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European Competitiveness Report 2013 : Towards knowledge driven reindustrialisation

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Chapter 2.
STRUCTURAL CHANGE

Economic development is linked to major changes in the structure of economies. Changes in technology and skills enable economies to produce the same goods at higher levels of productivity, and to develop new products and services. At the same time, consumer demand and derived demand for intermediate goods and services shift to different sets of goods. This process of long-lasting changes in the set of goods and services produced and in the composition of capabilities – the physical and human capital base as part of the factors of production – is called structural change. This long-term process should be distinguished from shorter-term changes in the structure of economies that may, for example, be induced by economic bubbles and their collapse. In this regard, the chapter does not focus on sector changes occurring during the current financial crisis.

Structural change is not only related to changes in the composition of economies associated with economic development. The growth potential of economies is also affected by the sectoral composition of output and employment. Some sectors experience higher long-term growth than others, leading to shifts in the shares of these industries in the economy. However, it is important to note that the structure of the economy can also change with no positive impact on economic growth, if structural change increases the share of sectors with low growth potential. Thus, the structural composition of economies and structural change are important elements to be addressed by economic policy making in order to ensure that the positive growth enhancing structural change is facilitated. For this reason, this chapter deals with the pattern of structural change observed over recent decades. The driving forces of structural change are technological change and its impact on productivity, as well as changes in the structure of demand associated with changes in the prices of goods and aggregate income. These determinants are interrelated and difficult to disentangle, but they explain a large part of the observed trends in structural change.

The primary aim of this chapter is to explore broad patterns of structural change and its determinants with a look at the policy relevance of structural change for European policymaking. Europe is currently experiencing an economic crisis the impact of which on individual EU Member States varies. Within this context, the importance of economic structure is amplified when international trade and the sectoral distribution of employment and output across the production of tradable and non-tradable output are taken into account. International trade can modify, deepen and relax patterns of structural-change across countries (McMillan and Roderick 2011).

The chapter covers the main trends of structural change, the drivers, and the role of policies and institutions in the process.

Broad trends of structural change are associated with economic developments that are quite robust and homogenous over time in the countries under consideration. The share of agriculture is declining, while the share of manufacturing displays a hump-shaped pattern and the share of services is increasing for almost all industrialized countries. The primary drivers are productivity improvements based on technical change and innovation, and changing patterns in demand due to income effects and price changes. International trade also has an important influence on differences in economic structure across countries.

Growth-enhancing structural change is associated with the upgrading of capabilities, as well as with a process of "creative destruction". This process can be observed by analysing a country's export basket. In more advanced economies, industries producing more sophisticated and complex products are replacing other industries. However, more sophisticated and complex products require specific knowledge-bases and specialisation patterns. The process of reconfiguring capabilities and the range of products produced by an economy is thus an important part of the interaction between structural change and the international division of labour.

The analysis of the relationship between broad policies and institutions within the process of structural change reveals that policies can guide structural change, but that there are also important limits to the impact of policies due to the existing structure of economies. Because of international trade and the associated specialisation patterns, economies have different industrial structures. Therefore, policy intervention should aim to support growth-enhancing structural change by developing and building upon existing strengths, rather than taking a completely open approach.

2.1. BROAD TRENDS IN STRUCTURAL CHANGE

Structural change originates from microeconomic changes which affect economic sectors in different ways and with different magnitude. The changes at the microeconomic level are important at the aggregate level, because they are systematic and

affect the long-run performance of economies. The result is that some sectors experience higher long-term growth rates than others, leading to shifts in the shares of these industries in the aggregate. This process unfolds over longer periods of time. This chapter looks at the long-run changes between sectors. These changes are best outlined using a simple sectoral disaggregation which breaks down the economic aggregates into three sectors:

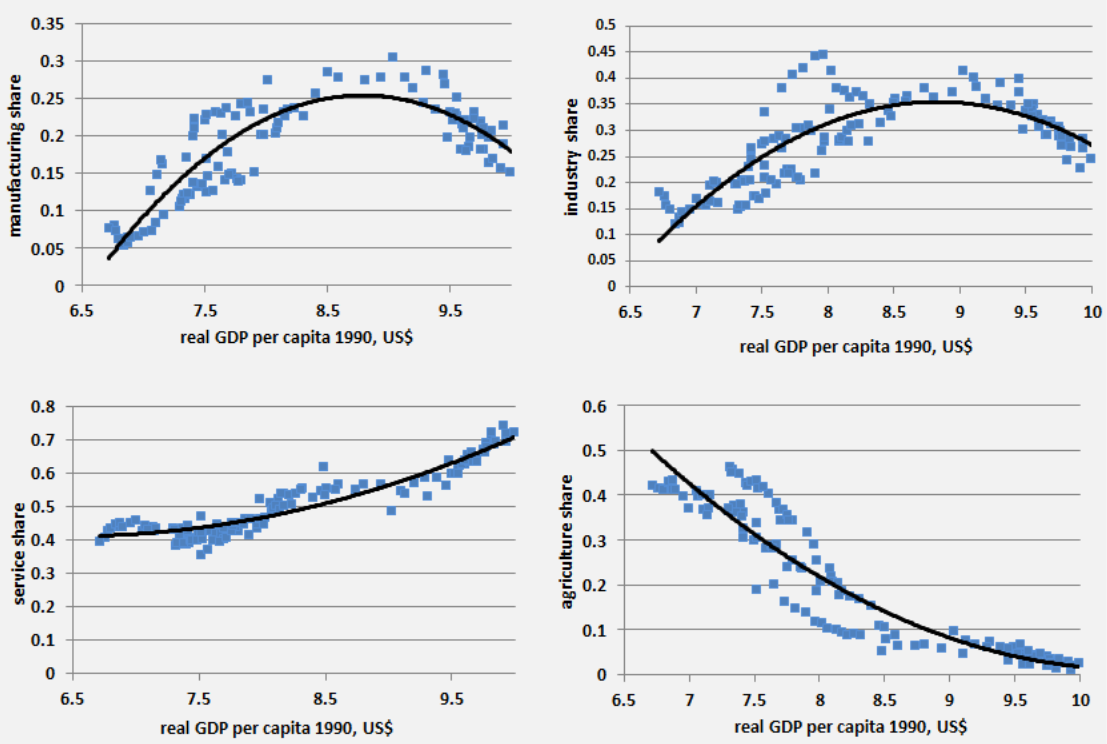
1. Agriculture, fishery and forestry;
2. Industry in a broad sense covering manufacturing, mining, construction and public utilities, and
3. Services, covering the different business, personal and public service sectors.

In presenting the broad trends, results are given for the manufacturing sector as a whole, as much discussion of industrial policies focuses on the manufacturing sector. In a subsection of the chapter, services are examined in greater detail, as services have become the dominant sector in terms of employment and production in all advanced economies.

This pattern can be easily identified using historical value-added shares for six European countries (Belgium, Finland, France, Italy, Netherlands, Spain and Sweden) over the 19th and 20th centuries. Unfortunately, information is only available for these six countries. Figure 2.1 plots the current value added shares over the past 150 years. In order to make the patterns comparable across countries, nominal sectoral shares (nominal value added of a sector in proportion to total nominal value added) are plotted against the level of economic development measured as the logarithm of per capita GDP in 1990 dollars (Bolt and van Zanden 2013). The line in the figure is a polynomial prediction that does not take into account country weights. The prediction provides a better perspective of the association of the sectoral value-added shares with economic development (measured in GDP per capita at constant prices).

This historical pattern is quite similar to the pattern identified in the cross section of a large number of countries. Indeed, the historical patterns of structural change would be of much less interest if findings for

Figure 2.1. Structural change in a historical perspective: Value-added shares for six European countries



Source: WIFO calculations based on data from University of Groningen and EU Klems

The broad trends in structural change are quite similar across countries in the course of their economic development. As economic development gets under way, the share of agriculture in national employment and value added falls, while there is a rapid increase in the share of manufacturing and services. The resource reallocation process associated with structural change shifts economic activities from agriculture to industry and services.

the broad patterns of structural change were very different for countries that are currently becoming wealthier, in which case information on historical patterns of structural change would not be very useful for policymaking today. Figure 2.2 shows that the patterns are quite similar if a very different dataset is used, which has broader country coverage and comparatively short time coverage. The National Accounts Dataset collected by the United Nations Statistics Division provides information on value

added shares for 164 countries over the period from 1960 to 2010.

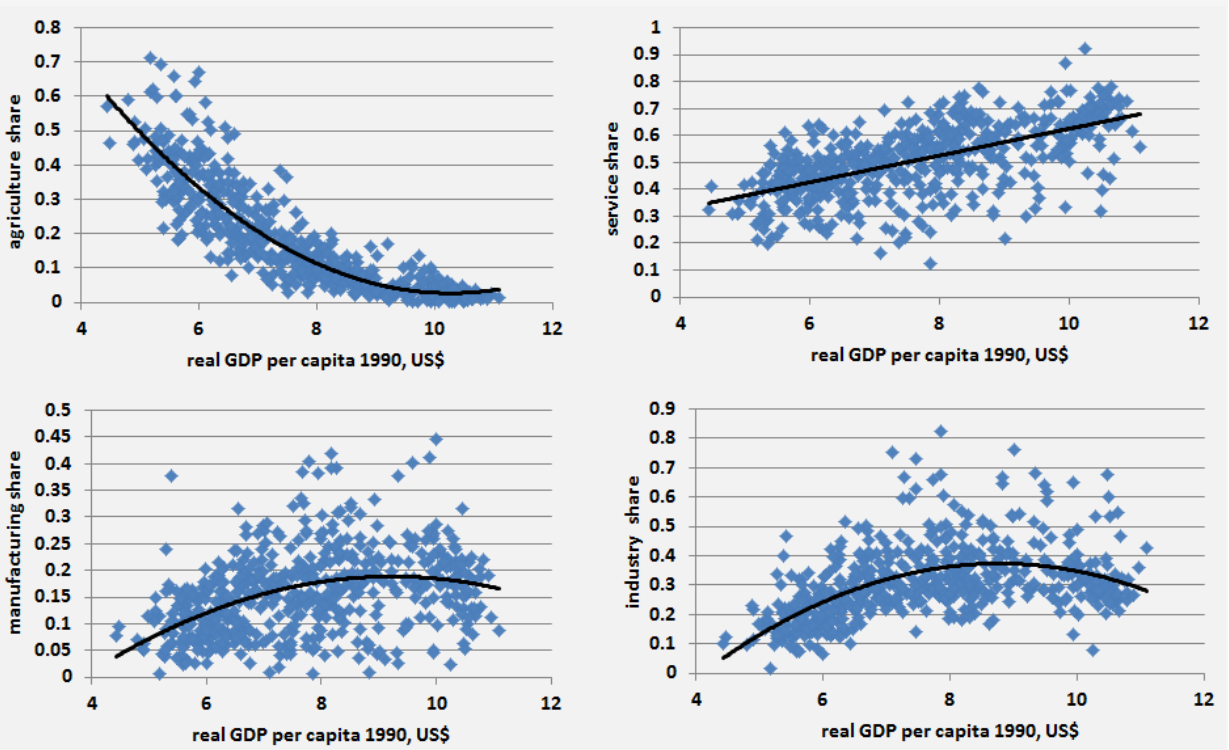
Figure 2.2 plots the current sectoral value added shares against GDP per capita from the UN National Accounts dataset. The sectoral breakdown is again agriculture, manufacturing, industry (manufacturing, mining, utilities and construction) and services. The line in the Figure 2.2 corresponds to a polynomial prediction without country weights. The prediction makes it possible to see the point estimate of the association between sectoral value added shares and economic development (measured in GDP per capita in constant prices) which is independent of individual countries.

