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# SECTORAL SPECIALISATION IN THE EU

## A MACROECONOMIC PERSPECTIVE

by MPC task force
of the ESCB

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* see page 4.

**Address**
Kaiserstrasse 29
60311 Frankfurt am Main
Germany

**Postal address**
Postfach 16 03 19
60066 Frankfurt am Main
Germany

**Telephone**
+49 69 1344 0

**Website**
http://www.ecb.int

**Fax**
+49 69 1344 6000

**Telex**
411 144 ecb d

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## MPC TASK FORCE OF THE ESCB

This report has been drafted by an ad hoc Task Force on Sectoral Specialisation of the Monetary Policy Committee (MPC) of the European System of Central Banks. Its members comprised:

| | |
|---|---|
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| Ekkehard Ernst | European Central Bank, Secretariat |
| Christophe Madaschi | European Central Bank |
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# EXECUTIVE SUMMARY

Economic integration as experienced by European Union (EU) countries since the 1980s is thought to have the potential to result in important changes in the sectoral composition and thereby the macroeconomic dynamics of Member States. The aim of this report, which has been prepared by an ad hoc Task Force on Sectoral Specialisation of the Monetary Policy Committee of the European System of Central Banks (ESCB), is to review the main stylised facts concerning sectoral specialisation in EU countries and the changes that have occurred. The report assesses these developments from the point of view of their likely impact on the macroeconomy and their relevance for monetary policy.

Sectoral composition and changes in the economic structure are relevant for monetary policy for at least three reasons. Firstly, sectoral specialisation may have consequences for the transmission of monetary policy and other macroeconomic shocks. Second, sectoral specialisation may contribute to inflation developments, as different sectors may be characterised by different price dynamics. Finally, sectoral composition may shape potential growth and business cycle developments, thereby indirectly affecting inflationary pressures. This report analyses trends in sectoral specialisation observed over recent decades, with a particular emphasis on aspects related to the last channel mentioned above. This report also tries to assess whether the features of and changes in sectoral composition have significantly affected the conditions under which monetary policy operates in the euro area. In contrast, it is still too early to detect whether Economic and Monetary Union (EMU) has had any potential impact on the production structures of euro area countries. However, care must be taken when interpreting the results since changes might have taken place that would only be discernible when looking at finer definitions of sectors than those considered in this report.

The report draws the following conclusions:

– There are some indications that there are relatively few cross-country differences in sectoral specialisation in the EU and the euro area compared with other regions; in particular, the production structure of the EU/euro area appears to be more homogenous than that of the United States, an economic area of a similar size.

– As a general trend, the direction of sectoral re-allocation has been towards business sector services. Only in some EU countries is an increasing specialisation in relatively high-technology industries apparent.

– Synthetic measures of sectoral specialisation do not show much variation over time. However, there was a slight increase in sectoral specialisation for some smaller euro area countries as well as in Denmark and Sweden towards the end of the 1990s. This phenomenon is somewhat more evident within business sector services. As mentioned, it is too early to detect any potential impact of EMU on the production structures of euro area countries.

– The analysis of labour productivity developments indicates that aggregate labour productivity growth patterns have been predominantly shaped by intra-sectoral increases of labour productivity, rather than sectoral re-allocations, particularly in manufacturing. Sectoral re-allocations, however, have contributed positively to labour productivity developments in business sector services. Sectoral re-allocation accounts, on average, for as much as 50% of the increase of labour productivity growth in these activities in the euro area.

– While in the longer term the EU and the euro area have not systematically under-performed the United States in terms of productivity growth, European productivity slowed relative to that of the United States in the mid-1990s. At the sectoral level, this

widening difference of aggregate labour productivity developments between the United States and the EU/euro area in the second half of the 1990s is mainly explained by stronger labour productivity performance in the US wholesale and retail trade, in financial intermediation and in high-technology manufacturing sectors. However, care should be taken when comparing EU/euro area and US productivity data owing to data measurement issues, such as quality adjustments.

– Sectoral composition and changes therein seem to have had only a limited impact on shaping the business cycle fluctuations in EU countries. Rather, decreased aggregate output volatility has been driven by across-the-board decreases of sectoral output volatility. Nevertheless, the extent of the output volatility decline has not been the same in manufacturing and in services sectors. Moreover, despite some changes in sectoral composition between EU countries, business cycles became increasingly synchronised over the 1990s. In particular, exposed sectors contributed to increased business cycle synchronisation across Member States.

