92	0.00	1.43	0.12	0.86	1.87	0.00	0.08	0.00	0.00	0.00	0.17	4.51	0.00	0.84
CPA_J58	Publishing services	1.00	1.06	1.02	0.45	0.13	0.81	0.27	0.30	6.14	0.77	0.40	0.91	0.15	0.71	0.97	0.60	1.94	0.20	0.62	0.36	0.62	0.19	2.06	0.58	0.70	0.29	0.01	2.01	0.90
CPA_J59_J60	Motion picture, video and television program	0.53	0.28	0.85	0.10	2.24	0.16	0.04	0.78	0.00	1.35	4.24	0.82	0.86	0.82	2.15	0.01	1.45	0.18	4.23	0.43	0.19	0.07	1.24	0.08	0.11	0.49	0.28	0.43	0.87
CPA_J61	Telecommunications services	1.28	1.67	0.37	0.96	1.09	1.73	0.10	0.59	0.94	2.35	3.90	0.69	1.19	1.00	0.90	0.50	1.28	0.89	0.75	1.86	1.72	0.46	0.99	0.32	0.21	1.27	2.96	3.76	1.28
CPA_J62_J63	Computer programming, consultancy and rel	0.66	0.22	0.77	1.45	0.33	2.18	1.93	0.20	4.99	0.63	0.67	0.91	0.24	1.94	1.05	1.82	1.57	0.58	0.93	0.31	0.85	0.73	1.02	0.24	0.23	0.46	0.30	1.09	1.01
CPA_K64	Financial services, except insurance and pens	1.36	0.39	0.54	0.21	0.52	0.90	0.32	0.31	1.67	0.17	21.17	0.74	0.26	0.58	2.42	0.72	0.13	0.06	0.26	0.07	1.23	6.85	0.18	0.04	0.26	0.12	0.37	0.21	1.50
CPA_K65	Insurance, reinsurance and pension funding s	1.10	0.27	0.46	0.56	0.73	0.41	0.23	0.22	4.22	0.96	6.17	0.23	0.10	0.34	3.13	0.29	0.39	0.07	0.06	0.12	0.54	0.52	0.39	0.09	0.07	0.07	2.70	0.42	0.89
CPA_K66	Services auxiliary to financial services and ins	0.09	0.93	0.00	0.40	0.00	0.97	0.06	0.00	0.62	0.77	1.02	0.07	0.49	0.10	5.32	1.57	2.20	0.13	0.03	0.00	0.00	0.99	0.03	0.00	0.02	0.00	0.00	0.56	0.58
CPA_L68	Real estate services	0.79	0.14	2.25	0.03	0.00	0.22	2.66	0.00	0.00	2.33	1.75	0.00	0.07	0.00	0.82	1.14	0.20	0.75	0.00	2.68	0.00	0.45	4.47	0.00	0.00	0.04	0.00	0.00	0.74
CPA_M69_M70	Legal and accounting services; services of hea	1.26	2.26	0.87	0.25	0.27	1.36	0.91	0.64	0.18	0.36	0.41	1.76	0.39	1.27	1.07	0.15	2.46	0.58	0.70	0.15	0.46	5.99	0.83	0.19	0.35	0.29	0.20	0.43	0.93
CPA_M71	Architectural and engineering services; techn	0.87	0.82	0.86	1.34	0.13	2.53	0.61	1.37	0.51	0.92	0.14	0.69	0.56	1.12	1.06	0.06	0.67	0.28	0.28	0.08	0.28	0.12	0.59	0.16	0.17	0.82	0.56	1.36	0.68
CPA_M72	Scientific research and development services	1.06	0.95	0.97	0.40	0.23	0.83	3.11	0.95	0.21	1.36	1.01	0.61	0.07	1.20	1.48	0.00	0.31	0.08	0.48	0.11	0.26	0.02	0.44	0.09	0.24	0.63	0.29	0.39	0.64
CPA_M73	Advertising and market research services	0.98	0.55	0.67	0.58	0.70	3.49	0.26	0.41	0.14	1.56	0.28	0.57	0.90	0.65	1.46	0.47	2.86	1.43	1.06	1.18	4.25	0.41	2.39	1.30	0.31	0.92	1.02	1.11	1.14
CPA_M74_M75	Other professional, scientific and technical se	0.45	0.11	0.14	0.19	1.37	0.01	0.22	0.02	0.85	1.81	0.31	0.36	1.94	0.60	4.20	1.24	0.32	0.37	1.36	1.15	0.35	0.03	2.50	1.39	2.06	0.00	0.00	1.00	0.87
CPA_N77	Rental and leasing services	0.54	0.15	0.14	0.13	0.10	0.73	0.69	1.95	1.87	1.31	0.17	2.77	0.19	1.78	0.24	34.86	0.34	0.68	0.93	0.22	0.65	9.40	0.08	0.13	0.13	0.17	0.01	0.00	2.16
CPA_N78	Employment services	0.63	0.18	1.19	0.36	0.00	0.00	1.47	0.00	0.00	2.14	0.56	0.22	0.00	0.00	3.25	0.08	0.04	1.38	0.00	0.00	3.24	0.09	0.00	0.00	0.00	0.00	0.00	0.08	0.53
CPA_N79	Travel agency, tour operator and other reserv	0.31	0.02	0.00	0.00	0.00	0.00	0.09	0.00	0.00	3.89	2.63	1.17	0.08	9.03	0.30	23.52	0.01	0.05	0.00	0.70	0.00	9.68	1.65	0.00	0.00	2.13	0.00	0.00	1.97
CPA_N80-N82	Security and investigation services; services t	0.10	0.13	0.09	1.32	0.23	5.56	0.03	0.68	0.00	0.83	0.08	0.13	0.84	0.12	3.17	0.00	0.45	0.22	0.41	0.00	0.38	0.18	0.25	0.00	0.00	0.37	0.00	0.00	0.56
CPA_O84	Public administration and defence services; c	0.93	0.01	1.07	1.50	0.00	2.79	1.04	0.00	0.12	0.00	0.07	1.05	0.00	2.62	1.43	12.40	4.91	3.56	3.53	9.57	5.46	1.50	0.00	2.03	1.50	7.62	0.00	37.49	3.65
CPA_P85	Education services	0.18	0.45	0.00	0.18	1.46	0.00	0.67	0.00	0.00	0.00	0.30	0.81	0.17	0.06	2.64	5.12	0.00	1.44	1.10	0.33	0.86	0.01	0.45	1.07	0.11	1.73	61.84	0.05	45.83	4.53
CPA_R90-R92	Creative, arts and entertainment services; libr	0.61	0.37	0.41	0.13	0.84	3.89	0.05	1.22	0.25	0.55	0.01	0.47	0.47	0.07	2.55	0.00	0.74	0.11	0.03	0.57	0.09	6.27	0.49	0.02	0.00	0.05	3.46	1.92	0.92
CPA_TOTAL	Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	Average	1.24	0.84	0.80	1.10	1.32	1.11	1.01	0.91	0.96	1.00	1.24	0.94	1.00	1.22	1.23	2.12	1.25	2.91	1.00	1.22	2.52	1.59	1.20	0.85	0.84	2.35	1.24	2.90	

Figure A2: Balassa Index heat map across Member State Sectors based on WIOD database, 2014