Figure 2.2 confirms the basic regularities for structural change found in the historical data. However, the country coverage is much more heterogeneous in terms of sector development. There are countries in the sample that have a share of agriculture of around 80% at very low levels of economic development. A few countries even have service shares as low as 10% of GDP. In addition, there are countries that have very high value added shares in manufacturing and industry. The results for industry are often driven by countries with important natural resources and a high share of mining in GDP, such as oil-producing countries.

A visual inspection of the figures for manufacturing shows that at a value of log real GDP per capita in 2005 of around 9, which corresponds to USD 8,100 in 2005 prices, the manufacturing share begins to decline on average. This is broadly in line with the evidence from the historical time series.

Figure 2.2 reports the results from a more rigorous test using regression analysis. The sector share in nominal value added is regressed on log real GDP per capita (RGDP)[1] using a fixed-effects regression in order to control for unobserved, country-specific factors affecting the composition of country shares. Real per capita GDP of USD 8,100 (in 2005 prices) is used to divide the country-year observations into two sub-samples. For agriculture, it is observed that the negative relationship between the agricultural share and economic development is less strong for the sub-sample covering the country-year observations with a real GDP per capita above US$ 8100. This may be related to the fact that for these countries, the value added share of agriculture is already very small (4% on average) for the more

Figure 2.2. Structural change in the cross section: evidence from value added shares for 164 countries, 1960–2010



Source: WIFO Calculations based on national accounts statistics from the UN.

[1] Whilst Figure 2.2 displays a degree of non-linearity for certain sectors, a linear relationship was modelled to illustrate the direction and strength of the relationships in the two sub-samples.

Table 2.1. Value-added share regressions for cross-section data, UN National Accounts data for 164 countries, 1960–2010

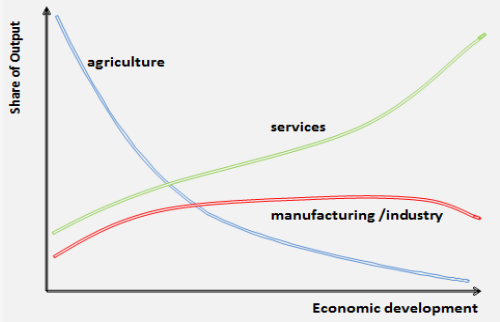
	all observations	y<US$8100 sample	y>=US$8100 sample	all observations	y<US$8100 sample	y>=US$8100 sample
	Agriculture share			**Service share**		
RGDP	–0.0869***	–0.117***	–0.0623***	0.0543***	0.0655***	0.106***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.007)
Observations	5872	4505	1367	5830	4463	1367
R^2	0.866	0.835	0.758	0.690	0.651	0.691
	Manufacturing share			**Industry share**		
RGDP	0.00816***	0.0257***	–0.0828***	0.0343***	0.0553***	-0.0436***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.006)
Observations	5838	4471	1367	5872	4505	1367
R^2	0.720	0.738	0.821	0.644	0.689	0.723

Source: WIFO Calculations
*Note: Standard errors in parentheses. *** denotes significant estimate.*

developed economies in the upper sub-sample while it is still substantial (an average of 23%) for the sub-sample covering the poorer countries. For the service sector, an acceleration of the service share value-added for the second sub-sample (country-year observations with a real GDP per capita above USD 8100) can be seen. This finding corresponds to the stylised facts reported by Buera and Kaboski (2012a) for historical time series covering a larger set of countries. Different relationships are found for the manufacturing and industry shares in the two sub-samples. There is a positive relationship for the first sub-sample (real GDP per capita below US$ 8100) and a negative relationship for the second sub-sample (real GDP per capita above USD 8100) is observed. The negative relationship between economic development and the manufacturing share in the second sub-sample is stronger than the negative relationship between the industry share and economic development for the same sample. This is partly due to oil-exporting countries which have a high industry share and a high level of real GDP per capita with a low manufacturing share (e.g. Saudi Arabia, Kuwait, United Arab Emirates) and partly due to the fact that utilities and construction – which are also part of the industry share – do not show a very strong association with the level of economic development as services and the manufacturing sector.

It is important to note that these patterns are not restricted to nominal value-added shares but also show up in employment shares. Figure 2.3 shows this process in a stylised way. It shows that economic development has consisted of a gradual shift from agriculture to manufacturing and services, followed by a shift from manufacturing towards the service sector. In other words, when the market economy first emerged, a vast majority of workers were employed in agriculture, which accounted for the largest share of production. The production of goods was limited to handicrafts while market services played even less of a role. Successive industrial revolutions, exemplified by the creation, diffusion and use of new technologies, led to a gradual increase in productivity in both the primary and secondary sectors. The share of income spent on food decreased and employment in the primary sector declined relative to the other sectors. In manufacturing the increase in productivity has led to lower prices. In the course of economic development this has resulted in lower factor demand (demand for labour, for instance) once productivity outstrips the growth in demand for manufactured goods. Over time, the tertiary sector has gained in importance, both in terms of employment and output, as enterprises have demanded support services and consumption patterns have shifted towards services, and productivity gains in manufacturing have become much higher than those in service sectors.

Figure 2.1. Stylised broad patterns of structural change



Source: WIFO

2.2. PRODUCTIVITY IMPROVEMENTS AND CHANGES IN DEMAND AS DRIVERS OF STRUCTURAL CHANGE

The need to understand the mutual interdependency between economic growth and structural change requires analyses that enrich the general one-sector macroeconomic perspective with multi-sectoral perspectives, in order to understand the main economic mechanisms that drive broad patterns of structural change.

There are two central, possibly complementary, explanations of the observed patterns of structural change in the literature. The first explanation relates to differential patterns of technical change between different industries. The second explanation relates to the different income elasticity of demand between products of different sectors. From a conceptual standpoint, the potential significance of these mechanisms in explaining the broad trends of structural change has long been recognized. For instance, a pioneer in the theory of structural change, Fourastié (1949), explained economic development based on the combination of differential productivity growth rates across agriculture, industry and services, and the differential income elasticity of demand. Technological progress was the main driving mechanism behind structural change in his theory, while the income elasticity of demand provides something like a sorting mechanism that gave new weights to the sectors. Fourastié maintained that in the long run, the sorting mechanism of demand dominates supply-side forces in shaping the economic structure of countries. As income rises, the demand for primary products will become saturated first, followed by the growth of demand for manufactured goods, which become eventually saturated, and an increase in demand for products in the tertiary sectors take place. Fourastié's vision of the three-sector hypothesis is one of the most elaborate theories of structural change, but his explanation of why products from industry can become saturated neglects the role of intermediate inputs from industry that are used in all sectors of the economy. A decline in the demand for consumer goods in manufacturing does not necessarily imply a declining share of the secondary sector in total value added.

Other economists held such views at the time. For example Kaldor (1981, 1996) argued that expanding domestic and international markets engendered a process of cumulative causation in which manufacturing growth played a central role as many growth-enhancing learning activities such as R&D and the mechanisation of activities are closely related to manufacturing. This allows a higher rate of productivity growth in the manufacturing sector. Today manufacturing is an important sector, but it is also recognised that manufacturing industries are heterogeneous, and that there are important production and demand linkages which play a significant role in the process of economic development. More recently, the theoretical literature has examined the conditions under which the two determinants of different productivity growth (e.g. Ngai and Pissarides 2007) and differential income elasticities of demand (e.g. Echevarria 1997, Kongesamut et al. 2001) can lead to an aggregate balanced growth path. Herrendorf et al. (2013) claim that the conditions under which these theories can simultaneously generate balanced growth and structural change are rather strict. Theories of balanced growth, which constitute the workhorse of growth theory, may not provide the right analytical tools to explain the broad set of empirical regularities of structural change.

2.2.1. Interaction of supply and demand factors

Pasinetti (1981, 1993) emphasised the importance of the interaction of supply and demand side influences in determining the outcome of the process of structural change. Pasinetti stresses the influence of income elasticity on the pattern of demand – Engel's law[2] – and technological progress as the main drivers of structural change and long-term economic growth. Hölzl and Reinstaller (2007) identify two mechanisms linking the inter-industry and intra-industry dynamics: sorting and selection. Sorting is based on the idea that the industrial composition of demand varies with income growth. This captures the observation that the consumption of agricultural products rises proportionally less than aggregate income. Consumer preferences and the demand derived by other firms for intermediate goods have an impact on the relative growth patterns of sectors within an economy. Selection in turn reflects price competition within and between sectors: firms or sectors able to produce the best value for money will be able to increase their demand and grow faster.

Pure demand-side explanations of structural change emphasise that changes in consumption associated with income effects are a central driving force behind the process of structural change. Rising income leads to demand shifts from necessities towards manufactured goods and then towards services (e.g. Echevarria 1997, Kongsamut et al. 2001). However, pure demand-side explanations do not take into account the observed persistent differences in technical change and productivity across sectors. Baumol's (1967) theory of imbalanced economic growth is perhaps the most important supply-side explanation for why the tertiary sector will gain in

[2] Strictly speaking, Engel's law refers to the low income elasticity of food but in the literature on structural change Engel's law is used to refer to structural change driven by nonlinear income effects that affect demand for all types of goods (e.g. Pasinetti 1981, 1993, or Iscan 2010).

importance over time. Baumol divides the economy into two types of activities: '*technologically progressive activities in which innovations, capital accumulation, and economies of large scale all make for a cumulative rise in output per man hour and activities which, by their very nature, permit only sporadic increases in productivity*' (Baumol 1967, p. 415-416). Baumol contends that productivity growth in progressive activities drives wage growth in the economy as a whole, causing relative costs in non-progressive activities to rise. This leads to a fall in the relative weight of the non-progressive sectors or, if the relative outputs are maintained, to a slowing of the aggregate growth rate, as an increasing proportion of resources must be channelled into these activities.

Little is known about the relative importance of these two mechanisms in the process of structural change and economic development from the empirical perspective. Part of the difficulty in understanding the relative importance of the supply-side and demand-side drivers of aggregate growth is the paucity of data on the services sector. There are still significant measurement issues with service sector output, value added and productivity growth. It is also very difficult to establish the importance of preference parameters governing the income elasticity of demand for services in a rigorous way.

A closer look at the empirical broad patterns of structural change reveals that both processes are relevant. The gradual shift in value added and employment shares from agricultural to manufacturing and onwards to the services sector seems to be mainly due to changes in market demand. However, this account of the shift of demand also needs to take into account big productivity improvements in agriculture over the past decades. Thus the mechanics of Engel's law –that as income rises, the proportion of income spent on a good falls, even if actual expenditure on it rises – needs to be complemented by an account of productivity improvements. Up to now, there is no clear evidence as to whether technological progress or changes in demand is the driver of structural change. Baumol et al. (1989) and more recently Nordhaus (2008) provide empirical evidence favouring the technological explanation. In contrast, Dietrich and Krüger (2010) find empirical evidence for the demand story for the rise of the service sector in Germany. Additionally, results by Curtis and Murthy (1998), Rowthorn and Ramaswamy (1999) and Peneder et al. (2003) suggest that the income elasticity is greater than unity for most service branches as well as for aggregate services, and below unity for manufacturing branches.