– The recent enlargement of the EU could entail an increase in the sectoral heterogeneity given that the new Member States are relatively more specialised in low-technology industries. However their pattern of specialisation is changing very quickly, and at least some of the new Member States have experienced strong convergence of their productive structures to the EU average.

Overall, sectoral specialisation and structural adjustments are relevant for the long-term growth potential of EU countries, affecting the "speed limit" at which the economy can grow without building up inflationary pressures. In this regard, while changes in sectoral specialisation in the EU over the past two decades have only been limited, sectoral re-allocations have contributed positively to labour productivity developments. Nevertheless, this positive contribution has been less significant than in the United States over the most recent period, indicating the need to improve the capacity of EU economies to adjust their productive structures. As far as business cycle synchronisation is concerned, given that the production structures of euro area countries appear to be relatively similar and have been fairly stable over time, misalignments in the business cycles of euro area economies, which could hinder the smooth conduct of the single monetary policy, are not quantitatively important. Indeed, over time, there has been a convergence towards more similar business cycle characteristics across euro area countries. These results may be seen as reassuring from a monetary policy point of view.

# I THE RELEVANCE OF SECTORAL SPECIALISATION FOR MONETARY POLICY



## 1.1 INTRODUCTION AND MOTIVATION

The introduction of the Single Market in 1993 and the implementation of the single monetary policy six years later contributed to the increasing integration of the economies of EU countries during the 1990s. The economic integration process experienced by EU countries can result in significant changes in the location of industry and the macroeconomic dynamics of Member States[1], although economic theory offers different predictions as to how product and factor market integration will affect cross-country differences in sectoral composition.

Sectoral specialisation is broadly understood as the degree to which suitably defined economic sectors attract larger shares of employment or output in one country relative to another. This report will review sectoral specialisation in EU countries – using the EU as a benchmark – and the changes that have taken place in the sectoral composition of output and employment – i.e. sectoral re-allocation[2] – from the point of view of their likely impact on the macro-economy and their relevance for monetary policy. In this regard, the report complements previous work undertaken by the European Commission and the OECD on the issue of sectoral specialisation.

In particular, the impact of sectoral specialisation on both productivity increases and business cycle developments will be addressed. Moreover, national inflation developments may be partly affected by sectoral composition on account of differences in price dynamics across sectors. Finally, sectoral specialisation may have an impact on the transmission mechanism through which monetary policy changes affect inflation dynamics. Nevertheless, these latter two points will not be followed up in this report.

## 1.2 THE RELEVANCE OF SECTORAL SPECIALISATION FOR MONETARY POLICY

Given that price dynamics differ between sectors, national inflation developments may be partly influenced by the sectoral specialisation of Member States[3]. Moreover, similar sectors could experience different price dynamics across countries; this can happen if, for instance, shocks are country-specific rather than sector-specific or if the ability to absorb common sectoral shocks varies across countries as a result of differences in the detailed economic structure of the sector concerned and the regulatory framework affecting this sector. Overall, the national inflation rates of EU countries can be temporarily influenced by the relative size of sectors with strong or weak price dynamics or by similar sectors experiencing different degrees of relative price adjustments.

Sectoral specialisation may have a bearing on the way monetary policy is conducted when it affects the transmission mechanisms of monetary policy. Existing studies[4] suggest that sectoral characteristics such as capital intensity, average firm size and – to a lesser extent – the degree of openness to foreign competition play an important role in determining the impact of monetary policy on sectoral output growth and inflation. For instance, sectors with higher capital intensity, lower average firm size and lower degrees of openness appear to be more affected by monetary policy changes. Consequently, cross-country differences within the euro area regarding the effects of monetary

1 The location of European industry has already been the subject of several reports, for instance by the European Commission, see K. H. Midelfart-Knarvik, H. G. Overman, S. J. Redding, and A. J. Venables (2000), "The Location of European Industry", report prepared for DG ECFIN, European Commission, Brussels.

2 Throughout this report the terms "sectoral re-allocation" and "structural adjustment" are used synonymously, referring to the change in sectoral composition of output or employment.