CPA	Product	AT	BE	DE	DK	EL	ES	FI	FR	IE	IT	LU	NL	PT	SE	UK	CY	CZ	EE	HU	LT	LV	MT	PL	SI	SK	BG	RO	HR	Average
CPA_A01	Products of agriculture, hunting and related se	0.40	0.76	0.52	1.64	2.33	2.44	0.67	1.48	1.90	0.84	0.16	1.55	0.92	0.29	0.21	0.81	0.80	0.73	1.53	3.36	2.76	0.04	1.26	0.53	0.87	4.22	2.24	1.85	1.32
CPA_A02	Products of forestry, logging and related servic	0.70	0.58	0.55	0.44	0.46	0.85	1.55	0.54	2.90	0.33	0.44	0.60	2.69	0.51	0.14	0.18	4.92	14.79	1.43	5.26	25.21	0.14	1.67	9.09	4.24	2.84	2.24	9.01	3.37
CPA_A03	Fish and other fishing products; aquaculture pr	0.02	0.18	0.15	5.14	3.21	1.48	0.35	0.72	1.96	0.41	0.05	0.55	1.08	10.42	1.23	1.76	0.42	1.26	0.12	0.25	1.92	1.66	0.09	0.05	0.06	0.22	0.22	4.78	1.42
CPA_B	Mining and quarrying	0.17	0.86	0.18	0.64	0.11	0.46	0.16	0.14	0.07	0.07	0.00	7.54	0.20	0.37	0.88	0.07	0.23	0.15	0.14	0.06	0.35	0.06	0.20	0.16	0.23	1.05	0.00	0.10	0.52
CPA_C10-C	Food products, beverages and tobacco product	1.09	1.36	0.82	1.88	0.27	1.50	0.42	1.19	2.25	1.20	0.07	1.04	1.06	0.48	0.48	0.21	0.73	0.95	0.97	1.31	1.50	0.24	1.47	0.30	0.19	1.06	0.39	1.30	0.92
CPA_C13-C	Textiles, wearing apparel and leather products	0.78	0.77	0.83	1.09	0.05	1.59	0.36	1.14	0.03	3.56	0.08	0.50	2.96	0.49	0.37	0.19	0.98	1.07	0.47	1.19	0.89	0.06	1.05	0.70	0.70	1.59	1.54	1.29	0.94
CPA_C16	Wood and of products of wood and cork, excep	3.17	0.76	0.77	0.59	0.15	0.63	5.60	0.44	0.42	0.57	0.24	0.20	3.86	3.08	0.09	0.03	1.63	13.99	0.96	3.58	14.72	0.01	2.62	3.41	1.08	1.20	3.72	4.80	2.58
CPA_C17	Paper and paper products	1.85	0.68	1.06	0.43	0.24	0.98	9.57	0.72	0.11	1.08	0.11	0.38	2.51	3.86	0.20	0.00	1.02	1.02	0.64	0.93	0.52	0.03	1.44	1.59	0.79	0.63	0.27	1.07	1.20
CPA_C18	Printing and recording services	5.71	1.37	2.10	0.13	0.09	0.11	3.81	0.16	0.56	0.18	0.00	0.04	0.54	0.02	0.14	0.00	0.72	15.48	0.03	0.07	0.41	39.83	0.33	0.13	0.12	0.04	0.00	0.14	2.58
CPA_C19	Coke and refined petroleum products	0.38	2.44	0.52	0.80	8.49	2.20	2.64	0.67	0.01	0.82	0.23	1.51	1.54	1.61	0.53	0.83	0.38	0.24	0.64	4.89	0.57	2.02	0.70	1.23	0.73	1.66	0.80	1.74	1.46
CPA_C20	Chemicals and chemical products	1.18	1.93	1.28	0.51	0.23	1.12	0.64	1.19	1.10	0.89	0.07	1.00	0.61	0.66	0.58	0.12	0.73	0.69	0.79	1.00	0.30	0.06	0.73	0.90	0.27	0.54	0.25	0.80	0.72
CPA_C21	Basic pharmaceutical products and pharmaceut	0.56	0.98	1.03	2.11	0.37	0.77	0.29	1.05	4.28	1.30	0.01	0.69	0.26	0.90	0.75	0.84	0.50	0.06	0.87	0.47	0.68	0.34	0.34	2.45	0.08	0.69	0.22	1.06	0.86
CPA_C22	Rubber and plastics products	1.08	0.96	1.34	0.53	0.43	1.02	0.98	0.85	0.24	1.35	0.63	0.46	1.76	0.71	0.49	0.10	2.03	0.90	1.56	1.07	0.71	0.36	1.76	1.67	1.59	1.04	1.19	0.93	0.99
CPA_C23	Other non-metallic mineral products	1.47	1.01	1.06	0.66	0.85	1.94	0.94	0.71	0.27	2.19	0.25	0.25	2.67	0.50	0.31	1.26	2.00	1.41	1.58	0.91	1.88	0.05	1.63	1.67	0.97	2.03	0.44	2.51	1.19
CPA_C24	Basic metals	1.48	1.24	0.93	0.26	1.52	1.23	1.78	0.79	0.10	1.41	0.58	0.40	0.83	1.22	1.54	0.24	1.07	0.44	0.45	0.28	0.92	0.02	1.23	1.59	1.50	2.97	0.81	0.52	0.98
CPA_C25	Fabricated metal products, except machinery a	1.83	0.61	1.35	0.79	0.37	1.06	0.93	0.71	0.22	1.87	0.27	0.31	1.85	1.01	0.33	0.19	2.39	2.23	0.92	0.80	1.21	0.10	1.55	2.08	1.67	0.98	0.82	2.00	1.09
CPA_C26	Computer, electronic and optical products	0.86	0.36	1.42	0.74	0.00	0.26	0.79	0.90	0.94	0.52	0.07	1.49	0.53	1.24	0.58	0.35	1.76	2.38	2.20	0.56	1.45	0.52	1.24	0.59	3.07	0.47	0.92	0.36	0.95
CPA_C27	Electrical equipment	1.38	0.40	1.48	0.62	0.25	0.91	1.84	0.80	0.14	1.37	0.05	0.39	1.05	1.00	0.44	0.66	2.04	1.58	2.34	0.86	0.63	0.39	1.45	2.48	1.27	1.18	2.29	1.10	1.09
CPA_C28	Machinery and equipment n.e.c.	1.34	0.52	1.62	1.05	0.15	0.56	1.44	0.74	0.13	2.18	0.11	0.50	0.34	1.08	0.51	0.12	1.43	0.73	0.99	0.66	0.36	0.07	0.65	1.04	0.92	0.62	0.79	0.29	0.75
CPA_C29	Motor vehicles, trailers and semi-trailers	0.90	0.86	1.84	0.15	0.00	1.48	0.25	0.79	0.03	0.70	0.06	0.15	0.87	0.83	0.58	0.09	2.44	0.41	2.33	0.40	0.43	0.01	1.06	1.11	2.27	0.24	0.88	0.19	0.78
CPA_C30	Other transport equipment	0.73	0.20	0.95	0.27	0.69	0.80	0.61	2.81	0.02	0.95	0.04	0.25	0.22	0.16	2.47	3.87	0.43	0.13	0.21	0.16	0.14	0.01	0.55	0.20	0.26	0.23	0.47	0.45	0.65
CPA_C31_(	Furniture; other manufactured goods	1.18	1.37	1.09	1.04	0.32	0.47	0.62	0.82	1.14	2.20	0.04	0.67	0.67	0.57	0.60	0.27	1.02	1.55	0.73	2.16	1.05	0.75	1.59	1.37	0.79	0.71	1.05	1.32	0.97
CPA_C33	Repair and installation services of machinery ar	3.17	0.57	0.74	3.06	0.00	0.73	0.29	3.24	0.00	0.00	0.25	0.94	4.26	0.74	0.15	0.65	0.88	2.12	1.43	0.00	2.18	3.67	0.62	0.87	0.00	1.08	0.58	14.61	1.67
CPA_D35	Electricity, gas, steam and air-conditioning	3.46	3.34	0.71	1.71	0.27	0.34	0.76	1.05	0.00	0.19	0.30	0.94	0.52	0.98	0.13	0.00	3.17	4.31	2.73	0.65	1.57	0.01	0.75	5.30	0.11	5.51	0.94	0.74	1.45
CPA_E37-E	Sewerage; waste collection, treatment and disp	0.76	1.01	1.19	0.41	0.56	0.73	0.62	1.13	0.00	0.40	0.56	1.32	1.11	0.41	1.40	0.55	1.29	2.34	0.61	1.22	2.60	0.17	0.93	1.26	0.84	2.09	2.84	2.13	1.09
CPA_F	Constructions and construction works	0.75	2.34	0.08	2.76	2.95	2.01	0.02	0.00	0.00	0.55	0.76	1.10	4.03	0.00	0.66	0.91	1.52	5.11	0.84	1.50	2.38	0.37	7.10	2.90	1.07	1.79	1.92	2.24	1.70
CPA_G45	Wholesale and retail trade and repair services	0.85	1.80	0.91	0.34	0.00	1.43	0.11	0.81	0.06	0.37	0.11	0.39	0.00	2.62	1.66	0.00	0.05	0.29	0.75	0.00	0.00	0.00	4.86	0.00	0.00	0.32	0.00	0.00	0.63
CPA_G46	Wholesale trade services, except of motor vehi	1.09	1.06	0.81	1.43	0.73	0.72	0.22	1.65	1.13	0.32	1.45	1.10	1.98	0.71	1.50	0.28	0.11	0.40	0.76	1.73	0.79	0.17	0.90	0.71	0.76	0.90	0.94	0.00	0.87
CPA_G47	Retail trade services, except of motor vehicles a	0.00	0.00	0.00	0.00	9.62	1.46	0.00	1.02	0.60	1.32	4.59	0.00	0.00	3.38	1.07	3.08	0.00	1.85	0.00	0.00	0.00	0.00	7.05	0.00	0.00	4.07	4.64	5.47	1.76
CPA_H49	Land transport services and transport services v	2.34	0.85	0.15	1.07	0.18	1.68	0.74	1.45	0.09	0.54	0.86	1.71	1.80	0.12	0.24	0.71	1.68	1.45	1.78	5.59	5.92	0.02	2.33	3.85	1.19	2.78	7.86	3.78	1.88
CPA_H50	Water transport services	0.15	0.73	0.96	9.85	14.74	0.25	0.94	1.31	0.10	0.33	0.01	0.75	0.29	0.96	0.81	2.50	0.01	1.04	0.04	0.17	0.48	0.40	0.05	0.21	0.00	0.09	0.59	2.37	1.43
CPA_H51	Air transport services	0.57	0.78	0.41	1.67	1.05	1.36	1.71	1.77	2.23	0.39	1.60	1.36	5.16	0.76	0.93	1.56	0.51	0.46	0.95	0.29	1.99	1.40	0.59	0.53	0.07	2.11	1.10	1.27	1.23
CPA_H52	Warehousing and support services for transpor	1.26	2.43	0.48	1.15	1.05	1.00	0.52	0.58	0.00	1.16	0.50	1.00	1.73	4.07	0.51	8.90	0.51	6.68	1.55	4.47	4.61	3.01	0.94	1.03	0.51	1.13	1.96	3.12	1.99
CPA_H53	Postal and courier services	1.78	1.03	0.66	0.89	0.06	0.15	0.91	1.15	2.61	0.49	0.83	2.23	0.34	0.00	1.80	1.04	0.21	0.67	0.70	0.34	0.90	0.00	0.15	0.15	0.00	0.21	0.15	0.28	0.70
CPA_I	Accommodation and food services	2.57	0.78	1.04	0.22	0.00	3.08	0.43	0.00	1.44	0.00	0.00	0.00	2.01	0.00	3.38	0.00	0.33	0.17	0.31	1.18	0.00	0.08	0.00	0.00	0.00	0.26	3.59	0.00	0.75
CPA_J58	Publishing services	1.00	0.63	0.95	0.53	0.43	0.81	0.06	0.56	4.62	0.43	3.13	0.60	0.25	1.13	1.45	1.88	1.66	0.41	0.36	0.58	1.15	0.12	0.59	1.19	0.75	0.21	0.15	0.69	0.94
CPA_J59_J	Motion picture, video and television programm	0.66	0.57	1.06	0.36	0.49	0.53	0.25	0.79	0.37	0.69	1.68	0.21	1.27	0.85	3.53	0.20	0.77	0.73	0.39	0.18	0.22	0.06	0.62	0.24	0.48	0.70	0.13	0.51	0.66
CPA_J61	Telecommunications services	0.79	1.68	0.35	0.67	0.19	0.83	0.24	1.09	0.66	1.60	4.44	0.49	1.35	1.20	1.87	0.77	0.57	1.16	0.38	0.32	0.86	0.51	0.36	1.83	2.66	0.81	1.38	1.52	1.09
CPA_J62_J	Computer programming, consultancy and relate	0.92	0.76	0.68	0.95	0.34	1.25	2.18	0.42	6.35	0.21	1.21	0.87	0.41	2.58	0.80	3.16	0.51	0.91	0.65	0.24	0.84	0.91	0.64	0.24	0.32	1.55	1.91	0.85	1.17
CPA_K64	Financial services, except insurance and pensio	0.44	0.40	0.48	0.16	0.36	0.40	0.31	0.54	1.86	0.13	17.42	0.45	0.11	0.34	2.19	3.33	0.07	0.13	0.05	0.03	1.16	8.36	0.09	0.09	0.23	0.21	0.13	0.12	1.41
CPA_K65	Insurance, reinsurance and pension funding ser	0.74	0.42	0.54	0.14	1.07	0.33	0.35	0.30	6.02	0.49	3.36	0.21	0.11	0.17	3.73	1.11	0.29	0.03	0.03	0.03	0.23	0.58	0.15	0.58	0.07	0.40	0.44	0.17	0.79
CPA_K66	Services auxiliary to financial services and insur	0.10	1.41	0.00	0.18	0.00	0.41	0.03	0.00	0.61	0.42	2.06	0.12	0.25	0.11	7.36	8.23	0.09	0.39	0.01	0.00	0.00	1.28	0.02	0.00	0.02	0.00	0.00	0.42	0.84
CPA_L68	Real estate services	0.53	0.04	0.84	0.01	0.00	0.08	0.00	0.00	0.00	2.43	0.23	0.02	0.06	0.00	0.71	1.58	0.14	1.23	0.00	1.23	0.00	0.52	2.50	0.00	36.40	0.05	0.00	0.00	1.74
CPA_M69_	Legal and accounting services; services of head	0.87	2.67	0.84	0.38	0.31	0.40	1.63	1.20	0.17	0.23	0.73	1.60	0.53	1.80	1.21	0.21	0.76	0.56	0.77	0.13	0.32	7.01	0.56	0.30	0.43	0.45	0.57	0.80	0.98
CPA_M71	Architectural and engineering services; technica	1.38	0.56	1.11	1.82	0.15	1.38	1.03	1.58	0.25	0.76	0.30	0.36	0.81	1.38	1.56	0.06	0.64	0.38	0.46	0.06	0.22	0.34	0.54	0.28	0.40	1.24	1.56	2.52	0.83
CPA_M72	Scientific research and development services	1.57	1.33	1.33	0.85	0.30	0.37	4.94	0.94	0.71	0.81	0.43	0.40	0.13	1.92	1.32	0.00	0.20	0.27	0.47	0.06	0.25	0.02	0.36	0.17	0.39	0.97	0.50	0.70	0.78
CPA_M73	Advertising and market research services	1.26	2.40	0.59	0.51	0.25	0.99	0.25	1.20	1.50	0.46	1.66	0.21	1.01	1.01	1.74	0.49	0.76	1.17	0.59	0.66	2.88	0.85	1.62	1.42	0.62	1.51	2.03	2.24	1.14
CPA_M74_	Other professional, scientific and technical serv	0.19	0.13	0.52	0.14	0.38	0.00	0.18	0.01	3.25	1.24	0.90	0.12	1.05	0.49	4.65	0.90	0.08	0.42	2.38	0.53	0.25	0.03	1.31	1.80	1.03	0.00	0.00	1.37	0.83
CPA_N77	Rental and leasing services	0.51	0.67	0.17	0.08	0.06	0.06	2.10	1.47	4.10	0.57	4.24	3.10	0.21	1.98	0.15	11.25	0.15	0.88	1.42	0.13	0.38	7.85	0.04	0.14	0.09	0.18	0.03	0.00	1.50
CPA_N78	Employment services	0.50	0.21	1.22	0.41	0.00	0.00	4.07	0.00	0.00	1.98	0.46	0.17	0.00	0.00	4.10	1.41	0.09	6.26	0.00	0.00	3.48	0.15	0.00	0.00	0.24	0.00	0.05	0.10	0.89
CPA_N79	Travel agency, tour operator and other reservat	0.34	0.01	0.00	0.17	0.00	3.76	0.00	0.00	0.00	2.76	1.32	2.30	0.05	8.22	0.17	7.46	0.10	0.09	0.00	0.33	0.00	4.26	0.35	0.00	0.44	3.09	0.00	0.02	1.26
CPA_N80-I	Security and investigation services; services to b	0.13	0.58	0.26	1.36	0.12	1.51	0.08	2.42	0.00	0.72	0.27	0.14	0.90	0.13	4.35	0.00	0.17	0.23	0.00	0.00	0.30	0.35	0.19	0.00	0.09	0.28	0.00	0.01	0.52
CPA_O84	Public administration and defence services; con	0.45	5.38	0.60	1.02	0.00	1.04	0.95	0.00	0.24	0.00	0.04	0.76	0.00	2.12	2.29	10.00	0.42	1.02	0.75	1.57	2.08	1.37	0.00	1.03	0.51	0.57	0.00	6.74	1.46
CPA_P85	Education services	0.19	0.33	0.00	0.65	1.06	0.42	0.04	0.00	0.00	0.05	1.09	0.10	0.07	1.53	7.95	0.00	0.10	0.28	0.11	0.13	0.00	0.09	0.15	0.05	0.00	4.22	0.00	8.00	0.95
CPA_R90-R	Creative, arts and entertainment services; libra	0.74	0.55	0.41	0.30	0.34	0.53	0.07	1.09	0.70	0.40	0.10	0.18	0.59	0.08	4.14	1.27	0.06	0.55	0.01	0.36	0.16	87.17	0.23	0.07	0.00	0.12	1.81	2.72	3.74
CPA_TOTA	Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
	Average	1.10	1.05	0.78	1.03	1.05	0.98	1.13	0.87	1.06	0.88	1.10	0.83	1.12	1.32	1.51	1.56	0.86	1.93	0.79	0.98	1.76	3.23	1.11	1.10	1.34	1.18	1.08	1.87	