Table 2.2. Dynamics in value added shares 1975 to 2005 between EU-15 Member States and the US

	Agriculture	Industry	Services
EU-15 avg. value added share 2005	2.3	26.2	71.5
US avg. value added share 2005	1.8	23.8	74.4
EU-15 change in share 1975-2005	–5.3	–11.1	16.5
US change in share 1975-2005	–3.7	–7.8	11.5
EU-15 change in inequality 1975-2005	1.6	1.9	–1
US change in inequality 1975-2005	–5.6	2.1	–1.4

Source: WIFO, calculation EUKLEMS for the EU-15, Bureau of Economic Analysis (BEA) for US states.
Note: Differences in the industry classifications limit the comparability of the data across regions (EU-15 and US). For European data NACE 1 is used, while US data follow the NACIS classification. The change in shares between 1975 and 2005 refers to the difference in the value added shares between the two periods. Inequality is measured using the Gini coefficient within the broad regions (US, EU-15).

Productivity and growth decompositions generally lead to a view that structural components appear to be largely dominated by the intra-industry and intra-firm effects of productivity growth (Isaksson 2009). The empirical literature confirms that the broad patterns of structural change are driven by both demand-side and supply-side dynamics. It confirms that structural change can generate both positive and negative contributions to aggregate productivity growth. If structural change reallocates resources towards sectors with higher potential of productivity growth, structural change is growth-enhancing, and if structural change shifts resources and employment towards sectors with below-average productivity gains, structural change may be growth-reducing. In many cases the effects of structural change net out, and structural change on average appears to have only a weak impact on aggregate growth over short time periods. Hence, if certain types of industries achieve higher rates of productivity growth and expansion in output than others, structural change in favour of specific industries might still be conducive to economic growth. However, this might not be seen at the aggregate level. The comparison between patterns of structural change in the EU-15 and in the US shown in Box 2.1 confirms that structural change has been quite similar. Both have experienced a dramatic growth in the value added share of services across all constituent EU countries and US states, and this shift towards services has been associated with a relative decline in industry and agriculture.

Box 2.1. A comparison between patterns of structural change in EU-15 Member States and US states

The fact that the majority of industrialized economies experienced a shift from manufacturing to services in recent decades illustrates the similarity in the change in contributions of agriculture, manufacturing and service sectors to total value added in the US and the EU. Between 1975 and 2005, the shares of services saw double-digit increases in both the US and the EU-15. The increase of the services sector has taken place largely at the expense of industry (mining, utilities, construction and manufacturing). On average across the US states, the share of services has increased by 11.5 percentage points. This shift has been even more pronounced in the EU, where the share of services increased by 16.5 points to 71.5 % in 2005. During this time, some member states (notably Greece, Spain and Portugal) experienced a substantial catch-up. The share of manufacturing in the EU fell by 11.1 percentage points on average. The decline has been slightly less (7.8 percentage points) in the US states. The comparatively small shares of agriculture decreased further, more so in the EU than in the US.

One important question is whether structural change leads economies to become more similar over time or magnifies regional and interregional disparities in the composition of aggregate output. This question is important for several reasons. The tradability of agricultural and manufacturing commodities coupled with positive agglomeration effects in their production foster regional specialisation, yet there are limits to specialisation in the production of some services, which may not be tradable. Increasing structural disparities between the regions together with stark differences in productivity developments across the three sectors have the potential to reduce or increase income inequality within the regions. Economic policies aimed at attaining or maintaining a certain composition of output also need to take into account regional inequalities and the underlying specialisation trends.

To answer this question in a simplified way, the inequality of the shares of agriculture, manufacturing and services between the 15 EU Member States and the 50 US states relative to their aggregate economies (US and EU-15) is considered. The preferred measure of structural cohesion is the difference between the values of the ubiquitous Gini coefficient of inequality, calculated across the member states and federal states of both regions for the years 1975 and 2005 (Table 2.2).

Negative differences mean that regional (country/state) differences have decreased. This is the case for the share of services, as the nationwide rise in the contribution of services has been due in part to their low tradability and local character. On the contrary, as expected, disparities in the structure of manufacturing have increased.

An apparent difference between the 15 Member States and 50 US states lies in the evolution of the inequality in the contribution of agriculture. Regional inequality has increased in the EU-15, while it has decreased in the US. This may be related to the fact that the US has had a common agricultural market since its early days, with regional differences and specialisation in agriculture taking place long before 1975. In the EU this process started around this time. This may explain why differences appear to have decreased in the US, while they have increased in the EU. Interestingly, quite similar patterns in inequality are observed for the industry and services sectors for the US states and the EU-15. Industry shares have become more unequal across Member States and US states, and services shares (almost by nature) have become more similar across the two regions.

2.3. THE EXPANSION OF THE SERVICES SECTOR

The analysis of broad changes has revealed that the biggest shift experienced by industrialised countries over the past decade has been the reallocation of resources and employment linked to the growth in services. All highly industrialised countries have become service economies, in terms of the share of value-added generated in the services sector and when employment shares are considered. This structural change is uneven as it has not affected all services in the same way. In fact, the rise of the services sector taken as a whole has mainly been due to the expansion of business services and some non-market services.

For a long time, the shift towards services was seen as growth-reducing structural change. The rates of productivity growth in manufacturing and services are very different and can to some extent explain the large-scale labour reallocation in favour of the services sector. However, more recent economic research clearly shows that many knowledge-intensive services are important factors in economic growth. For example, Pugno (2006) emphasises the importance of education and human capital formation for economic growth.

Buera and Kaboski (2012b) emphasise the skill intensity of many service sectors and propose a theory of the rise of the service economy based on an increasing importance of specialised highly-skilled labour at high levels of productivity. Thus the rise of the service economy is a growth in the range of services that are market-produced relative to those that are home-produced. Buera and Kaboski (2012b) provide an explanation of the rising level of skills and "skill premium" that goes in hand with the rising relative level of prices for services, which is associated with changes in demand towards knowledge-intensive services in the process of economic development. In particular, the application of modern information and communication technology to the production of services has changed

the perception of services as low productivity and low skill sectors of the economy. Eichengreen and Gupta (2013) and Jorgenson and Timmer (2011) show that more traditional services like lodging, housecleaning, distribution, education and healthcare are increasingly complemented by modern services such as banking, insurance, communication and business services.

Figure 2.4 provides evidence on the heterogeneity of services sector expansion in the most advanced economies, including most EU Member States. In these figures EUKLEMS data are used and four different types of services are distinguished:

- Distribution
- Personal services
- Business services
- Non-market services (education, health and government services)

Figure 2.4 reports both the value-added and the hours-worked shares. While the share in hours worked is almost constant, the value share of distribution decreases with economic development. The expansion of business services is more dynamic in terms of valued added shares than for hours-worked shares. However, the opposite seems to be true for non-market services. This shows that the expansion of the service share is mainly driven by the expansion of two quite different service subsectors: business services and non-market services. While the pattern of expansion of non-market services – government services, health and education to name the most important – could be explained by a supply-side 'cost disease' argument, the same argument does not apply for the expansion of business services, because for many countries the increase in economic weight is more substantial in terms of value added than hours worked.

This evidence shows that services are heterogeneous and is compatible with the argument provided by Peneder et al. (2001) and Buera and Kaboski (2012b), indicating that the rise of the service economy has primarily been driven by the growth of knowledge-based services.

Even if the shift in structure towards services has reached unprecedented proportions, the understanding of the factors accounting for the shift to services is still partially contested. This is related to a number of issues. Different mechanisms have been proposed to explain the shift of economic activities towards services. The thesis of marketization or de-marketisation of home production proposed by Buera and Kaboski (2012a) is one that combines the differential development of technology with a mechanism of a shift in demand.

Schettkatt and Yocarini (2006) emphasise the importance of demand-side explanations. They argue that shifts in demand associated with income effects have been the driving force of the expansion of services employment in past decades. However, the different productivity developments between services and manufacturing are also important. Price trends in some services support this view (e.g. Schettkat and Yocarini 2006): prices of services generally rise more than prices for manufactured output. However, as emphasised by Peneder (2001) some services sectors are obviously technologically progressive. Jorgenson and Timmer (2012) clearly show that price and productivity developments in distribution sectors are very different from other service sectors.

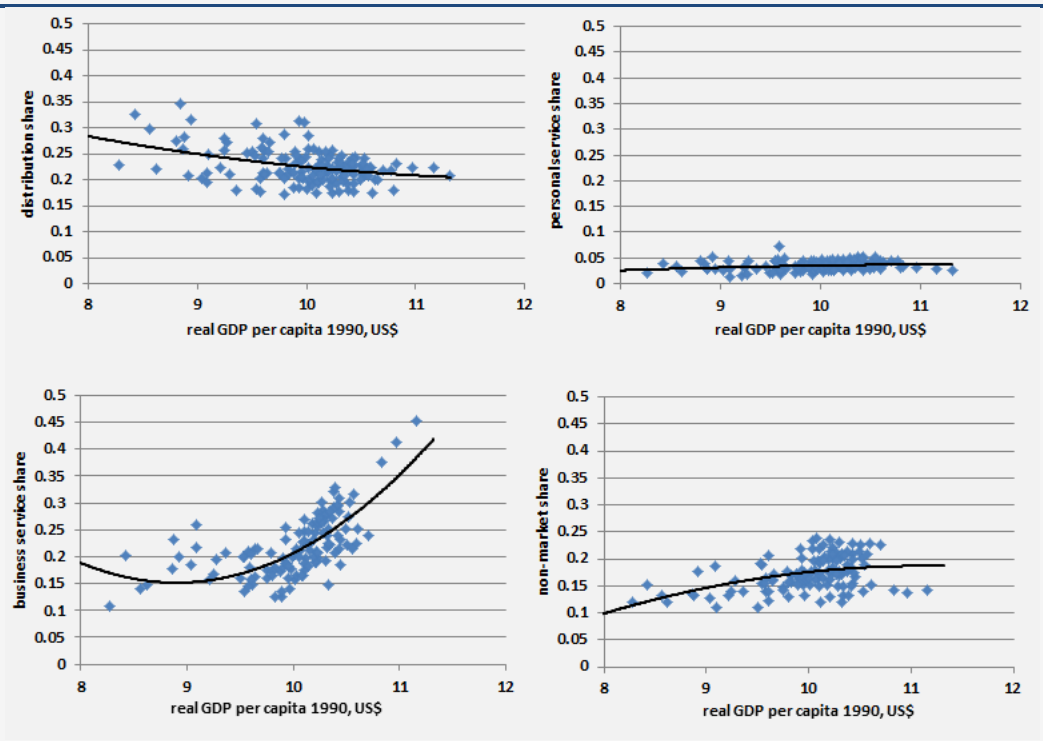
Table 2.3 gives an indication by using the relative price development of sectoral prices compared to the GDP deflator as a measure of sectoral price developments. Values below 1 indicate that price developments were below the aggregate price development (GDP deflator). Conversely, a value above 1 indicates that prices rose faster than average. The table displays average values for the EU27 Member States and the associated standard deviations. Across Member States, agriculture and manufacturing have had a below-average price development. The price development in distribution was on average approximately the same as for aggregate prices. For personal services, business services and non-market services, an above-average price development is observed. These price trends are consistent with the view of differential productivity developments across services and manufacturing and higher productivity dynamics in manufacturing.[3] The associated standard deviations show that these differences are statistically significant. Nevertheless, it is also important to note that these price series are themselves subject to a considerable composition bias, as it is very unlikely that the structure of these quite aggregate sectors remained identical over time.[4]

[3] Price developments of manufacturing products would be further below the aggregate price development if they were corrected for increases in the quality of finished products (see Cummins and Violante (2002).