3 For a recent overview of inflation differentials and its causes across euro area countries see the MPC report on "Inflation differentials in the euro area: potential causes and policy implications", ECB, September 2003.

4 See, for instance, G. Peersman and F. Smets (2002), "The Industry Effects of Monetary Policy in the Euro Area", ECB Working Paper 165.

policy can be related to differences in the sectoral composition of member countries, as sectors respond in different ways to monetary shocks.

Regarding the long-run effects of specialisation, the literature on (endogenous) economic growth suggests that sectoral composition has a major impact on productivity growth[5]. On the one hand, sectors may differ with regard to their productivity potential, depending on fundamentals such as the scope for technological progress or economies of scale, but also on the regulatory framework under which firms operate in a particular sector[6]. On the other hand, structural adjustments where resources are shifted from low-productivity to high-productivity sectors are in themselves a source of improved long-term growth.

Sectoral specialisation may also affect short-run macroeconomic dynamics. Sectors may follow different patterns over the aggregate business cycle depending on their position in the value-added chain and their integration in world markets. Moreover, distinct product and production characteristics of sectors – such as the longevity of their products, the importance of inventories and the capital intensity – may trigger different reactions of sectors to similar shocks. Overall, this not only means that economies are exposed to different kinds of exogenous shocks but also that the way in which they respond to similar shocks differs. This is directly related to the relative magnitude and amplitude of the business cycles of Member States and to the synchronisation of business cycles across EU countries.

The aim of this section is to review some of the existing literature related to these issues. The next sub-section will look at the factors that affect the composition of a country's productive structure while the last sub-section will look at the impact of sectoral specialisation on business cycle evolutions.

## 1.3 ECONOMIC INTEGRATION AND SECTORAL SPECIALISATION

The process of EU integration may have constituted an important driver of sectoral trade and production specialisation of EU countries. However, the impact of economic integration and in particular trade integration on sectoral specialisation is thought to be ambiguous, and several channels through which product and factor market integration affect sectoral specialisation can be distinguished (see Chart 1).

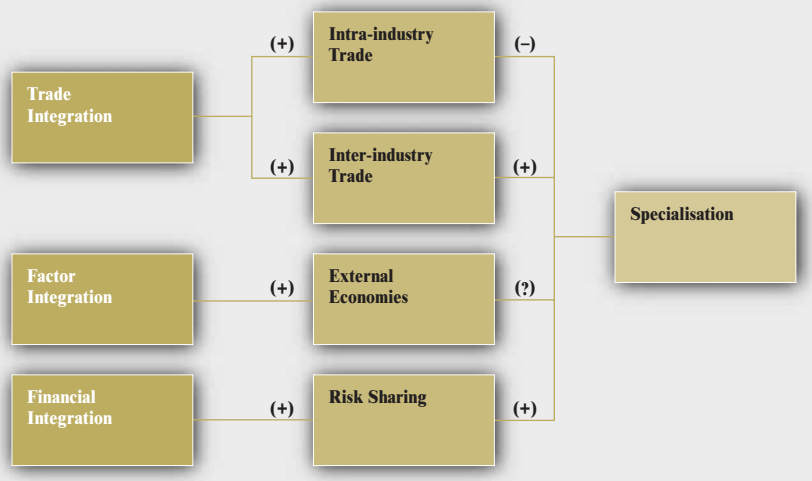
Classical trade theory suggests that economic integration and the elimination of obstacles to trade lead to greater divergence in the productive structures of countries and to an increase in inter-industry trade. Each country becomes specialised in producing those goods it has a comparative advantage in or a relatively lower opportunity cost in producing.

Introducing imperfect competition on product markets, the new trade theory by contrast suggests that economic integration leads to less inter-industry specialisation and a convergence of productive structures between countries. A more open access to markets allows for the exploitation of economies of scale and leads monopolistically competitive firms to specialise in producing different varieties of similar products resulting in an increase in intra-industry trade, which in turn is likely to reduce cross-country sectoral specialisation.

5 For instance, in a two-sector endogenous growth model, the growth rate depends on the size of the innovative sector, see R. E. Lucas Jr (1998), "On the mechanisms of economic development", Journal of Monetary Economics, no 2, pp 3-42, and P. Aghion and P. Howitt, (1992), "A model of growth through creative destruction", Econometrica, no 60/2, pp. 323-351.