Figure A3: Balassa Index heat map across Member State Sectors based on STAN database, 1995

Balassa Index for 1995 (relative to EU goods total)										Member State (in order of accession)																			
Sector	**AT**	**BE**	**DE**	**DK**	**EL**	**ES**	**FI**	**FR**	**IE**	**IT**	**LU**	**NL**	**PT**	**SE**	**UK**	**CY**	**CZ**	**EE**	**HU**	**LT**	**LV**	**MT**	**PL**	**SI**	**SK**	**BG**	**RO**	**HR**	**Average**
D01: Crop and animal production, hunting and	0.09	0.27	0.10	0.35	1.23	0.70	0.10	0.38	0.12	0.16	0.16	0.67	0.07	0.02	0.10	1.22	0.22	0.11	0.74	0.41	0.08	0.02	0.26	0.08	0.13	0.39	0.37	0.18	0.31
D02: Forestry and logging	0.50	0.24	0.23	0.96	0.30	0.30	0.66	0.54	0.10	0.13	0.97	0.14	0.87	0.39	0.06	0.00	2.99	13.84	1.76	6.14	34.15	0.00	0.35	0.44	1.90	1.09	0.05	1.65	2.53
D03: Fishing and aquaculture	0.02	0.33	0.25	8.43	7.84	1.50	0.03	0.96	2.16	0.48	0.10	1.57	1.67	1.19	1.33	1.43	1.07	1.97	0.41	0.49	0.83	1.51	0.76	0.03	0.10	0.37	0.02	3.88	1.45
D05: Mining of coal and lignite	0.00	0.41	0.43	0.06	0.04	0.00	0.00	0.19	0.00	0.01	0.00	0.85	0.00	0.00	0.25	0.00	26.25	0.69	0.00	0.02	0.19	0.00	49.52	0.02	0.00	0.09	0.00	0.00	2.82
D06: Extraction of crude petroleum and natur	0.01	0.12	0.02	2.45	1.00	0.01	0.00	0.07	0.00	0.04	0.01	4.30	0.00	0.00	4.89	0.00	0.15	0.01	0.00	0.06	0.30	0.00	0.02	0.00	0.05	0.00	0.00	0.66	0.51
D07: Mining of metal ores	0.03	2.43	0.12	0.00	4.21	1.10	0.72	0.21	3.68	0.12	0.06	0.59	15.70	12.12	0.23	0.00	0.14	0.15	0.09	0.02	0.00	0.00	1.55	0.00	1.29	12.97	1.20	0.07	2.10
D08: Other mining and quarrying	0.91	8.42	0.47	0.49	2.66	0.83	0.59	0.52	0.38	0.42	0.15	0.66	0.63	0.30	4.63	0.99	1.12	2.01	0.18	1.02	1.06	0.18	1.77	0.14	1.31	1.06	0.40	0.60	1.21
D10: Food products	0.47	1.40	0.61	3.59	2.83	1.18	0.31	1.31	2.91	0.67	0.51	2.31	0.68	0.29	0.64	0.94	0.66	2.52	2.15	2.73	2.17	0.16	1.27	0.46	0.50	1.28	0.46	1.19	1.29
D11: Beverages	0.34	0.41	0.24	0.45	1.08	0.80	0.16	1.63	0.88	0.67	0.45	0.61	1.40	0.15	1.00	2.00	0.57	0.46	1.15	0.30	0.68	0.19	0.34	0.29	0.31	2.06	0.22	0.82	0.70
D12: Tobacco products	0.28	0.74	0.79	1.01	3.71	0.30	0.17	0.26	0.55	0.16	4.55	4.56	0.12	0.08	0.59	84.29	0.97	0.23	0.03	0.14	1.85	1.20	0.34	0.33	0.78	9.84	0.03	1.29	4.26
D13: Textiles	1.40	1.74	1.08	0.69	1.79	1.04	0.35	1.03	0.41	2.11	2.20	0.72	2.81	0.42	0.75	2.17	1.90	2.33	0.93	2.48	2.59	0.16	0.92	1.35	0.58	1.31	0.75	1.04	1.32
D14: Wearing apparel	0.80	0.62	0.52	1.11	6.20	0.43	0.25	0.70	0.42	2.23	0.32	0.57	6.00	0.16	0.64	3.27	0.76	2.90	2.96	2.79	2.06	3.08	3.70	2.92	1.94	2.05	6.35	5.35	2.18
D15: Leather and related products	1.07	0.29	0.36	0.55	0.59	1.96	0.28	0.63	0.18	3.65	0.08	0.37	5.54	0.12	0.42	1.08	1.34	0.94	1.82	1.15	1.29	1.48	1.19	1.84	1.63	1.86	3.77	3.67	1.40
D16: Wood and products of wood and cork, ex	3.73	0.89	0.49	1.81	0.56	0.69	6.74	0.63	0.36	0.56	1.52	0.48	4.54	4.43	0.14	0.06	3.10	8.03	1.63	4.61	15.51	0.02	3.99	4.07	2.27	1.33	3.21	4.61	2.86
D17: Paper and paper products	2.23	0.71	0.84	0.48	0.27	0.76	8.93	0.77	0.15	0.56	1.00	0.81	2.02	4.18	0.54	0.41	1.01	0.39	0.42	0.51	0.36	0.03	0.75	1.74	1.63	0.48	0.35	0.89	1.19
D18: Printing and reproduction of recorded m	0.11	0.07	0.28	0.32	1.02	0.09	0.05	0.14	16.26	0.18	0.29	0.14	0.03	0.10	0.48	0.05	0.06	0.06	0.11	0.01	0.02	6.93	0.07	0.09	0.21	0.15	0.01	0.02	0.98
D19: Coke and refined petroleum products	0.27	1.81	0.54	0.88	4.39	1.38	1.34	0.64	0.21	0.88	0.03	3.33	2.16	1.31	1.10	2.71	1.33	3.16	2.12	6.66	0.57	1.13	1.57	0.12	2.67	3.95	5.70	5.85	2.06
D20: Chemicals and chemical products	0.49	1.79	1.22	0.52	0.52	0.86	0.54	1.48	1.56	0.63	0.55	1.52	0.47	0.35	1.12	0.39	1.06	0.86	1.06	1.27	0.66	0.19	0.81	0.74	1.11	1.93	1.26	1.54	0.95
D21: Basic pharmaceutical products and pharr	0.69	0.78	0.59	1.32	0.22	0.41	0.16	0.72	1.48	0.48	0.04	0.68	0.19	1.00	0.93	0.99	0.31	0.33	0.66	0.59	0.91	0.37	0.30	1.17	0.44	0.70	0.18	0.91	0.63
D22: Rubber and plastics products	1.71	1.21	1.05	1.05	0.63	1.06	0.54	1.26	0.47	1.14	3.18	0.85	0.56	0.84	0.99	0.35	1.11	0.67	0.92	0.36	0.20	0.89	0.71	1.27	1.41	0.42	0.26	0.58	0.92
D23: Other non-metallic mineral products	1.41	1.04	0.73	0.72	1.88	1.74	0.55	0.91	0.37	1.86	2.11	0.44	2.05	0.45	0.60	0.74	2.93	1.12	0.94	0.80	0.80	0.06	1.35	1.26	1.88	1.27	1.42	1.38	1.17
D24: Basic metals	1.67	1.70	1.08	0.40	1.80	1.18	1.59	1.10	0.11	0.93	6.69	0.83	0.19	1.46	1.00	0.16	2.14	0.46	1.30	0.65	1.03	0.06	2.31	1.34	3.61	3.52	3.24	0.58	1.50
D25: Fabricated metal products, except machi	1.56	0.77	0.95	0.99	0.58	0.82	0.70	0.74	0.31	1.25	1.23	0.69	1.06	0.93	0.66	0.33	1.96	0.98	0.89	0.34	0.35	0.27	1.52	1.50	1.12	0.48	0.75	0.60	0.87
D26: Computer, electronic and optical product	0.61	0.52	0.98	0.84	0.14	0.53	1.43	0.94	2.92	0.62	1.20	1.43	0.68	1.34	1.81	0.54	0.23	0.55	0.64	0.54	0.21	6.06	0.23	0.47	0.30	0.10	0.05	0.24	0.93
D27: Electrical equipment	1.05	0.48	1.27	0.90	0.59	0.83	1.13	1.00	0.79	1.18	0.72	0.62	0.98	0.93	0.80	0.87	0.85	0.37	1.66	0.61	0.53	0.82	0.79	1.97	0.88	0.47	0.48	0.94	0.88
D28: Machinery and equipment n.e.c.	1.32	0.62	1.50	1.14	0.16	0.56	1.03	0.78	0.36	1.61	0.71	0.57	0.19	1.08	0.97	0.26	0.96	0.59	0.53	0.26	0.56	0.12	0.50	0.63	0.63	0.57	0.48	0.30	0.68
D29: Motor vehicles, trailers and semi-trailers	1.05	1.35	1.57	0.20	0.09	2.29	0.29	1.08	0.06	0.76	0.28	0.39	1.14	1.16	0.83	0.10	0.79	0.61	0.63	0.36	0.31	0.02	0.47	1.11	1.06	0.11	0.27	0.18	0.66
D30: Other transport equipment	0.35	0.16	0.67	0.57	0.41	0.62	0.88	1.54	0.16	0.57	0.12	0.49	0.32	0.69	1.08	0.02	0.36	0.18	0.07	0.40	0.70	1.07	1.23	0.20	0.69	0.48	0.67	1.37	0.57
D31T32: Furniture, other manufacturing	1.59	1.61	0.80	1.93	0.28	0.82	0.51	0.76	0.98	2.50	0.24	0.55	0.74	0.92	0.98	0.59	1.30	1.81	0.82	0.72	1.37	2.73	2.14	2.28	0.85	0.41	2.36	1.46	1.22
D35: Electricity, gas, steam and air conditionir	0.93	0.19	0.15	0.35	0.00	0.05	0.03	2.10	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.68	1.86	0.00	2.96	0.74	0.00	0.71	1.63	0.05	0.00	0.16	0.05	0.45
D36T99: Other activities	1.40	0.76	0.96	1.25	0.51	0.98	0.90	0.95	0.78	0.70	0.72	1.11	0.23	0.52	2.43	0.53	1.03	0.26	0.43	0.17	0.18	0.25	0.52	0.64	1.01	0.25	0.04	0.27	0.71
Note: LX is for 1999, SK for 1997 and BG for 1996																													
Average	0.91	1.09	0.67	1.15	1.53	0.83	1.00	0.84	1.26	0.88	0.97	1.06	1.71	1.19	1.03	3.43	1.91	1.63	0.87	1.28	2.33	0.94	2.64	0.97	1.04	1.64	1.11	1.36	