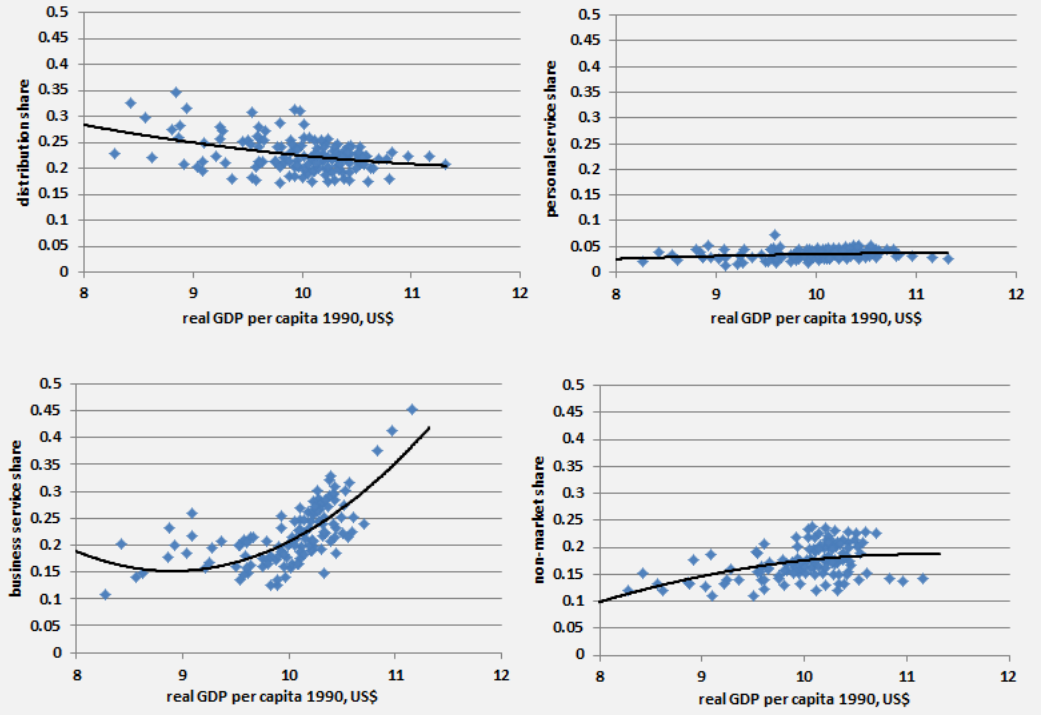
[4] This remark is important for the comparison of real shares over time. Structural change is a process that changes the weights of economic activities in the aggregate. Moreover, structural change is driven by differences in demand and productivity that react to or determine prices. Therefore these data not only identify a price effect but also a quantity effect associated with the changing weights of economic activities.

Figure 2.4. Service shares and economic development

(a) Value added shares



(b) Shares in hours worked



Source: WIFO calculations, EUKLEMS

Box 2.2. Household production and structural change

It has been widely recognised that income and wealth generated by household production could introduce a bias in the measurement of the economic structure. Kuznets (1944) and Clark (1958) already indicated that the neglect of home production leads to a significant underestimation of national income in general and the contribution of agriculture, construction, and services to national income in particular. These missing activities contribute to economic welfare and can be 'marketised' to different degrees across countries, thereby affecting the measurement of sector shares, since only market services are taken into account in the official statistics.

Hill (1977) defined household production as economically productive households or do-it-yourself activities that can be provided through the market by choice. Home-produced and market-produced services are gross substitutes. Cooking and cleaning are productive activities because the market *can* provide them, whereas eating and sleeping are non-productive activities because the market cannot provide them. Unfortunately, no systematic data are available which would allow differences in structural change to be quantified across EU Member States. The results for the US suggest that incorporating the value of non-market home production increases the level of nominal GDP. Bridgman et al. (2012) estimate that in 1965 household production increased GDP by 39%, and by 26% in 2010. The relative decline in home production is almost solely due to the reduction of hours spent in home production by women. Their contribution declined from 40 to 26 hours during this period, whereas the number of hours spent by men increased from 14 to 17 hours. Thus the allocation of hours between market and home production can also be considered in the context of structural change. Yet Freeman and Schettkat (2005) and Rogerson (2008) suggest that it is not a driver of structural change but part of the increase in leisure deriving from the reallocation of labour from home production to the market production of services.

It is also important to take into account the impact of technical change on home production. A good example is the contribution of the mechanisation of home production, namely the growth of the manufacturing of household appliances. The spread of washing machines, dryers, vacuum cleaners, microwaves, and other home appliances was accompanied by declines in domestic servants, laundries and drycleaners. Buera and Kaboski (2012a) emphasise that innovations which change the scale economies of productive activities are an important determinant of the boundaries between home and market production of goods and services over time. They argue that scale economies are a driving force in the process of marketisation of services, but that this process can also be reversed if technological change and mechanisation lowers the cost of producing services and scale economies, as households value the flexibility of home production. Their result suggests that the spread of manufactured goods into the home leads to a 'demarketisation' of services and a growth of manufacturing relative to services. Technical change that leads to an increase in the economies of scale of services will lead to the marketisation and relative growth of the service sector. However, it is important to note that the empirical verdict on the importance of the thesis of the marketization and demarketisation of home production for structural change is still not settled.

It should also be noted that the de-marketization of certain activities, because they can be done at home at a low cost in terms of time, can potentially increase labour supply and reinforce the tertiarization of the economy because services are labour-intensive.

2.3.1. Interaction of manufacturing and services

Another important explanation that has been brought forward is the hypothesis of the inter-industry division of labour. It is sometimes claimed that outsourcing jobs from manufacturing to services is a primary driver of the rise of service sectors (see Schettkatt and Yocarini (2006) for a discussion). However, most of the studies using input-output analysis come to the conclusion that outsourcing from manufacturing to services took place at a very modest rate[5]. According to Gregory and Russo (2004), the rise of business services is largely explained by outsourcing from other service sectors. This shows that the trend towards an increasing services share cannot be understood without considering changes at the microeconomic level. The interaction between manufacturing and services has become more complex. Services and manufactured goods are used as intermediary inputs to produce a larger number of final products (goods and services).

[5] The methodological limitations of using input-output analysis to examine the outsourcing process are discussed in Montesor and Vitucci (2007).

Table 2.3. Relative price developments at the sector level, 1995–2007

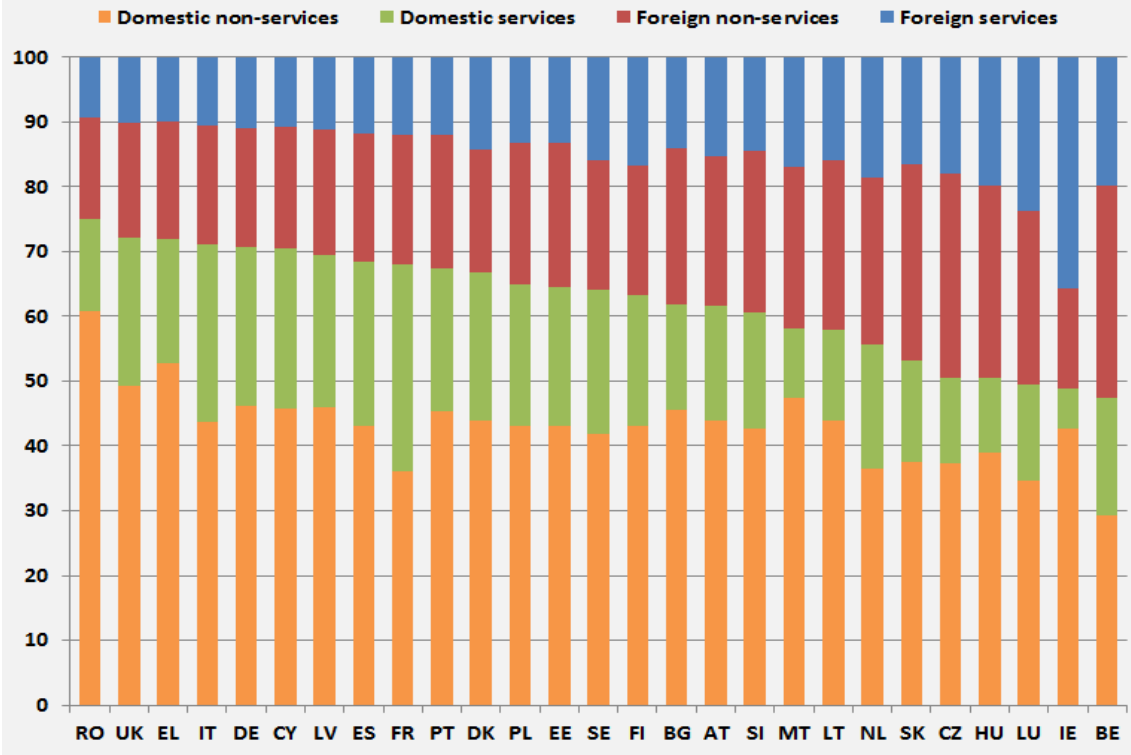
	Average	Standard deviation
Agriculture	0.77	0.18
Manufacturing	0.82	0.13
Construction	1.22	0.20
Distribution	0.97	0.09
Personal services	1.17	0.16
Business services	1.13	0.13
Non-market services	1.18	0.16

Source: EUKLEMS

products are also used for producing services, the manufacturing content of services is about three times smaller than the service content of manufacturing and has increased much less over time.