6 For a recent study that has looked – among other things – at the impact of sectoral regulations on sectoral innovation intensity as an important determinant of productivity, see A. Bassanini and E. Ernst (2002), "Labour market institutions, product market regulation, and innovation: Cross-country evidence", OECD Economics Department Working Paper, no 316.

Chart I Economic Integration and Sectoral Specialisation




Notes: The signs in parentheses indicate the predicted direction of the effect of economic integration on sectoral specialisation depending on the underlying mechanism.
Note that the graph does not describe single-sided causal links, as trade and financial integration are themselves affected by specialisation and are thus endogenous variables.

In addition, the theory of New Economic Geography[7] highlights the existence of certain external effects or "economies of agglomeration" such as a pool of specialised suppliers, knowledge spillovers and specialised labour markets. These factors may lead to a concentration of industrial activity in certain countries or regions ("cumulative causation"). However, the spatial concentration of production implies specialisation in a particular sector or industry only if agglomeration forces are induced by spillovers that affect firms within the same industry rather than firms belonging to different industries; in the latter case, diverse industrial activities are pooled in certain regions ("cluster theory"). Nevertheless, the predictions for the distribution of activity arising from economic geography theory are ambiguous because agglomeration also creates congestion costs, thus offsetting the positive agglomeration effects.

Economic integration may diminish the importance of transport costs, reduce barriers to labour mobility and more generally lower transaction costs, which increases the likelihood of agglomeration dynamics. In this respect EMU constitutes an additional factor affecting productive structures, fostering intra-industry trade and thus reducing relative specialisation between countries beyond the supply-side effects that may be expected from reduced exchange rate volatility.[8] On the other hand, financial integration can also foster sectoral specialisation by facilitating risk-sharing among countries; this then allows them to fully exploit their comparative advantages through trade and specialisation.[9] Empirical studies, however, do not point to any major improvement of risk sharing for the euro area,[10]

7 P. Krugman (1991), "Increasing returns and economic geography", Journal of Political Economy; M. Fujita, P. Krugman, A. J. Venables (1999) – "The spatial economy. Cities, regions and international trade", MIT Press, Cambridge, MA.
8 J. Frankel and A. Rose (1998), "The Endogeneity of the Optimum Currency Area", Economic Journal, 108/449, pp. 1009-1025.
9 S. Kalemi-Ozcan, B. E. Sorensen and O. Yosha (2003), "Risk Sharing and Industrial Specialization: Regional and International Evidence", American Economic Review, no 93/3, pp. 903-918.
10 G. Moser, W. Pointner and J. Scharler (2003), "International Risk Sharing in Europe: Has Anything Changed?", OeNB Working Paper.

which is probably related to the limited changes in sectoral specialisation.

Therefore, economic integration does not necessarily lead to a monotonic relationship with sectoral specialisation. To the extent that economic integration raises the level of per capita income, particular patterns of changes in sectoral specialisation are possible. For instance, combining different hypotheses, Imbs and Wacziarg[11] conclude that economies may be able to undergo different stages of specialisation as income per capita grows. Countries may initially diversify but will then re-specialise at a relatively higher level of income per capita. However, even without changes in overall sectoral specialisation, one can expect that some sectoral re-allocation will take place to account for the significant changes in the economic environment.

## 1.4 SECTORAL DETERMINANTS OF BUSINESS CYCLE FLUCTUATIONS

Differences in sectoral specialisation across Member States have the potential to affect both the volatility and synchronisation of business cycles in the EU. In theory, the impact of changes of sectoral specialisation on business cycle characteristics is ambiguous and depends on the particular channels that underlie the change in the composition of the production structure (see Chart 2).

*Business cycle volatility* in the EU has experienced a marked decline over the last two decades. One suggested explanation for this regards the impact of stability-oriented policies that may have resulted, for instance, in the stabilisation of low inflation expectations (not shown in Chart 2). In addition, the decline in business cycle volatility can be related to additional factors:

– A *declining share of stock building* (which is highly pro-cyclical) as a share of GDP.[12]

– This in turn could be explained by a *shift of production towards the services sector* following increased global restructuring of manufacturing industries and improved inventory management. However, the increased share of services results partly from outsourcing processes, and outsourced services are likely to follow the more volatile cycle of industry. Thus the effect of services on overall volatility is ambiguous.