Figure A4: Balassa Index heat map across Member State Sectors based on STAN database, 2016

Balassa Index for 2016 (relative to EU goods total)										Member State (in order of accession)																			
Sector	**AT**	**BE**	**DE**	**DK**	**EL**	**ES**	**FI**	**FR**	**IE**	**IT**	**LU**	**NL**	**PT**	**SE**	**UK**	**CY**	**CZ**	**EE**	**HU**	**LT**	**LV**	**MT**	**PL**	**SI**	**SK**	**BG**	**RO**	**HR**	**Average**
D01: Crop and animal production, hunting and	0.12	0.21	0.09	0.40	0.72	0.63	0.10	0.33	0.05	0.15	0.24	0.69	0.24	0.05	0.08	0.47	0.13	0.31	0.28	0.66	0.77	0.02	0.20	0.20	0.14	0.88	0.68	0.33	0.33
D02: Forestry and logging	0.26	0.21	0.21	2.09	0.19	0.28	0.52	0.64	0.10	0.18	1.06	0.36	0.39	0.15	0.06	0.00	1.27	4.52	0.26	2.06	5.95	0.00	0.37	2.97	0.78	0.40	0.10	3.04	1.02
D03: Fishing and aquaculture	0.03	0.21	0.14	4.84	11.25	1.36	0.31	0.71	1.09	0.32	0.27	1.07	2.19	13.01	1.51	8.88	0.37	0.27	0.08	0.28	1.35	14.09	0.08	0.03	0.02	0.25	0.03	4.27	2.44
D05: Mining of coal and lignite	0.00	1.25	0.24	0.06	0.15	0.46	0.00	0.09	0.26	0.08	0.00	3.63	0.02	0.00	0.41	0.00	5.49	0.00	0.15	0.35	0.09	0.00	8.43	0.06	0.08	0.34	0.02	1.29	0.82
D06: Extraction of crude petroleum and natur	0.00	2.62	0.87	2.66	0.30	0.27	0.00	0.44	0.01	0.12	0.00	0.04	0.01	0.02	7.67	0.00	0.62	0.06	0.24	0.15	0.04	0.00	0.07	0.67	2.33	0.01	0.04	0.85	0.72
D07: Mining of metal ores	0.00	1.24	0.06	0.01	0.88	2.58	1.79	0.11	0.86	0.11	0.06	0.41	3.41	7.39	0.06	0.00	0.01	0.01	0.05	0.00	0.01	0.01	0.27	0.01	0.13	10.38	0.32	0.00	1.08
D08: Other mining and quarrying	1.09	16.37	0.71	0.81	5.47	1.43	1.37	0.82	0.60	0.87	0.35	1.23	1.51	0.59	1.90	5.22	0.58	3.25	0.24	1.62	7.95	0.12	0.46	1.73	0.82	1.54	0.34	1.70	2.17
D10: Food products	0.86	1.25	0.74	2.56	2.25	1.66	0.34	1.11	1.42	1.00	1.03	2.04	1.21	0.54	0.62	2.07	0.49	1.00	0.86	1.74	1.29	0.73	1.67	0.59	0.41	1.28	0.45	1.49	1.17
D11: Beverages	1.13	0.51	0.27	0.63	0.49	0.90	0.20	2.00	0.65	1.08	0.51	0.64	1.21	0.40	1.35	0.94	0.26	0.76	0.22	0.79	2.20	0.13	0.25	0.24	0.16	0.26	0.13	0.72	0.68
D12: Tobacco products	0.00	0.99	1.07	0.70	3.98	0.28	0.02	0.27	0.09	0.31	3.00	1.32	3.83	0.48	0.22	7.20	1.58	0.10	0.32	5.00	1.02	1.32	3.20	0.01	0.02	2.03	3.84	1.40	1.56
D13: Textiles	1.20	1.16	0.87	1.05	1.51	1.27	0.46	0.87	0.13	2.14	3.69	0.83	3.21	0.59	0.74	0.09	1.45	2.20	0.72	2.31	1.46	0.61	1.19	1.16	0.64	1.92	1.86	1.14	1.30
D14: Wearing apparel	0.80	1.03	0.63	2.03	1.11	2.12	0.24	1.04	0.14	2.22	0.46	0.88	2.96	0.60	0.95	0.33	0.56	0.90	0.30	1.35	0.86	0.14	1.20	0.44	0.61	3.07	2.33	2.47	1.13
D15: Leather and related products	0.68	1.29	0.46	0.59	0.49	1.16	0.20	1.44	0.07	3.30	0.25	0.77	3.09	0.27	0.57	0.46	0.58	0.52	0.65	0.40	0.26	0.15	0.67	0.78	1.28	0.80	1.82	2.27	0.90
D16: Wood and products of wood and cork, ex	3.19	0.64	0.62	0.76	0.23	0.60	5.08	0.51	0.35	0.43	1.66	0.32	3.18	2.77	0.12	0.04	0.99	8.94	0.66	3.71	16.68	0.01	1.94	2.43	0.94	1.17	2.97	5.29	2.37
D17: Paper and paper products	1.81	0.74	0.92	0.58	0.54	0.88	9.58	0.78	0.09	0.88	1.58	0.75	2.67	4.36	0.43	0.09	0.82	0.99	0.77	0.70	0.66	0.02	1.43	1.84	0.92	0.70	0.34	0.98	1.32
D18: Printing and reproduction of recorded m	0.62	0.78	0.48	0.36	0.48	0.07	0.27	0.30	0.36	0.23	0.21	0.44	0.16	0.70	0.69	0.01	0.94	0.91	0.21	0.50	1.10	15.01	0.28	0.36	0.12	0.21	0.16	0.39	0.94
D19: Coke and refined petroleum products	0.30	2.10	0.37	0.82	10.81	1.33	2.93	0.63	0.18	0.96	0.02	3.51	2.15	1.98	1.01	8.04	0.28	2.36	0.44	5.26	1.17	9.81	0.75	0.90	0.83	2.58	1.22	2.35	2.32
D20: Chemicals and chemical products	0.63	2.21	1.04	0.67	0.65	1.05	0.94	1.39	3.58	0.79	0.81	1.51	0.65	0.72	0.94	0.52	0.42	0.58	0.67	1.21	0.51	0.33	0.78	0.82	0.39	0.79	0.33	0.62	0.91
D21: Basic pharmaceutical products and pharr	0.90	1.68	0.87	2.16	0.64	0.61	0.24	0.96	3.82	0.74	0.14	0.58	0.34	0.87	1.22	2.28	0.23	0.09	0.68	0.48	0.60	3.53	0.22	1.27	0.11	0.50	0.19	1.09	0.97
D22: Rubber and plastics products	0.97	0.67	1.01	0.62	0.61	0.73	0.70	0.80	0.23	0.90	3.10	0.61	1.41	0.61	0.57	0.25	1.19	0.71	1.23	1.01	0.66	0.71	1.42	1.11	1.23	0.86	1.26	0.71	0.92
D23: Other non-metallic mineral products	1.22	0.69	0.84	0.81	1.39	1.75	0.67	0.75	0.27	1.63	2.35	0.47	2.52	0.46	0.50	2.01	1.23	1.13	1.07	0.89	1.77	0.13	1.38	1.13	0.84	1.92	0.43	2.27	1.16
D24: Basic metals	1.77	1.23	0.92	0.38	2.05	1.22	2.56	0.89	0.05	1.37	4.74	0.89	0.75	1.50	1.67	0.49	0.74	0.56	0.37	0.30	0.83	0.11	1.05	1.46	1.26	2.51	1.00	0.54	1.19
D25: Fabricated metal products, except machi	1.80	0.52	1.01	1.03	0.53	0.94	0.76	0.64	0.21	1.34	1.05	0.64	1.65	0.86	0.53	0.20	1.78	1.80	0.71	1.15	1.23	0.10	1.49	1.70	1.33	0.64	0.89	2.27	1.03
D26: Computer, electronic and optical product	1.11	0.43	1.12	0.91	0.60	0.32	0.75	0.88	1.66	0.44	0.55	1.85	0.63	1.19	1.03	1.45	1.90	1.94	1.80	0.69	1.45	1.85	1.07	0.50	2.24	0.56	0.72	0.52	1.08
D27: Electrical equipment	1.32	0.39	1.21	1.47	0.51	0.87	1.22	0.78	0.39	0.99	0.62	0.60	1.06	0.94	0.66	0.33	1.68	1.54	2.19	0.65	0.57	1.07	1.49	1.92	1.11	1.23	2.09	1.25	1.08
D28: Machinery and equipment n.e.c.	1.37	0.63	1.37	1.18	0.24	0.56	1.34	0.81	0.24	1.84	1.14	0.90	0.41	1.20	0.85	0.23	1.16	0.74	0.87	0.69	0.41	0.27	0.64	0.86	0.84	0.66	0.86	0.74	0.82
D29: Motor vehicles, trailers and semi-trailers	0.89	0.86	1.49	0.21	0.07	1.57	0.35	0.79	0.02	0.66	0.55	0.33	0.84	1.06	1.01	0.23	1.75	0.49	1.99	0.35	0.42	0.06	1.12	1.33	2.33	0.33	1.61	0.29	0.82
D30: Other transport equipment	0.54	0.18	0.90	0.22	0.17	0.57	0.41	2.64	1.03	0.60	0.34	0.46	0.28	0.23	1.89	0.06	0.22	0.16	0.17	0.11	0.17	0.77	0.72	0.17	0.09	0.19	0.52	0.45	0.51
D31T32: Furniture, other manufacturing	1.13	1.35	0.89	1.33	0.42	0.55	0.81	0.98	1.66	1.65	0.28	1.20	1.14	0.76	0.97	0.46	1.36	1.47	0.69	2.31	1.06	1.52	1.84	1.21	0.71	0.84	1.27	1.07	1.10
D35: Electricity, gas, steam and air conditionir	0.97	0.13	0.38	0.40	0.58	0.18	0.29	0.74	0.08	0.14	0.00	0.02	0.87	1.02	0.06	0.00	1.12	2.58	1.01	0.50	0.05	0.00	0.43	2.73	0.03	3.27	0.88	5.16	0.84
D36T99: Other activities	1.12	0.44	0.85	0.63	0.77	0.55	0.36	1.17	0.67	0.53	0.32	0.76	0.20	0.63	3.96	0.28	1.39	1.28	0.28	0.60	1.54	0.39	1.77	0.74	0.43	0.28	0.21	0.71	0.82
Average	0.90	1.42	0.73	1.06	1.62	0.93	1.12	0.85	0.66	0.90	0.98	0.96	1.42	1.48	1.11	1.38	1.05	1.36	0.65	1.22	1.75	1.71	1.22	1.01	0.75	1.37	0.93	1.54	