These results explain that there is a high degree of complementarity between manufacturing goods and services, but that this complementarity is biased towards the increasing importance of services as inputs to manufacturing. Services such as maintenance and training are very important elements in the delivery of complex manufactured products. At the same time the importance of specialised services such as financial intermediation, communications, insurance and knowledge-intensive business services

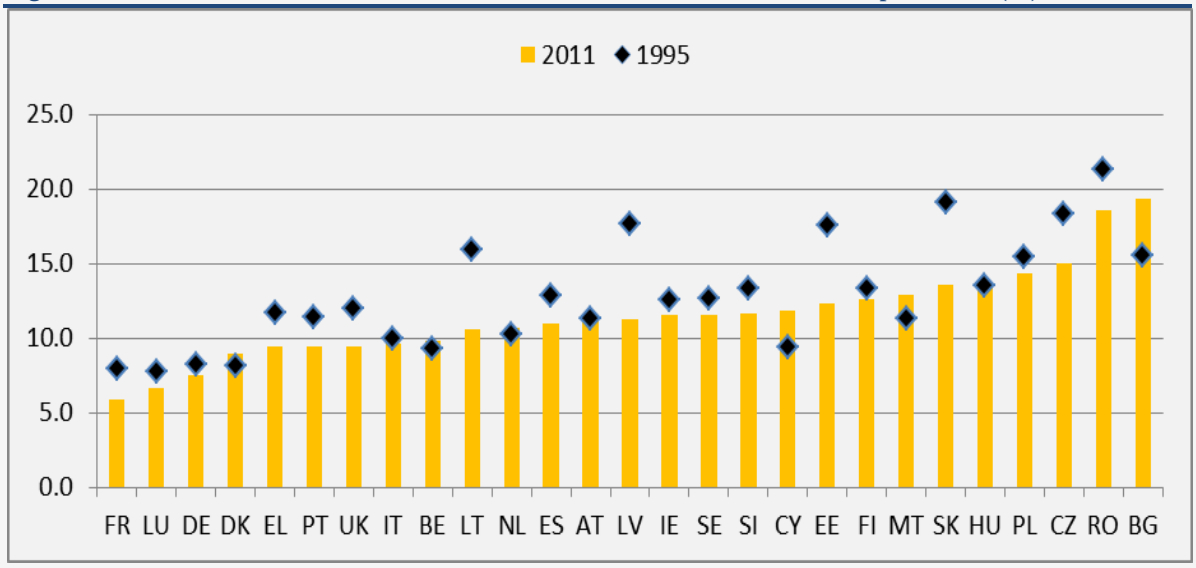
Figure 2.5. Value added decomposition for manufacturing production in per cent, 2011



Note: Countries are ranked according to their domestic value added share (i.e. Domestic non-services + domestic services)
Source: WIOD, wiiw calculations

The increasing contribution of the service industry at the expense of manufacturing can in part be explained by an increasing service content of manufacturing final output, reflecting the total value of the services required for the development, production and marketing of a modern manufacturing product. The service content of manufacturing has been growing in the EU and elsewhere in the world. In 2011, the share of value added embodied in manufacturing final output that was created in the service industry ranged from above 40% in Belgium, Ireland and Luxembourg to below 30% in Romania, United Kingdom and Greece (see Figure 2.5). This means that more than a third of the value of a European manufacturing product that is sold to final users is created in the services sector. Whereas manufacturing (KIBS) are becoming important inputs in the production of sophisticated manufacturing output. This process is one of several explanations for the increasing contribution of services to the overall output of an economy. Figure 2.5 shows that an increasing share of intermediate services used in modern manufacturing is being imported, reflecting the fragmentation of production processes within and across national borders which was made possible by the ICT revolution (Guerrieri and Meliciani 2005). The relocation of business processes from one country to another also affects the structure of an economy and its services share. However, the degree of offshoring and outsourcing is dependent on the particular industry and activity.

Figure 2.6. Share of value added created in non-services sectors embodied in services production (%)



Note: Services sectors are NACE Rev. 1 50 to 95.
Source: WIOD, wiiw calculations

In the discussion of the rise of services, two issues have so far been neglected. The first issue relates to the quality of data on services. There are still measurement issues associated with services sector output, value added and productivity.[6] Griliches (1992), for example, documented that services sectors with hard-to-measure outputs, such as health services, experienced the largest labour productivity slowdown after 1973. In many services there are conceptual and empirical problems in measuring output and prices. Therefore, there are still substantial differences in the measurement of productivity in manufacturing and in services, and thus major limits in the comparability of its growth rates across these sectors. These problems primarily affect the value added shares in GDP and the identification of productivity developments, while employment shares are unaffected by these issues. However, the importance of human capital and education for economic growth in developed economies (e.g. Lucas 1988, Pugno 2006) leaves an additional question mark concerning the usefulness of comparing sectoral productivity differences. If human capital is essential for economic growth and the educational sector provides most of the human capital used in the form of capabilities in the manufacturing and services sectors to develop new products and to improve productivity, then the reallocation of resources to a low-productivity activity such as education may be the reason why productivity improves in other sectors of the economy. Pugno (2006) explicitly takes this situation into account, concluding that not only can the expansion of business services support long-term economic growth but also the expansion of some non-market activities such as education. In this case the productivity and quality of the educational system are of primary importance. The productivity of the education system needs to be measured in terms of its quality in providing the right competences and capabilities.

2.4. HETEROGENEITY OF STRUCTURAL CHANGE IN EUROPE

The discussion so far has shown that broad trends in structural change are quite homogeneous across countries.

Table 2.4 summarises developments between 1995 and 2011 for the EU-27 countries. There has been a decline in most production sectors, both in terms of employment shares and nominal value-added shares. The biggest reductions are for agriculture and the manufacturing sector. In the period 2005 to 2011, construction also shows a negative trend for employment as well as value- added shares, reflecting its sensitivity to aggregate downturns (cf. Hölzl et al. 2011). These declines have been offset primarily through the expansion in business services and non-market services. Overall, these results are consistent with a view suggesting that labour productivity growth has been especially strong in agriculture, manufacturing, distribution, mining and utilities.

Of greater interest is the development in the dispersion within the EU-27.

[6] There is a literature on problems with measuring productivity in services. One of the best overviews on measurement problems in the services sector in general is provided by Triplett and Bosworth (2004). Diewert, Fixler and Zieschang (2012) cover banking services and Diewert (2011) cover public services.

Table 2.4 provides descriptive statistics of this dispersion, in terms of Gini indices. The Gini index is a widely used measure of relative inequality. The coefficient takes values between zero and one, or, as in Table 2.4, between 0 and 100 on the percentile scale. A value of 0 corresponds to total equality. This would be the case if all sectors had equal shares. The higher the value of the Gini coefficient, the more unequal the distribution. A value of 100 expresses maximum inequality, for example if all countries had different sectors. The formula for computing the Gini coefficient is:

$$G = \frac{2\sum_{i=1}^{n} i y_i}{n\sum_{i=1}^{n} y_i} - \frac{n+1}{n},$$

where y_i are the sector shares sorted in an ascending order and n the number of sectors.

Table 2.4 shows that the disparity is highest for agriculture and for mining and utilities. The lowest inequality ratings are for construction, distribution and non-market services for the employment share, and for distribution, non-market services and business services for the value-added share. The changes in inequality show that most services sectors experienced a reduction in inequality during the longer period 1995 to 2005. For the shorter time horizon inequality increased for personal services, probably due to a transitory divergence in the consumption of personal services across countries. However, for manufacturing we observe a rising disparity across the EU27, for both the employment and value-added shares.

Table 2.5 displays the heterogeneity of structural change for the EU-15 over the longer time period between 1975 and 2005 using EU KLEMS data. The results confirm the earlier picture of the EU-15 experiencing a reduction in disparity of services shares, along with an increase in disparity for the production sectors, especially manufacturing both in terms of employment and the value added share.

Overall these results suggest that there was considerable heterogeneity in economic development. The trends of structural change are quite similar across countries, but we observe some divergent developments, especially for the manufacturing sector. The results in Box 2.2 (US EU Comparison) also show an increasing inequality between the value-added shares in manufacturing across Member States and US states. The similarity in broad trends of economic development is also compatible with important heterogeneity at the country level. Further analysis for the EU Member States shows that common trends in structural change are able to explain a large part of the development of employment and value-added shares over time, but also that idiosyncratic and contrasting elements are important in determining the development of sectoral shares across countries.

The same patterns of structural change emerge from a more detailed look at structural adjustments in the EU-12[7] economies during the transformation from a planned economy to a market economy, and then during the process of integration into the Single Market (see Box 2.3). The broad trend of a decrease in production activities, especially manufacturing and agriculture, and an increase in services sectors was quite uniform across these countries. However, at the level of individual countries important differences can be observed.

2.5. INTERNATIONAL TRADE AND SPECIALISATION AS DRIVERS OF DIFFERENCES IN THE ECONOMIC STRUCTURE

What explains these differences in economic structure across countries? The differences for the manufacturing sector are the most interesting, showing a polarisation process with an increasing disparity across Member States. One important factor is international trade. Openness and international specialisation patterns clearly have an impact on observed structural change. Connolly and Yi (2008) claim that up to 30% of South Korea's catch-up between 1962 and 1995 can be traced to its openness. Matsuyama (2009) and Yi and Zhang (2010) show that differences in the structure of economies can be related to differences in international trade, specialisation, and differences in economic development, which is partly path-dependent.

Two important drivers of specialisation and structural change are innovation, i.e. the creation of new varieties of products, and the selection of new products through the process of market competition or changes in demand that affect the economic weight of products and may even lead to the replacement of products. The replacement mechanism is very important as it captures the key mechanism behind Schumpeter's vision of economic development driven by the process of "creative destruction". This perspective of qualitative change is closely related to a view of economic development as a process of structural change, where resources are continuously reallocated from activities with low productivity to activities with higher productivity.

This view has been emphasised in a series of contributions by Hidalgo et al. (2007), Hidalgo and Hausmann (2009) and Felipe et al. (2012) – see also Reinstaller et al. (2012) – which linked the process of

[7] Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia.

economic development of a country to the idea of changes in the space of its exported products. In such

Table 2.4. Dynamics and heterogeneity of structural change in the EU27, 1995–2011

	Employment shares					
	Share 2011	**Change 1995–2005**	**Change 2005–2011**	**Inequality 2011**	**Change 1995–2005**	**Change 2005–2011**
Agriculture	5.8	–2.6	-0.6	39.6	2.9	1.1
Mining and Utilities	1.3	–0.5	0.0	31.8	–2.1	–0.2
Manufacturing	15.3	–3.2	–1.9	16.6	4.0	1.4
Construction	7.1	0.8	–0.7	9.6	2.2	–5.0
Distribution	26.6	1.1	0.5	7.5	–0.3	1.5
Personal Services	6.1	0.5	0.3	18.3	–0.9	1.1
Business Service	14.6	3.0	1.7	18.9	–1.8	–1.4
Non-market Services	23.1	1.0	0.7	10.1	–1.5	–0.6

	Value added shares					
	Share 2011	**Change 1995-2005**	**Change 2005-2011**	**Inequality 2011**	**Change 1995-2005**	**Change 2005-2011**
Agriculture	2.7	–2.2	–0.1	30.3	–1.5	0.9
Mining and Utilities	3.7	–0.5	0.5	26	2.4	1.7
Manufacturing	16.8	–3.0	–0.8	18.2	5.2	1.7
Construction	5.6	0.6	–0.9	14.4	2.8	1.1
Distribution	23.3	0.9	–1.1	8.9	2.0	–1.1
Personal Services	4.3	0.4	0.4	20	–0.1	8.1
Business Service	25.3	3.3	1.3	11.7	–0.3	–1.4
Non-market Services	18.3	0.6	0.6	10.3	1.2	0.5

Source : WIFO calculations, Eurostat, National Accounts.
Note: unweighted averages; inequality is measured using the Gini Index across countries.