Appendix B Manufacturing Sector Coverage for Theil Indices

The table below shows the 2-digit manufacturing sector coverage for the two SBS databases used in the study (NACE Rev1.1 for the 2003 and 2007 periods, and Nace Rev2 for the 2011 and 2015 periods).

NACE Rev1.1		**NACE Rev2**	
Code	Sector Name	Code	Sector Name
DA	Manufacture of food products, beverages and tobacco	C10	Manufacture of food products
DB	Manufacture of textiles and textile products	C11	Manufacture of beverages
DD	Manufacture of wood and wood products	C13	Manufacture of textiles
DE	Manufacture of pulp, paper and paper products; publishing and printing	C14	Manufacture of wearing apparel
DG	Manufacture of chemicals, chemical products and man-made fibres	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
DH	Manufacture of rubber and plastic products	C17	Manufacture of paper and paper products
DI	Manufacture of other non-metallic mineral products	C18	Printing and reproduction of recorded media
DJ	Manufacture of basic metals and fabricated metal products	C20	Manufacture of chemicals and chemical products
DK	Manufacture of machinery and equipment n.e.c.	C22	Manufacture of rubber and plastic products
DL	Manufacture of electrical and optical equipment	C23	Manufacture of other non-metallic mineral products
DM	Manufacture of transport equipment		

NACE Rev1.1		NACE Rev2	
Code	Sector Name	Code	Sector Name
DN	Manufacturing n.e.c.	C24	Manufacture of basic metals
		C25	Manufacture of fabricated metal products, except machinery and equipment
		C26	Manufacture of computer, electronic and optical products
		C27	Manufacture of electrical equipment
		C28	Manufacture of machinery and equipment n.e.c.
		C29	Manufacture of motor vehicles, trailers and semi-trailers
		C31	Manufacture of furniture
		C32	Other manufacturing
		C33	Repair and installation of machinery and equipment

Appendix C Detailed EG Statistics

Table C1: Co-agglomeration results across EU regions (2003)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.0005	0.0014	-0.0007	-0.0010	0.0003	0.0009	-0.0003	-0.0008	-0.0006	-0.0006	0.0005	0.0001	-0.0003	0.0001	-0.0002	0.0003	-0.0010
DB			0.0029	-0.0006	-0.0002	0.0012	0.0020	0.0026	0.0011	-0.0002	-0.0031	0.0030	-0.0010	0.0000	-0.0012	-0.0010	-0.0010	-0.0043
DD				-0.0010	-0.0015	0.0004	0.0020	0.0009	-0.0002	-0.0010	-0.0020	0.0024	-0.0001	-0.0004	-0.0002	-0.0004	-0.0002	-0.0024
DE					0.0004	-0.0004	-0.0011	-0.0006	-0.0003	0.0001	0.0003	-0.0006	-0.0003	0.0002	0.0001	0.0004	0.0002	0.0012
DG						0.0016	-0.0010	0.0019	0.0021	0.0014	0.0001	-0.0009	-0.0001	-0.0001	-0.0007	-0.0011	-0.0004	-0.0003
DH							0.0004	0.0020	0.0025	0.0014	0.0009	0.0006	-0.0002	-0.0009	-0.0007	-0.0013	-0.0012	-0.0008
DI								0.0004	0.0006	-0.0004	-0.0007	0.0015	0.0000	-0.0004	-0.0003	-0.0004	-0.0004	-0.0016
DJ									0.0030	0.0007	-0.0012	0.0010	-0.0003	-0.0005	-0.0009	-0.0014	-0.0012	-0.0025
DK										0.0032	0.0025	0.0006	-0.0004	-0.0012	-0.0013	-0.0019	-0.0022	0.0000
DL											0.0029	-0.0003	-0.0003	-0.0008	-0.0008	-0.0010	-0.0011	0.0017
DM												-0.0013	-0.0003	-0.0007	-0.0006	-0.0008	-0.0011	0.0021
DN													-0.0002	-0.0002	-0.0004	-0.0005	-0.0006	-0.0019
G50														0.0000	0.0003	0.0001	0.0001	0.0003
G51															0.0001	0.0002	0.0006	-0.0001
G52																0.0005	0.0004	0.0006
H																	0.0002	0.0010
I60																		-0.0005
K73																		

Source: CE calculations.

Table C2: Co-agglomeration results across EU regions (2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.0005	0.0014	-0.0006	-0.0009	0.0004	0.0009	-0.0002	-0.0009	-0.0005	0.0002	0.0007	0.0001	-0.0002	0.0000	-0.0002	0.0003	-0.0011
DB			0.0030	-0.0004	-0.0004	0.0012	0.0020	0.0027	0.0007	-0.0001	-0.0022	0.0034	-0.0010	0.0001	-0.0012	-0.0010	-0.0009	-0.0044
DD				-0.0008	-0.0017	0.0006	0.0019	0.0009	-0.0008	-0.0008	-0.0006	0.0026	-0.0001	-0.0003	-0.0003	-0.0004	-0.0002	-0.0026
DE					0.0004	-0.0005	-0.0011	-0.0006	-0.0001	-0.0001	-0.0006	-0.0006	-0.0003	0.0003	0.0001	0.0003	0.0003	0.0010
DG						0.0010	-0.0012	0.0010	0.0018	0.0013	-0.0002	-0.0011	-0.0001	0.0001	-0.0005	-0.0008	0.0000	0.0006
DH							0.0004	0.0019	0.0020	0.0017	0.0021	0.0007	-0.0001	-0.0009	-0.0007	-0.0013	-0.0010	-0.0008
DI								0.0005	-0.0001	-0.0003	0.0001	0.0016	0.0000	-0.0003	-0.0003	-0.0002	-0.0003	-0.0020
DJ									0.0023	0.0009	-0.0002	0.0011	-0.0002	-0.0005	-0.0008	-0.0013	-0.0010	-0.0023
DK										0.0034	0.0030	0.0001	-0.0004	-0.0009	-0.0012	-0.0015	-0.0015	0.0010
DL											0.0029	-0.0002	-0.0002	-0.0009	-0.0008	-0.0011	-0.0011	0.0020
DM												-0.0007	0.0001	-0.0014	-0.0005	-0.0011	-0.0016	0.0013
DN													-0.0003	-0.0001	-0.0004	-0.0005	-0.0004	-0.0022
G50														-0.0001	0.0002	0.0001	0.0000	0.0003
G51															0.0002	0.0002	0.0006	-0.0003
G52																0.0004	0.0003	0.0004
H																	0.0001	0.0009
I60																		-0.0005
K73																		

Source: CE calculations.

Table C3: Co-agglomeration results across EU regions (2011)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.0007	0.0001	0.0012	0.0015	-0.0001	0.0001	-0.0016	0.0001	0.0006	-0.0018	-0.0001	-0.0010	-0.0015	-0.0014	-0.0011	0.0009	0.0001	0.0002	0.0002	-0.0002	0.0003	-0.0001	0.0001	-0.0012
C11			-0.0004	0.0004	0.0010	-0.0001	-0.0001	-0.0006	0.0002	0.0004	-0.0019	-0.0002	-0.0002	-0.0004	-0.0007	-0.0005	0.0003	0.0003	-0.0001	0.0002	-0.0003	0.0001	0.0002	-0.0001	-0.0001
C13				0.0097	0.0034	0.0013	0.0015	-0.0001	0.0018	0.0011	0.0017	0.0037	-0.0014	0.0013	0.0021	-0.0037	0.0032	0.0024	0.0001	-0.0007	-0.0002	-0.0009	-0.0009	-0.0017	-0.0039
C14					0.0050	0.0001	0.0012	-0.0032	0.0002	0.0029	-0.0022	0.0024	-0.0015	-0.0011	-0.0006	-0.0045	0.0047	0.0035	0.0007	-0.0011	0.0000	-0.0007	-0.0004	0.0000	-0.0048
C16						0.0006	0.0004	-0.0027	0.0006	0.0014	-0.0009	0.0016	-0.0018	-0.0011	-0.0006	-0.0030	0.0038	0.0014	0.0003	0.0000	-0.0006	0.0000	-0.0003	-0.0005	-0.0028
C17							0.0000	0.0012	0.0010	0.0000	0.0019	0.0009	-0.0001	0.0013	0.0019	0.0012	0.0008	0.0002	-0.0003	0.0000	-0.0002	-0.0004	-0.0008	-0.0006	-0.0010
C18								-0.0009	-0.0004	-0.0003	-0.0010	0.0002	-0.0006	-0.0009	-0.0008	-0.0020	0.0004	0.0003	-0.0003	0.0000	0.0002	0.0002	0.0002	0.0000	-0.0002
C20									0.0014	-0.0005	0.0051	0.0006	0.0012	0.0028	0.0026	0.0023	-0.0016	-0.0012	0.0002	-0.0001	0.0004	-0.0009	-0.0011	0.0003	0.0003
C22										0.0003	0.0017	0.0014	0.0008	0.0028	0.0029	0.0023	0.0010	0.0006	0.0000	0.0001	-0.0006	-0.0006	-0.0012	-0.0012	-0.0007
C23											-0.0009	0.0003	0.0004	0.0000	0.0000	0.0002	0.0012	0.0007	0.0004	-0.0002	-0.0003	-0.0002	-0.0003	0.0001	-0.0013
C24												0.0031	-0.0013	0.0039	0.0046	0.0002	0.0002	-0.0020	0.0001	0.0002	0.0001	-0.0009	-0.0019	-0.0010	-0.0015
C25													-0.0007	0.0017	0.0027	-0.0009	0.0017	0.0007	0.0000	-0.0001	-0.0003	-0.0006	-0.0009	-0.0011	-0.0019
C26														0.0034	0.0025	0.0054	-0.0018	0.0012	0.0008	-0.0005	-0.0004	-0.0009	-0.0003	0.0002	0.0030
C27															0.0072	0.0053	0.0005	0.0008	-0.0001	-0.0001	-0.0007	-0.0013	-0.0015	-0.0023	0.0014
C28																0.0059	0.0007	0.0008	-0.0007	0.0000	-0.0009	-0.0015	-0.0018	-0.0035	0.0004
C29																	-0.0026	-0.0004	0.0000	-0.0005	-0.0008	-0.0013	-0.0014	-0.0008	0.0019
C31																		0.0014	-0.0002	0.0000	-0.0003	-0.0002	-0.0008	-0.0009	-0.0025
C32																			0.0003	-0.0002	-0.0004	-0.0004	0.0000	-0.0005	-0.0004
C33																				-0.0001	0.0000	-0.0002	-0.0003	0.0007	-0.0004
G45																					-0.0001	0.0002	0.0000	-0.0004	0.0001
G46																						0.0000	0.0000	0.0006	-0.0001
G47																							0.0004	0.0001	0.0002
I																								0.0003	0.0010
H49																									-0.0003
M72																									

Source: CE calculations.

Table C4: Co-agglomeration results across EU regions (2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.0008	0.0002	0.0013	0.0016	0.0002	0.0002	-0.0015	0.0002	0.0005	-0.0018	-0.0001	-0.0011	-0.0014	-0.0015	-0.0010	0.0010	0.0002	0.0003	0.0001	-0.0001	0.0002	-0.0002	0.0003	-0.0011
C11			-0.0003	0.0002	0.0009	-0.0001	-0.0001	-0.0006	-0.0001	0.0003	-0.0023	-0.0005	0.0001	-0.0006	-0.0011	-0.0005	-0.0001	0.0007	0.0000	0.0003	-0.0003	0.0001	0.0003	0.0002	0.0006
C13				0.0093	0.0028	0.0015	0.0013	-0.0001	0.0019	0.0006	0.0019	0.0033	-0.0016	0.0007	0.0017	-0.0031	0.0037	0.0021	-0.0002	-0.0006	-0.0001	-0.0007	-0.0008	-0.0012	-0.0032
C14					0.0039	0.0005	0.0013	-0.0030	-0.0002	0.0023	-0.0022	0.0020	-0.0018	-0.0015	-0.0009	-0.0044	0.0047	0.0034	0.0014	-0.0013	0.0003	-0.0007	-0.0001	0.0002	-0.0043
C16						0.0010	0.0005	-0.0028	0.0011	0.0010	-0.0008	0.0015	-0.0020	-0.0011	-0.0009	-0.0026	0.0044	0.0012	0.0001	0.0002	-0.0006	0.0001	-0.0004	-0.0001	-0.0024
C17							0.0000	0.0010	0.0013	0.0004	0.0017	0.0011	-0.0001	0.0012	0.0016	0.0009	0.0013	0.0004	-0.0003	0.0001	-0.0003	-0.0003	-0.0009	-0.0004	-0.0011
C18								-0.0009	-0.0003	-0.0004	-0.0008	0.0002	-0.0010	-0.0010	-0.0010	-0.0021	0.0007	0.0003	-0.0002	0.0000	0.0002	0.0002	0.0002	0.0001	-0.0001
C20									0.0013	0.0003	0.0060	0.0008	0.0018	0.0029	0.0029	0.0019	-0.0016	-0.0012	0.0005	-0.0001	0.0004	-0.0009	-0.0014	0.0001	0.0002
C22										0.0005	0.0025	0.0018	0.0005	0.0030	0.0033	0.0021	0.0017	0.0006	-0.0010	0.0003	-0.0009	-0.0005	-0.0014	-0.0012	-0.0008
C23											-0.0006	0.0002	0.0012	0.0007	0.0005	0.0012	0.0010	0.0007	0.0006	-0.0002	-0.0002	-0.0004	-0.0006	0.0001	-0.0012
C24												0.0037	-0.0010	0.0044	0.0050	-0.0005	0.0006	-0.0018	-0.0001	0.0002	-0.0001	-0.0008	-0.0022	-0.0010	-0.0020
C25													-0.0004	0.0019	0.0028	-0.0006	0.0019	0.0008	-0.0003	0.0000	-0.0004	-0.0006	-0.0011	-0.0008	-0.0017
C26														0.0047	0.0039	0.0062	-0.0019	0.0013	0.0003	-0.0003	-0.0006	-0.0011	-0.0007	-0.0004	0.0027
C27															0.0079	0.0058	0.0007	0.0009	-0.0016	0.0000	-0.0012	-0.0013	-0.0018	-0.0020	0.0013
C28																0.0065	0.0005	0.0009	-0.0022	0.0000	-0.0014	-0.0015	-0.0020	-0.0028	0.0001
C29																	-0.0024	-0.0001	-0.0006	-0.0003	-0.0010	-0.0013	-0.0016	-0.0011	0.0012
C31																		0.0014	-0.0004	-0.0001	-0.0003	-0.0002	-0.0011	-0.0005	-0.0027
C32																			0.0002	-0.0002	-0.0004	-0.0004	-0.0001	-0.0003	-0.0002
C33																				-0.0003	0.0006	-0.0001	-0.0002	0.0013	-0.0009
G45																					-0.0002	0.0002	-0.0001	-0.0002	0.0004
G46																						0.0000	0.0000	0.0007	-0.0003
G47																							0.0004	0.0001	0.0002
I																								0.0002	0.0010
H49																									-0.0004
M72																									

Source: CE calculations.

Table C5: Co-agglomeration results across UK NUTS2 regions (2003)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.0056	0.0050	-0.0051	0.0014	0.0033	0.0050	0.0010	0.0022	0.0010	-0.0005	0.0008	0.0011	-0.0021	-0.0003	-0.0017	0.0008	-0.0043
DB			0.0029	0.0003	0.0029	0.0039	0.0060	0.0012	0.0016	-0.0020	0.0008	0.0043	-0.0017	-0.0011	-0.0012	-0.0020	0.0008	-0.0124
DD				-0.0050	0.0017	0.0034	0.0051	0.0024	0.0029	0.0022	0.0019	0.0019	0.0015	-0.0022	-0.0002	-0.0019	-0.0007	-0.0033
DE					-0.0036	-0.0062	-0.0067	-0.0082	-0.0054	-0.0059	-0.0087	-0.0026	-0.0036	0.0018	0.0003	0.0048	0.0013	0.0052
DG						0.0028	0.0016	0.0000	0.0015	0.0015	0.0009	0.0027	0.0013	-0.0003	0.0000	-0.0024	-0.0009	-0.0007
DH							0.0066	0.0072	0.0054	0.0020	0.0075	0.0049	0.0014	-0.0011	-0.0010	-0.0039	-0.0007	-0.0045
DI								0.0069	0.0066	0.0016	0.0043	0.0036	0.0014	-0.0022	-0.0011	-0.0035	-0.0006	-0.0093
DJ									0.0067	0.0019	0.0150	0.0056	0.0011	-0.0014	-0.0017	-0.0046	-0.0003	-0.0091
DK										0.0033	0.0060	0.0036	0.0015	-0.0007	-0.0009	-0.0036	-0.0014	-0.0009
DL											0.0027	0.0004	0.0021	-0.0008	0.0002	-0.0021	-0.0019	0.0022
DM												0.0061	0.0017	-0.0016	-0.0017	-0.0048	-0.0015	-0.0093
DN													0.0005	-0.0006	-0.0008	-0.0028	-0.0010	-0.0042
G50														-0.0001	0.0001	-0.0016	-0.0007	-0.0001
G51															0.0000	-0.0001	0.0002	0.0031
G52																0.0005	-0.0001	0.0006
H																	0.0006	0.0024
I60																		-0.0011
K73																		

Source: CE calculations.