Table 2.5. Heterogeneity of structural change in the EU-15, 1975–2005

	Employment share		Value added share	
	Inequality 2005	**Change in inequality 1975-2005**	**Inequality 2005**	**Change in inequality 1975-2005**
Agriculture	38.5	1.8	29.4	–0.6
Mining and Utilities	32.0	9.2	24.3	1.0
Manufacturing	15.2	7.6	16.5	7.8
Construction	14.6	7.0	13.3	5.4
Distribution Services	6.0	1.7	10.0	3.9
Personal Services	17.2	–2.3	11.9	–3.1
Business Services	20.3	–2.4	13.1	–2.7
Non-Market Services	10.7	–5.8	9.8	–3.5

Source: WIFO calculations, EU KLEMS

a perspective, the overall complexity and sophistication of a country's productive structure is the key indicator to explain its economic development. Different abilities to accumulate capabilities to produce new improved products can explain differences in their performance. This literature provides a novel way to study the differences in structural change across countries.[8]

The processes of variety creation and creative destruction can be made visible by the appearance and disappearance of exported products or product classes. Exporting new products changes the composition of the product basket of countries. Therefore the structural change in one country may affect the economic structure in other countries. The analysis of changes in the composition of export baskets of countries using trade data at the four-digit product level for 232 countries covering the years 1995 to 2010 (cf. Gaulier and Zignago 2010) allows the study of structural change and what is termed "creative destruction". We use the product space indicators proposed by (Hidalgo et al. 2007; Hidalgo and Hausmann 2009) that capture trade specialisation,

Box 2.3. Structural change in the EU-12 during transformation and integration into the Common Market

In general, the Member States which joined the EU in 2004 and 2007 had oversized and inefficient industrial sectors. At the start of the transformation process, the high degree of industrialisation was a drawback. It implied, among other problems, the underdevelopment of important services sectors. Due to comparative disadvantage, industry in all the former communist countries suffered disproportionately from the 'transformational' recession in the early 1990s. The relative decline of industry went hand in hand with a rapid expansion of services sectors. By 2011, only the Czech Republic and Romania had a manufacturing sector with a share in GDP of more than 20% – about the same as in two of the more industrialised older Member States: Germany and Ireland. In Hungary, Poland, Romania, and the Baltic states, manufacturing industry managed to retain at least part of its previous position, thanks largely to active restructuring and privatisation efforts, fostered in particular by FDI inflows. At the beginning of the 2010s, the shares of manufacturing to GDP in the majority of EU-12 Member States were higher than in EU-15 economies. However, this is in line with many developing economies.

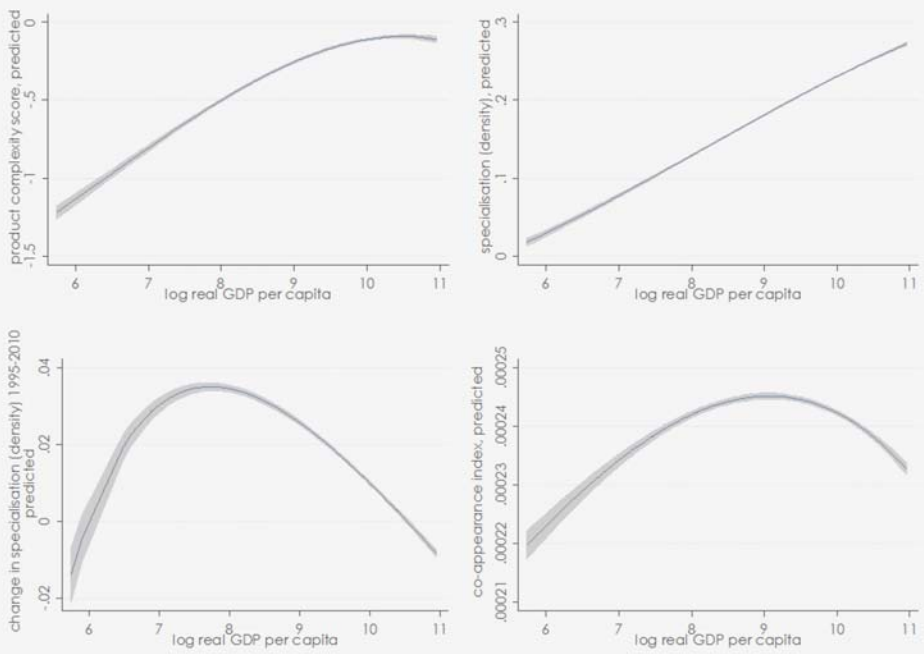
The changes in employment shares in the EU-12 countries were even more dramatic during the last two decades. Employment declined more than output and millions of jobs were lost during the transition from central planning to market economies. Nevertheless, the manufacturing sector remains an important job provider, with the highest employment shares in the manufacturing industry recorded in the Czech Republic, Slovakia and Slovenia. With the exception of Latvia, Cyprus and Malta, manufacturing accounts for more than 15% of total employment in all EU-12 Member States. Similarly high shares of manufacturing employment are recorded for only a few EU-15 countries: Portugal, Italy, Austria, Germany and Finland.

Structural change has been more pronounced in Bulgaria, Romania, Latvia and Lithuania than in the Czech Republic, Hungary, Estonia or Poland. Furthermore, the 'earlier' transition period 1995-2000 was more profound than the integration period immediately before EU accession (2000-2005). The most recent period, 2005-2011 is characterised in several countries by more restructuring than before EU accession (for instance in the Czech Republic, Slovakia and Slovenia). This period was also affected by the recent economic crisis which hit manufacturing, construction and tradable services much harder than other economic sectors. Among the EU-15, Sweden, Austria and Germany experienced only small adjustments, whereas structural adjustments were more pronounced in Ireland and Finland.

Despite varying country-specific restructuring patterns, several stylised facts common to most countries can be observed for the EU-12: the output shares of agriculture and manufacturing have declined whereas those of real estate, renting and business activities, information and communication, financial and insurance services, as well as public administration have increased. However, it must be said that the patterns of structural change were quite different across individual countries. It is especially interesting that a number of new distinct features of structural adjustment emerged during the relatively short crisis period between 2008 and 2011. Apart from a certain revival of manufacturing (Hungary, Romania and the Baltic states) it was construction and trade which suffered most from declining value-added shares during the crisis in a number of EU-12 countries. Structural adjustments were less pronounced in the Czech Republic during this period (as in a number of EU-15 Member States, such as Austria, France, Germany, Belgium, Italy and Sweden). In Poland – the only EU Member State which did not experience a decline in GDP during the crisis period – a certain return to a 'traditional' structural pattern occurred as a number of 'productive' sectors (energy, construction and trade) managed to increase their shares in GDP while the shares of information, communication services and especially financial services showed some declines.

[8] Some recent contributions argue that the hump-shaped pattern of development observed for the shares in value added of the manufacturing sector over time can only be explained by taking an open economy perspective and in the context of international specialisation in trade (Reyes-Heroles 2012; Uy et al. 2012).

Figure 2.7. Average product complexity, density and co-appearance across income levels. Predicted values on the basis of fitted fractional polynomials, 2010



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

product complexity, and appearance and disappearance of traded products across countries.

Figure 2.7 provides a summary of these indicators by relating them to per capita income levels of the countries. The upper panels (product complexity and trade specialisation) show values for 2010; the lower panels (change of trade specialisation and co-appearance and disappearance of products) show differences between 1995 and 2010.

The product complexity score (PCS) is shown in the upper left panel. This indicator can be interpreted as capturing latent information on both the depth (capability to produce exclusive products due to high levels of accumulated knowledge) and the breadth of the knowledge base (capability to make many products with different knowledge bases) needed to be active in a specific product class (cf. Reinstaller et al. 2012).[9] It is constructed using information on how many countries produce a specific product and on how diversified these countries are. The plot in the figure shows that more developed countries produce more sophisticated products which require higher capabilities and suggests that economic development goes along with a perpetual structural change in the export basket towards more complex products.

The upper right panel shows the product neighbourhood density[10]. This indicator is a proxy for the trade specialisation of countries. It exploits the fact that similar products are related to each other by drawing on common knowledge bases and similar factors of production. It is therefore also a measure for the factor substitutability across products. Higher scores imply a higher specialisation. In order to plot this indicator it has been averaged over products in the product basket of a country. The plot shows that countries at higher levels of economic development tend to become more specialised in their exports. The products they export are more closely related to each other in terms of similar factor input requirements.

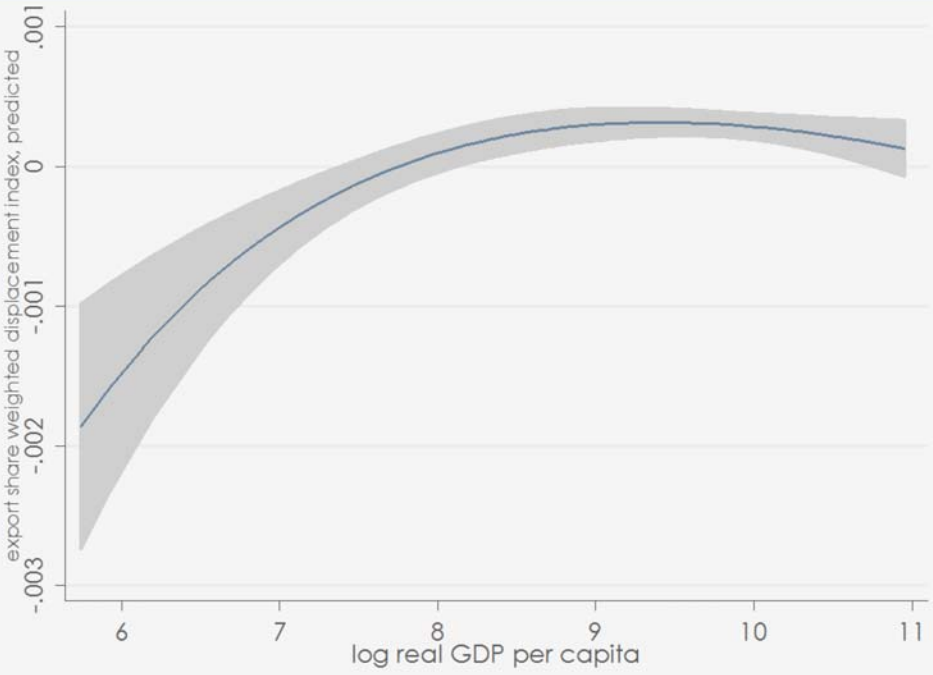
The lower left panel of Figure 2.7 shows the change of the neighbourhood density between 1995 and 2010. It is plotted against GDP per capita levels in 2010. The figure suggests that trade specialisation seems to be a fast process at lower levels of economic development, while it starts to slow down at a GDP per capita corresponding to about USD 3000 (or e^8), in a hump-shaped relationship.

[9] The empirical range of the product complexity scores lies between –4 and 2. These figures correspond to standard deviations from the mean product complexity score normalised to zero. Hence an indicator value of 2 indicates that the complexity score of a product or product class is two standard deviations away from the mean. A product with a complexity score of zero indicates that – relative to the entire sample – it has just average complexity.