Table C6: Co-agglomeration results across UK NUTS2 regions (2007)

	DA	DB	DD	DE	DG	DH	DI	DJ	DK	DL	DM	DN	G50	G51	G52	H	I60	K73
DA		0.0049	0.0050	-0.0051	0.0017	0.0039	0.0048	0.0020	0.0024	0.0006	0.0016	0.0011	0.0014	-0.0017	-0.0004	-0.0018	0.0003	-0.0026
DB			0.0022	0.0007	0.0027	0.0058	0.0066	0.0021	0.0023	-0.0028	0.0009	0.0064	-0.0010	-0.0006	-0.0011	-0.0018	0.0001	-0.0113
DD				-0.0062	0.0018	0.0031	0.0055	0.0036	0.0031	0.0028	0.0027	0.0010	0.0019	-0.0026	-0.0003	-0.0016	-0.0005	-0.0015
DE					-0.0047	-0.0061	-0.0066	-0.0078	-0.0052	-0.0057	-0.0080	-0.0026	-0.0045	0.0009	0.0004	0.0046	0.0013	0.0041
DG						0.0037	0.0025	0.0014	0.0026	0.0023	0.0027	0.0020	0.0022	-0.0001	-0.0004	-0.0027	-0.0007	-0.0006
DH							0.0078	0.0065	0.0052	0.0019	0.0066	0.0053	0.0022	-0.0009	-0.0010	-0.0035	-0.0011	-0.0063
DI								0.0081	0.0066	0.0006	0.0065	0.0051	0.0021	-0.0018	-0.0012	-0.0036	-0.0007	-0.0098
DJ									0.0056	0.0015	0.0102	0.0061	0.0018	-0.0012	-0.0013	-0.0034	-0.0013	-0.0093
DK										0.0033	0.0049	0.0036	0.0022	-0.0005	-0.0011	-0.0029	-0.0014	-0.0015
DL											0.0024	0.0005	0.0028	0.0000	-0.0001	-0.0022	-0.0016	0.0045
DM												0.0059	0.0023	-0.0016	-0.0014	-0.0033	-0.0019	-0.0079
DN													0.0010	-0.0003	-0.0009	-0.0024	-0.0014	-0.0075
G50														0.0001	-0.0001	-0.0020	-0.0007	0.0004
G51															0.0001	-0.0005	0.0000	0.0011
G52																0.0004	0.0002	0.0004
H																	0.0006	0.0022
I60																		0.0002
K73																		

Source: CE calculations.

Table C7: Co-agglomeration results across UK NUTS2 regions (2011)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.0075	0.0086	0.0049	0.0068	0.0075	0.0004	0.0044	0.0047	0.0056	0.0040	0.0026	0.0002	0.0028	0.0037	-0.0010	0.0036	-0.0008	0.0016	0.0014	-0.0006	-0.0008	-0.0031	0.0002	-0.0064
C11			0.0114	0.0037	0.0139	0.0060	-0.0058	-0.0041	-0.0029	-0.0008	-0.0078	0.0007	0.0012	-0.0035	0.0000	-0.0117	-0.0072	-0.0044	0.0109	0.0007	-0.0039	0.0005	-0.0004	0.0022	-0.0023
C13				0.0213	0.0084	0.0138	0.0060	0.0110	0.0065	0.0095	0.0036	0.0035	-0.0040	0.0045	0.0059	-0.0055	0.0169	0.0000	0.0007	0.0004	-0.0005	-0.0014	-0.0042	-0.0007	-0.0167
C14					0.0039	0.0080	0.0031	0.0059	0.0036	0.0035	0.0028	0.0047	-0.0055	-0.0004	0.0041	0.0005	0.0075	-0.0010	-0.0018	-0.0011	0.0006	-0.0012	-0.0017	-0.0005	-0.0112
C16						0.0075	-0.0006	0.0036	0.0045	0.0055	0.0061	0.0046	0.0022	0.0040	0.0059	0.0011	0.0028	0.0011	0.0045	0.0020	-0.0025	-0.0007	-0.0028	-0.0010	-0.0081
C17							0.0033	0.0073	0.0059	0.0059	0.0061	0.0026	0.0014	0.0041	0.0047	0.0003	0.0068	0.0006	0.0017	0.0018	-0.0009	-0.0010	-0.0037	-0.0001	-0.0084
C18								0.0032	0.0014	0.0021	-0.0013	-0.0006	0.0004	0.0017	0.0015	-0.0002	0.0044	0.0004	-0.0019	0.0000	0.0008	-0.0003	-0.0011	-0.0001	-0.0010
C20									0.0045	0.0055	0.0057	0.0030	-0.0001	0.0026	0.0041	0.0038	0.0067	-0.0001	-0.0005	0.0006	0.0003	-0.0011	-0.0029	-0.0012	-0.0041
C22										0.0063	0.0094	0.0055	0.0015	0.0051	0.0065	0.0071	0.0064	0.0031	0.0007	0.0026	0.0002	-0.0012	-0.0039	-0.0015	-0.0083
C23											0.0084	0.0044	-0.0002	0.0053	0.0071	0.0048	0.0085	0.0015	-0.0012	0.0022	-0.0004	-0.0009	-0.0042	-0.0008	-0.0092
C24												0.0132	-0.0055	0.0046	0.0077	0.0207	0.0100	0.0038	0.0009	0.0021	-0.0017	-0.0018	-0.0045	-0.0003	-0.0168
C25													-0.0007	0.0036	0.0073	0.0138	0.0053	0.0038	0.0024	0.0026	-0.0002	-0.0012	-0.0038	-0.0013	-0.0098
C26														0.0048	0.0030	-0.0016	-0.0009	0.0046	0.0050	0.0032	0.0007	-0.0003	-0.0017	-0.0028	0.0028
C27															0.0067	0.0053	0.0055	0.0045	0.0017	0.0029	-0.0005	-0.0009	-0.0030	-0.0020	-0.0064
C28																0.0113	0.0079	0.0046	0.0011	0.0034	-0.0001	-0.0016	-0.0041	-0.0025	-0.0080
C29																	0.0072	0.0057	-0.0002	0.0038	0.0004	-0.0018	-0.0049	-0.0018	-0.0105
C31																		0.0040	-0.0021	0.0023	0.0014	-0.0015	-0.0047	-0.0017	-0.0094
C32																			0.0032	0.0030	0.0005	-0.0008	-0.0019	-0.0028	-0.0031
C33																				0.0023	-0.0009	-0.0001	-0.0014	-0.0010	-0.0030
G45																					0.0005	-0.0005	-0.0023	-0.0012	-0.0027
G46																						-0.0002	-0.0009	-0.0006	0.0015
G47																							0.0007	0.0005	0.0010
I																								0.0006	0.0051
H49																									0.0002
M72																									

Source: CE calculations.

Table C8: Co-agglomeration results across UK NUTS2 regions (2015)

	C10	C11	C13	C14	C16	C17	C18	C20	C22	C23	C24	C25	C26	C27	C28	C29	C31	C32	C33	G45	G46	G47	I	H49	M72
C10		0.0070	0.0083	-0.0070	0.0076	0.0086	-0.0001	0.0045	0.0067	0.0063	0.0063	0.0032	0.0026	0.0036	0.0048	0.0008	0.0056	-0.0008	0.0029	0.0018	-0.0006	-0.0008	-0.0036	-0.0004	-0.0061
C11			0.0071	-0.0057	0.0104	0.0059	-0.0091	-0.0010	-0.0024	0.0003	-0.0099	-0.0010	0.0075	-0.0044	0.0069	-0.0104	-0.0069	-0.0032	0.0133	0.0027	-0.0034	-0.0010	0.0007	-0.0011	0.0033
C13				-0.0061	0.0053	0.0144	0.0043	0.0126	0.0086	0.0077	0.0014	0.0036	0.0014	0.0064	0.0073	-0.0037	0.0129	-0.0011	0.0022	-0.0003	0.0006	-0.0012	-0.0038	-0.0021	-0.0133
C14					-0.0106	-0.0104	0.0028	-0.0146	-0.0109	-0.0098	-0.0152	-0.0124	-0.0141	-0.0168	-0.0130	-0.0160	-0.0055	-0.0132	-0.0086	-0.0116	-0.0019	0.0021	0.0103	0.0048	-0.0022
C16						0.0074	-0.0008	0.0053	0.0067	0.0091	0.0107	0.0066	0.0040	0.0045	0.0076	0.0058	0.0064	0.0014	0.0052	0.0029	-0.0010	-0.0015	-0.0039	-0.0014	-0.0049
C17							0.0016	0.0093	0.0092	0.0060	0.0104	0.0055	0.0051	0.0079	0.0081	0.0036	0.0094	0.0021	0.0031	0.0023	-0.0007	-0.0015	-0.0044	-0.0024	-0.0060
C18								0.0017	0.0014	0.0016	-0.0001	0.0000	-0.0015	0.0019	0.0003	0.0004	0.0048	0.0011	-0.0019	-0.0005	0.0006	-0.0001	-0.0007	0.0002	-0.0014
C20									0.0063	0.0058	0.0068	0.0048	0.0025	0.0073	0.0053	0.0048	0.0069	0.0029	0.0023	0.0015	0.0002	-0.0010	-0.0036	-0.0020	-0.0038
C22										0.0080	0.0113	0.0074	0.0028	0.0064	0.0063	0.0087	0.0084	0.0021	0.0018	0.0027	0.0004	-0.0012	-0.0051	-0.0013	-0.0062
C23											0.0106	0.0076	0.0030	0.0060	0.0072	0.0068	0.0080	0.0017	0.0029	0.0024	0.0002	-0.0014	-0.0048	-0.0012	-0.0087
C24												0.0149	-0.0020	0.0089	0.0038	0.0231	0.0101	0.0080	0.0037	0.0021	-0.0013	-0.0025	-0.0053	-0.0006	-0.0173
C25													0.0020	0.0061	0.0065	0.0167	0.0066	0.0046	0.0033	0.0030	0.0008	-0.0017	-0.0048	-0.0017	-0.0058
C26														0.0057	0.0056	-0.0024	0.0007	0.0043	0.0044	0.0042	0.0003	-0.0006	-0.0026	-0.0030	0.0044
C27															0.0064	0.0075	0.0064	0.0058	0.0026	0.0033	0.0000	-0.0012	-0.0039	-0.0026	-0.0045
C28																0.0073	0.0059	0.0024	0.0038	0.0036	0.0002	-0.0015	-0.0042	-0.0021	-0.0013
C29																	0.0059	0.0048	0.0003	0.0031	0.0016	-0.0025	-0.0060	-0.0007	-0.0108
C31																		0.0020	0.0001	0.0019	0.0005	-0.0013	-0.0044	-0.0013	-0.0064
C32																			0.0038	0.0028	-0.0002	-0.0006	-0.0021	-0.0021	0.0018
C33																				0.0025	-0.0011	-0.0007	-0.0016	-0.0012	-0.0025
G45																					0.0006	-0.0005	-0.0028	-0.0009	0.0011
G46																						-0.0002	-0.0011	-0.0001	0.0016
G47																							0.0007	0.0005	0.0002
I																								0.0006	0.0022
H49																									-0.0020
M72																									

Source: CE calculations.

Table C9: Co-agglomeration results across UK local areas (2003)

	3	4	5	6	8	10	11	12	13	14	15	17	21	22	23	28	29	24	37
3 Food, drink & tobacco		0.0004	0.0007	0.0000	0.0004	0.0005	0.0002	-0.0001	0.0003	0.0002	-0.0006	0.0003	0.0003	-0.0001	-0.0001	-0.0005	-0.0004	0.0002	-0.0011
4 Textiles etc			0.0007	0.0001	0.0009	0.0007	0.0003	-0.0003	0.0003	0.0007	-0.0002	0.0004	-0.0001	-0.0001	-0.0002	-0.0010	-0.0005	-0.0001	-0.0010
5 Wood & paper				-0.0001	0.0011	0.0007	0.0004	0.0002	0.0007	0.0005	-0.0001	0.0004	0.0003	-0.0002	-0.0001	-0.0005	-0.0005	0.0000	-0.0012
6 Printing & recording					-0.0002	-0.0004	-0.0006	-0.0003	0.0001	-0.0002	-0.0008	-0.0001	0.0000	0.0002	0.0001	-0.0004	-0.0001	0.0001	0.0002
8 Chemicals, etc						0.0008	0.0002	0.0002	0.0004	0.0005	-0.0004	0.0005	0.0002	0.0000	-0.0002	-0.0010	-0.0004	0.0000	-0.0009
10 Non-metallic min. prods.							0.0011	0.0002	0.0008	0.0011	0.0011	0.0007	0.0003	-0.0001	-0.0003	-0.0013	-0.0006	-0.0002	-0.0015
11 Metals & metal prods.								0.0000	0.0009	0.0011	0.0017	0.0009	0.0002	0.0000	-0.0003	-0.0016	-0.0007	-0.0002	-0.0016
12 Electronics									0.0003	0.0005	0.0007	0.0003	0.0003	-0.0001	-0.0001	-0.0003	-0.0003	-0.0002	-0.0007
13 Electrical equipment										0.0012	0.0012	0.0008	0.0001	-0.0001	-0.0002	-0.0011	-0.0005	-0.0002	-0.0013
14 Machinery, etc											0.0013	0.0007	0.0003	0.0000	-0.0002	-0.0013	-0.0006	-0.0001	-0.0013
15 Motor vehicles, etc												0.0010	0.0002	-0.0001	-0.0005	-0.0020	-0.0009	0.0000	-0.0017
17 Other manuf. & repair													0.0002	0.0000	-0.0001	-0.0010	-0.0005	-0.0001	-0.0011
21 Motor vehicles trade														0.0000	0.0000	-0.0006	-0.0003	0.0000	-0.0008
22 Wholesale trade															-0.0001	-0.0004	-0.0001	0.0000	0.0001
23 Retail trade																0.0002	0.0001	0.0000	0.0001
28 Accomodation																	0.0008	-0.0003	0.0018
29 Food & beverage services																		0.0000	0.0009
24 Land transport																			-0.0002
37 Other professional services																			

Source: CE calculations.

Table C10: Co-agglomeration results across UK local areas (2007)

	3	4	5	6	8	10	11	12	13	14	15	17	21	22	23	28	29	24	37
3 Food, drink & tobacco		0.0006	0.0008	-0.0001	0.0007	0.0007	0.0004	0.0002	0.0003	0.0005	-0.0002	0.0003	0.0003	0.0000	-0.0002	-0.0006	-0.0005	0.0002	-0.0012
4 Textiles etc			0.0007	0.0006	0.0010	0.0007	0.0003	-0.0001	0.0001	0.0007	-0.0003	0.0004	0.0000	0.0001	-0.0002	-0.0009	-0.0004	0.0001	-0.0006
5 Wood & paper				-0.0001	0.0011	0.0011	0.0006	0.0005	0.0007	0.0007	0.0003	0.0005	0.0004	0.0000	-0.0001	-0.0005	-0.0005	0.0000	-0.0012
6 Printing & recording					-0.0002	-0.0003	-0.0004	-0.0001	0.0000	-0.0001	-0.0005	-0.0001	0.0000	0.0002	0.0000	-0.0006	0.0000	0.0000	0.0001
8 Chemicals, etc						0.0011	0.0005	0.0002	0.0005	0.0008	0.0001	0.0005	0.0004	0.0001	-0.0001	-0.0010	-0.0006	0.0001	-0.0012
10 Non-metallic min. prods.							0.0010	0.0003	0.0008	0.0010	0.0008	0.0007	0.0004	0.0000	-0.0002	-0.0010	-0.0006	0.0000	-0.0014
11 Metals & metal prods.								0.0002	0.0007	0.0011	0.0014	0.0008	0.0004	0.0001	-0.0003	-0.0013	-0.0006	0.0000	-0.0016
12 Electronics									0.0006	0.0007	0.0005	0.0006	0.0004	0.0001	-0.0001	-0.0006	-0.0004	-0.0002	-0.0006
13 Electrical equipment										0.0011	0.0013	0.0008	0.0004	0.0001	-0.0001	-0.0009	-0.0005	-0.0001	-0.0012
14 Machinery, etc											0.0008	0.0008	0.0004	0.0001	-0.0002	-0.0012	-0.0006	-0.0001	-0.0014
15 Motor vehicles, etc												0.0006	0.0003	0.0000	-0.0003	-0.0017	-0.0006	0.0000	-0.0014
17 Other manuf. & repair													0.0003	0.0001	-0.0001	-0.0009	-0.0004	-0.0001	-0.0010
21 Motor vehicles trade														0.0001	0.0000	-0.0007	-0.0003	0.0000	-0.0009
22 Wholesale trade															-0.0001	-0.0005	-0.0002	0.0000	-0.0001
23 Retail trade																0.0002	0.0001	0.0000	0.0000
28 Accomodation																	0.0007	-0.0002	0.0014
29 Food & beverage services																		0.0000	0.0007
24 Land transport																			-0.0002
37 Other professional services																			

Source: CE calculations.

Table C11: Co-agglomeration results across UK local areas (2011)

	3	4	5	6	8	10	11	12	13	14	15	17	21	22	23	28	29	24	37
3 Food, drink & tobacco		0.0008	0.0012	0.0002	0.0008	0.0008	0.0004	0.0002	0.0003	0.0005	-0.0003	0.0003	0.0004	0.0001	-0.0001	-0.0007	-0.0005	0.0002	-0.0012
4 Textiles etc			0.0011	0.0010	0.0014	0.0010	0.0005	-0.0003	0.0003	0.0010	-0.0003	0.0011	0.0002	0.0002	-0.0002	-0.0012	-0.0006	0.0000	-0.0012
5 Wood & paper				0.0004	0.0013	0.0011	0.0008	0.0005	0.0008	0.0008	0.0006	0.0006	0.0005	0.0000	-0.0001	-0.0007	-0.0006	0.0000	-0.0013
6 Printing & recording					0.0004	0.0002	-0.0001	0.0002	0.0004	0.0003	0.0000	0.0002	0.0002	0.0001	0.0000	-0.0008	-0.0002	0.0000	-0.0004
8 Chemicals, etc						0.0012	0.0005	0.0004	0.0005	0.0008	0.0004	0.0007	0.0004	0.0002	-0.0002	-0.0012	-0.0006	0.0000	-0.0011
10 Non-metallic min. prods.							0.0010	0.0004	0.0008	0.0010	0.0007	0.0007	0.0006	0.0001	-0.0002	-0.0012	-0.0006	0.0000	-0.0013
11 Metals & metal prods.								0.0001	0.0007	0.0013	0.0014	0.0009	0.0006	0.0002	-0.0002	-0.0015	-0.0007	0.0000	-0.0015
12 Electronics									0.0007	0.0008	-0.0003	0.0004	0.0004	0.0001	-0.0001	-0.0005	-0.0003	-0.0002	-0.0006
13 Electrical equipment										0.0013	0.0011	0.0006	0.0006	0.0001	-0.0001	-0.0009	-0.0005	-0.0001	-0.0012
14 Machinery, etc											0.0017	0.0008	0.0006	0.0001	-0.0002	-0.0014	-0.0006	-0.0002	-0.0014
15 Motor vehicles, etc												0.0003	0.0007	0.0000	-0.0003	-0.0017	-0.0007	-0.0001	-0.0013
17 Other manuf. & repair													0.0005	0.0002	-0.0001	-0.0010	-0.0004	-0.0001	-0.0010
21 Motor vehicles trade														0.0002	0.0000	-0.0008	-0.0004	0.0000	-0.0009
22 Wholesale trade															-0.0001	-0.0006	-0.0002	0.0000	-0.0001
23 Retail trade																0.0001	0.0001	0.0000	-0.0001
28 Accomodation																	0.0008	-0.0002	0.0012
29 Food & beverage services																		0.0000	0.0008
24 Land transport																			-0.0001
37 Other professional services																			

Source: CE calculations.

Table C12: Co-agglomeration results across UK local areas (2015)

	3	4	5	6	8	10	11	12	13	14	15	17	21	22	23	28	29	24	37
3 Food, drink & tobacco		0.0006	0.0012	0.0002	0.0007	0.0010	0.0004	0.0003	0.0005	0.0006	-0.0003	0.0005	0.0004	0.0001	-0.0002	-0.0005	-0.0006	0.0001	-0.0011
4 Textiles etc			0.0006	0.0006	0.0004	0.0006	0.0001	-0.0003	0.0001	0.0005	-0.0009	0.0003	-0.0003	0.0001	-0.0001	-0.0006	-0.0002	0.0000	-0.0002
5 Wood & paper				0.0005	0.0013	0.0015	0.0011	0.0006	0.0012	0.0010	0.0007	0.0009	0.0005	0.0001	-0.0002	-0.0007	-0.0007	-0.0001	-0.0011
6 Printing & recording					0.0004	0.0004	0.0002	0.0002	0.0005	0.0004	-0.0002	0.0004	0.0002	0.0001	0.0000	-0.0008	-0.0002	0.0000	-0.0002
8 Chemicals, etc						0.0012	0.0006	0.0005	0.0010	0.0009	-0.0001	0.0009	0.0004	0.0002	-0.0001	-0.0009	-0.0006	-0.0001	-0.0009
10 Non-metallic min. prods.							0.0012	0.0004	0.0010	0.0010	0.0008	0.0008	0.0006	0.0002	-0.0002	-0.0010	-0.0007	0.0000	-0.0012
11 Metals & metal prods.								0.0004	0.0009	0.0011	0.0014	0.0009	0.0005	0.0003	-0.0003	-0.0013	-0.0007	-0.0001	-0.0013
12 Electronics									0.0011	0.0011	-0.0006	0.0005	0.0005	0.0001	-0.0001	-0.0005	-0.0004	-0.0003	-0.0005
13 Electrical equipment										0.0012	0.0013	0.0009	0.0006	0.0001	-0.0001	-0.0007	-0.0006	-0.0002	-0.0010
14 Machinery, etc											0.0009	0.0008	0.0006	0.0002	-0.0002	-0.0010	-0.0006	-0.0002	-0.0010
15 Motor vehicles, etc												0.0002	0.0006	0.0002	-0.0004	-0.0013	-0.0007	0.0000	-0.0015
17 Other manuf. & repair													0.0005	0.0001	-0.0001	-0.0008	-0.0005	0.0000	-0.0008
21 Motor vehicles trade														0.0002	0.0000	-0.0006	-0.0004	0.0000	-0.0008
22 Wholesale trade															-0.0001	-0.0006	-0.0002	0.0000	-0.0002
23 Retail trade																0.0001	0.0001	0.0000	-0.0001
28 Accomodation																	0.0007	-0.0004	0.0008
29 Food & beverage services																		-0.0001	0.0006
24 Land transport																			-0.0001
37 Other professional services																			

Source: CE calculatio

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