[10] At the product level, the indicator takes on values between 0 and 1, where 0 indicates no relation and 1 a perfect relation of a product to the productive structures of a country the specialisation pattern of a country.

The lower right panel plots the co-appearance index of the products countries export. This measure captures the presence of 'temporal clustering', where products appear in the export basket across countries at the same time. A higher value indicates a temporal clustering and shows whether countries start exporting these products simultaneously. The plot shows that the co-appearance index follows an inverted U-shape over levels of per capita income, with a predicted maximum at an income level corresponding to about USD 8 000 per capita (=e^9). While a more thorough examination of the relationship between the co-appearance index and the change in neighbourhood density (specialisation) is necessary, a first glance at the results suggests that the co-appearance of products is closely related to the dynamics of related specialisation. Increases in specialisation appear to go along with bursts in the export activity of products.

Figure 2.8. Specialisation of productive structures and changes over the 1995–2010 period across income levels, predicted values on the basis of fitted fractional polynomials



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

Figure 2.8 displays the export share weighted displacement index. This index measures the number of disappearances of some product classes within a specified time window after a country has started exporting another product.[11] It captures the creative destruction induced in a productive system when a country starts making a specific product. Negative values indicate that a country exports mostly products which across all countries tend to be displaced by other products. Positive values indicate that products which tend to displace other products have a higher weight in the export basket of a country. Such products can be considered to be more innovative, high-end products. Beyond a threshold income level close to USD 3 000 per capita, displacing products start to dominate the export basket of countries. This figure gives a clear indication that the characteristics of traded products change in countries with levels of income per capita in the range between USD 3 000 and USD 8 000.

As Figure 2.9 shows, the export baskets of the EU-27 consist by and large of products with positive displacement scores. This indicates that most of the exports of the Member States are products from the upper end of the quality ladder. The data also shows that inside this group of products with positive displacement scores, some Member States have a higher export share in products with above-average complexity scores whereas others have a higher share of products with average or below-average complexity scores.[12] The product complexity score can be taken as a measure that captures the difficulty of imitating exported products. For Member States with average or below-average complexity scores, this evidence implies that they produce up-market

[11] The variable takes on values between -1 and 1. See Klimek et al. (2012) for details on the indicator.

[12] Unreported results show that the export basket of catching-up countries such as Brazil is dominated by products with negative displacement scores and a relatively high share of products with below-average complexity scores inside this product class.

products that are easier to imitate. As a consequence, they are also subject to more intense price competition from lower-income countries than Member States producing innovative products that rely on a more complex knowledge base and therefore are also more difficult to imitate.

Further results show that across manufacturing sectors, product classes with negative and positive displacement indices co-exist. In the chemical industry for instance, the share of the two product categories is almost equal. By contrast, in the machinery and equipment industry the share of displacing products, i.e. products with a positive displacement index, outweighs the number of products that tend to be displaced, whereas the opposite situation exists in the textile and apparel industries. Sectors thus undergo a permanent restructuring process which is driven by changes at the level of products or product classes. These results show that more sophisticated products both in terms of complexity and displacement scores are more frequent in medium-high and high-tech industries. Therefore, in the more advanced economies, sectors producing more sophisticated products drive out other sectors. However, it is important to stress from a policy perspective the considerable path dependence in the development paths of the productive structures of economies (e.g. Reinstaller et al. 2012). This implies that the diversification into economic structures characterised by innovative products which are difficult to imitate is harder to achieve by countries lacking specific knowledge bases and specialisation patterns than by countries that have these capabilities. Thus an important limit to the change in the export basket of countries is the path dependency of industrial structure.

The path dependency of industrial structure also suggests that it might be easier to lose some products and competences in the process of international competition than to build up different capabilities which allow the differentiation of the product space of a country. This dynamic process of reconfiguring capabilities, competencies and the national product space is part of the interaction between manufacturing share and international competiveness.

While it is true that for most countries agricultural and manufactured goods are the most important tradables, the discussion should not be reduced to the size of the manufacturing share alone. The composition of the manufacturing share itself, whether manufacturing consists of sophisticated and complex products with unique features or mainly of products which compete with goods from many countries, is very important as this determines the long-run position of countries.

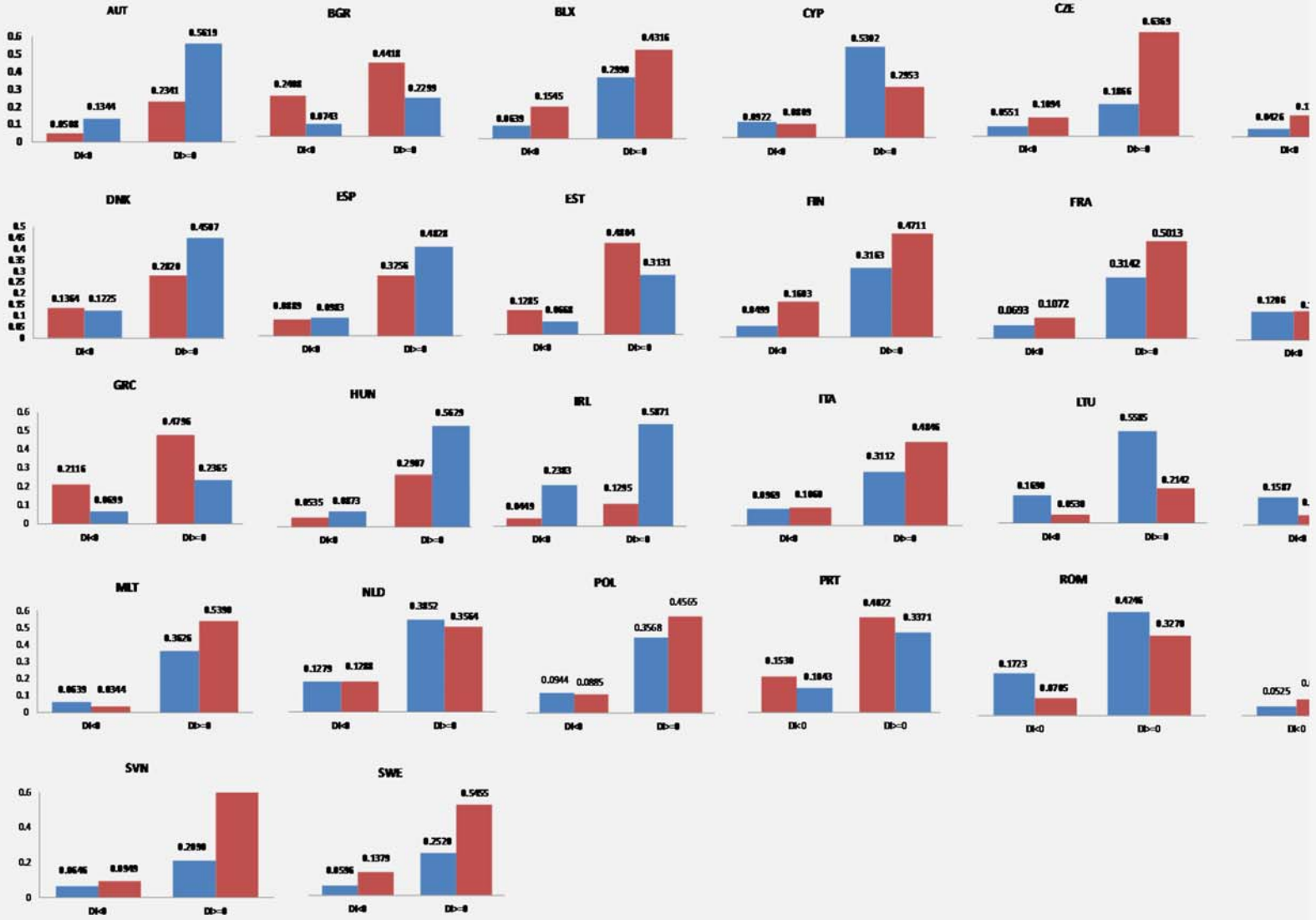
2.5.1. The role of institutions in structural change

The product space literature suggests that capabilities are crucial in explaining differences in structural change and economic development. On the other hand, economic development is closely linked to the institutional quality of countries. For example, Knack and Keefer (1995) and Dollar and Kraay (2001) argue that rule of law is an important driver of economic growth.

The literature on institutions and economic development suggests that many institutional indicators are highly correlated with economic development (e.g. Langbein and Knack 2010). A few studies have provided evidence of causality running from institutions to economic performance (Acemoglu et al. 2001, Rodrick et al. 2004). Reinstaller et al. (2012) confirm that product space indicators capturing the complexity of the export basket are closely correlated with institutional quality and high knowledge intensity. However, in this literature the relationship between structural change and institutional quality is not made very explicit, as it is not possible to measure structural change in an unambiguous way. The problem is that structural change can be growth-enhancing and growth-reducing. In the presence of international trade the reallocation of resources (e.g. labour and capital) can lean towards high-productivity sectors or in the opposite direction. Latin America has been cited as an example of a larger region which in the past experienced growth-reducing structural change. In the 1960s and 1970s in particular, economic policy driven by macroeconomic populism and protectionist import-substitution policies provided the basis for this outcome (e.g. McMillan and Rodrick 2011). This suggests that two different types of institutions and policies are central to fostering growth-enhancing structural change: institutions and policies to promote the efficient reallocation of resources across sectors and institutions, and policies to encourage the development of capabilities which allow enterprises to innovate.

The literature on market frictions in structural change emphasises that aggregate outcomes not only depend on rationalisation and reorganisation processes within firms and industries, but also on the reallocation of resources across sectors. Restuccia and Rogerson (2013) survey the evidence and show that structural change can be limited by the existence of regulations and other frictions that inhibit the reallocation of resources across sectors and firms. This can be costly in a static sense, as the resources are not used in

Figure 2.9. Composition of the export basket in terms of product complexity and displacement indices: shares in total exports, EU27



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

the most efficient way. However, even more importantly, the dynamic impact may affect the adoption of new technology and further development of capabilities. McMillan and Rodrick (2011) provide evidence that countries with more flexible labour markets experience growth-enhancing structural change. Many factors can be identified, such as certain types of taxes, labour market regulation, size-dependent policies or trade barriers, in addition to regulations and myriad costs of doing business in the formal sector. Bartelsman et al. (2013) provide an overall analysis that compares the United States to seven European economies for the period 1992 to 2001 and find that idiosyncratic distortions play an important role in the allocation of resources across establishments. Their results suggest that output could be increased by up to 15% in some countries if the allocation of resources was improved. However, it is very difficult to identify the sources of the misallocation. One of the biggest impediments to the reallocation of resources is financial frictions. Financial markets are an important selection mechanism for entrepreneurial projects and a well-developed financial system is therefore important to fostering entrepreneurial activity, structural change and economic growth (Aghion et al. 2007, Buera et al. 2011). Microeconomic evidence suggests that credit market imperfections are important sources of differences in productivity across countries. An inefficient financial sector can significantly impede the creation of new businesses and the growth of enterprises. In particular, sectors with a larger scale (e.g. manufacturing) and industries that have high costs of product development (e.g. biotechnology) are disproportionally affected by financial frictions. However, financial repression that directs finance towards certain sectors is not a force which supports growth-enhancing structural change (Johansson and Wang 2011). Institutional aspects such as government effectiveness, low corruption and the efficiency of the legal system are important to competitiveness in terms of foreign direct investment (Alfaro et al. 2008). Thus, institutional quality is likely to affect specialisation patterns.

Here the capabilities that affect specialisation and structural change, which are associated with the knowledge base of countries, are of greater importance. The national innovation system perspective also provides a useful view on these issues as systemic failures are significant in explaining the innovative performance of firms and countries. The national system of innovation is defined as a 'network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies' (Freeman 1987). Systemic failures such as the lack of interaction between the actors in the innovation system, mismatches between basic research in universities and applied research in industry, malfunctioning technology transfer institutions, and deficiencies in the absorptive capacity of enterprises may all contribute to poor innovation performance. Powell and Grodal (2005) show that innovation networks have a positive impact on innovation activity, but network failures can cause barriers to innovation. Other evidence suggests that differences in the patterns of technology diffusion may account for a sizable part of the divergence in incomes between rich and poor countries (e.g. Comin and Mestieri Ferrer 2013).

Differences in the time scales of the adoption of new technologies and the penetrations rates once new technologies are adopted are important in determining differences in economic structure. Here the lesson of the literature on systems of innovation clearly indicates that successful technology support policy must consider arguments of systemic and institutional failures. Growth traps and catch-up failures are most often related to failures to select the right set of institutions. For example, Acemoglu et al. (2006) emphasise the different need for policy institutions (educational systems, firm dynamics, innovation policies) in countries that are close to or far from the world technological frontier. Catching-up does not depend on a particular institutional configuration, but on the interlocking complementarities within the institutional arrangements of the national innovation system, an aspect that von Tunzelmann (2004) calls network alignment. Structural change is thus dependent on growth-enhancing policies and institutions that allow the efficient allocation of resources within economies. Policies and institutions that hinder such reallocation processes are a prime source of inefficiency and economic backwardness.

The recent crisis in Europe has shown that short-term cyclical developments can lead to mispricing of assets and a misallocation of economic resources, for example with respect to the expansion of the construction sector in the lead up to current crisis. However, the evidence shows that the changes in the manufacturing share are mainly related to the broad trends of structural change mediated by international specialisation documented earlier. For example, there is nothing in the analysis of the inequality of employment and value added shares, in Table 2.4 and Table 2.5 that suggests that the divergence between European countries increased substantially during the crisis period (the drop in 2009 was symmetric across countries and the manufacturing share normalised for most countries in 2010 and 2011). Nevertheless, it is known that some sectors such as manufacturing and construction are very responsive to demand downturns. The production of capital goods and consumer durables are central industries in manufacturing that are sensitive to changes in the economic climate. Investment falls during recessions as does business R&D (e.g. Aghion and Banerjee 2005, Hölzl et al. 2011). Thus fiscal policy measures which aim at demand management should also

consider the structure of the economy and the pro-cyclical behaviour of business R&D and innovation activities over the business cycle. Supporting business R&D and innovation during times of economic crisis can support the ability of countries to achieve economic growth in the long run and support economic restructuring. Policies that aim at reducing the openness of countries to international trade, in contrast, are likely to be counterproductive. The experience with financial repression and protection from international competition is more often negative than positive.

2.6. SUMMARY AND POLICY IMPLICATIONS

There are clearly identifiable broad patterns of structural change that are quite homogenous across countries and associated with the level of economic development. The agriculture share is declining with the process of economic development. The manufacturing share is declining, both in terms of its employment share and its value added share at a certain point of economic development, while the shares of services in employment and output are increasing over time. These patterns can be broadly explained in terms of the impact of technical change and productivity improvements together with changing patterns of demand due to higher income (the 'Engels curve').

New technologies and new skills change productivities, while demand patterns change with changing income. The decline in the economic weight of agriculture is associated with the increasing mechanisation of agriculture which still leads to a rise in labour and total factor productivity even in the richest countries of the world. The increase in productivity leads to lower prices and to a lower factor demand (e.g. labour) if productivity developments outstrip the growth in demand for sectoral products. The same mechanism characterises manufactured output, with the important difference that the products (and the product characteristics) in manufacturing are changing much faster than products in agriculture. A hundred years ago there was no computer industry and the output of the electronics industry was very different.

However, if we look at shorter time periods, such as the 15 years considered in the sectoral growth decompositions, it can be seen that most growth comes from processes of economic growth within industries. It is a well-known stylised fact that aggregate productivity improvements are mostly related to within-sector (and even within-firm) productivity improvements. Reallocation between sectors and between industries becomes more important the longer the time period of the analysis.

These patterns are almost the inevitable outcome of the basic mechanisms underlying structural change. Similar patterns are not only found using historical data for European countries or cross-sectional data for a large number of countries; these patterns are also very similar for US states and EU members. Nevertheless, it is equally important to realise that there is some heterogeneity in the structure of economies across countries. The working of structural change is also mediated through international trade, institutions, and international and domestic competition.

On-going reallocations in economic weight across different sectors should not be assessed only in terms of reallocation of sector shares towards more productive sectors. That would completely neglect the linkages between sectors that are essential in generating productivity improvement. Structural shifts towards education-intensive activities (business services and especially non-market services) do not necessarily impact on growth potential in a negative way, even if they apparently reduce aggregate productivity. The education sector generates skilled labour inputs for manufacturing and R&D.

International competitiveness is *inter alia* about trade balances at the aggregate level; but "creative destruction" at the product level is likely to be a major driver of developments at the aggregate level. Thus, international trade is an important determinant of the development of sectoral shares in countries. The successful catch-up stories of Germany in 19th century and Japan and South Korea in the 20th century cannot be explained without taking into account international trade, comparative advantage in tradables and specific competencies and capabilities in the production of new and high-value added products. Here it is important to acknowledge that structural change shaping the economic development of countries is highly path-dependent and cumulative. Any change is rooted in present knowledge bases and constrained by existing specialisation patterns. Complementary capabilities need to be built up. Therefore policies to support structural change should always start by taking into account the existing production structures of countries and regions, as well as the knowledge base of supporting institutions. Appropriate policies to foster structural change may therefore also be country-specific and region-specific, and depend on existing specialisation patterns. Skills and technology are essential for achieving growth-enhancing structural change. Structural change is generally associated with the emergence of new products and industries and the disappearance of other products and occupations at the micro-economic level which have a macroeconomic impact.

Producing more complex product classes and upgrading existing products requires technological competencies, skilled labour and administrative capabilities at the business and government levels. It should therefore not come as a surprise that the share

of services (non-government services such as education and business services) starts to rise once countries achieve income levels where the nature of international competition changes from a purely cost-driven to a more resource-intensive quality competition. For the most successful exporting countries it is crucial to develop new products that are not produced by many other countries. Upgrading possibilities are not distributed evenly: they seem to be concentrated in high technology sectors and complex products. Given the path-dependent development of economic structures and comparative advantage (as indicated by the product space literature), countries seeking to shift their industrial production up the technology ladder are likely to also need to increase and improve non-government services, such as education and business services.

The fact that upgrading structures is a cumulative process makes it difficult to develop new specialisation patterns out of the blue. This presents a problem for countries where industrial restructuring is necessary. The centrality of institutions and policies in the process of structural change leads to a view that the general quality of institutions is important to structural change. Policies that foster structural adjustments should therefore be conceived in a broad way and cover such different areas as education, research, technology and innovation policies, while also focusing on the general quality of governance.

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ANNEX 1
DEFINITION OF PRODUCT SPACE INDICATORS

Product space indicators

Hidalgo et al. (2007) define the product space as a bi-partite network linking countries to products. To construct this network, they define a proximity measure, $\varphi_{i,j}$, between two products i and j as the pairwise conditional probability *P* of a country exporting one good given that it exports another. This measure is defined as follows:

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

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

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

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

where χ is unity if product *i* has an RCA>1 in country *k*. The neighbourhood density takes on the value 1 if a country produces all *i* products to which product *j* is connected in the product space. The neighbourhood density is therefore normalised between 0 and 1 and takes on the maximum when a product is connected to all other products in the product mix of a country.

The product complexity scores (PCS) have been calculated using the method of reflections advanced by Hidalgo - Hausmann (2009). It exploits information on the diversification of a country and the ubiquity of the products (i.e. in how countries have an RCA>1 for a given product). $M_{c,p}$ is the matrix linking product to countries and has an entry of 1 if country *c* has an RCA for product *p*. Then the matrix can be summed up row wise over products *p* one obtains a measure for the diversification of a country *c*.

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

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

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

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

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

and h*ow diversified the countries are that produce a specific product*

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

If formula (3) goes through an additional iteration the indicator now tells us how diversified countries are that export similar products as those exported by country *c*. An additional iteration for formula (4) tells us then how ubiquitous products are that are exported by product *p*'s exporters. Each additional iteration *n* adds information on the neighbour of a country or product that is *n* steps away from country *c* or product *p*. Higher iterations than those presented in the table are increasingly difficult to interpret. The indicator $k_{p.n}$ standardised relative to all products at iteration n gives the **product complexity score PCS**.

It is possible to calculate the simultaneous or slightly lagged appearance and disappearance of products using product space metrics. In this way a dynamic view is introduced in the product space analysis. We follow the method proposed by Klimek et al. (2012). To calculate the co-appearance and displacement indices define appearance and disappearance events as follows:

- Appearance: $A(i)_{c,t} = 1 \cdots$ if $v_{c,t-1} \leq 50000USD$ and $v_{c,t} > 50000USD$; $A(i)_{c,t} = 0 \cdots$ otherwise.
- Disappearance: $D(i)_{c,t} = 1 \cdots$ if $v_{c,t-1} > 50000USD$ and $v_{c,t} \leq 50000USD$; $D(i)_{c,t} = 0 \cdots$ otherwise,

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

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

whereas the empirical number of displacements over period *t* after the appearance of a product class *i* is given by

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

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

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

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

where $PA_{i,j} = \sum_t \sum_c A(i,j)_{c,t}$ is the number of appearances of each product class *i* and *j* across countries *c* and over all observation periods *t*, and $\mathcal{N}$ is the normalisation factor rescaling the sum to the established range.

The **displacement index DI** is instead defined as

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

Clearly, if the sum in equation (4) is negative, then product class i is on average displaced more often by appearances of the other product classes j during the period *t* A positive indicator value instead means that *i* displaces on average more often any other product class *j* than *j* replaces *i* after its appearance. *t* is again the normalisation factor rescaling the sum to the established range.

In order to analyse the displacement across NACE sectors we have aggregated the displacement scores $PAD_{i,j}^{(t)}$ as follows:

$$PADS_{k,l}^{(t)} = \frac{1}{\mathcal{N}} \sum_{i \epsilon S_l} \omega_i \sum_{j \epsilon S_k} \omega_j PAD_{i,j}^{(t)} \ for\ each\ j = 1..n \qquad (5),$$

where weights ω represent the share in total export value of sectors *k* and *l* of products *i* and *j* in Sector *S*. The weights therefore give higher importance to product class displacements that have a higher value in total exports of a NACE sector than those that have a lower value. For all calculations period *t* has been set to 3, i.e. we include all disappearance events three years after the appearance of a product in the counts.