– In addition, *trade deepening* has also often acted to dampen the amplitude of cycles following the cushioning effect of a positive covariance between domestic demand and imports ("demand channel"); this effect, however, may have been reduced by the increasing share of non-traded services in GDP.

– *Increased financial market integration* may have had two opposite effects on business cycle volatility: while deepened capital markets make it possible to insure against shocks and to reduce volatility, a rise in the financial multiplier and contagion across countries and sectors may positively contribute to business cycle volatility.

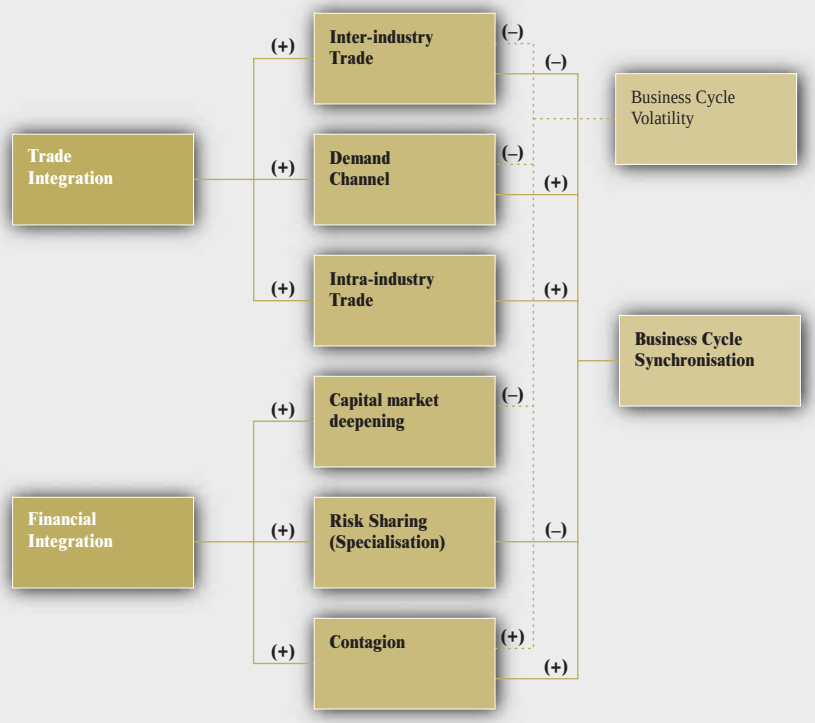
Meanwhile, there is evidence pointing to negative effects of differences in sectoral composition across countries on *business cycle synchronisation*.[13] However, as seen in the preceding section, sectoral specialisation can in itself be the result of trade and financial integration. Consequently, economic integration is likely to affect business cycle synchronisation, either directly through increased economic linkages or indirectly

11 J. Imbs and R. Wacziarg (2003), "Stages of Diversification", American Economic Review, 93/1, pp. 63-86.

12 T. Dalsgaard, J. Elmeskov and C. Park (2002), "Ongoing Changes in the Business Cycle – Evidence and Causes", OECD Economics Department Working Paper, 315; O. J. Blanchard and J. Simon (2001), "The Long and Large Decline in U.S. Output Volatility", Brookings Papers on Economic Activity, 1/2001, pp. 135-174.

13 See J. Imbs (2001), "Co-fluctuations", CEPR Discussion Paper, no 2267, and J. Imbs (2001), "Sectors and the OECD Business Cycle", CEPR Discussion Paper, no 2473 and references therein.

**Chart 2** Economic integration and business cycles




Note: The signs in parentheses indicate the predicted direction of the effect of economic integration on both business cycle volatility and business cycle synchronisation depending on the underlying mechanism. Dashed lines refer to mechanisms related to business cycle volatility; solid arrows refer to mechanisms related to business cycle synchronisation.

through processes of sectoral re-allocation and changes in sectoral specialisation.

Increased trade among member countries may indeed have opposite effects on business cycle synchronisation. On the one hand, increased intra-industry trade can lead to more synchronisation across member countries. Conversely, sectoral specialisation linked to inter-industry trade is thought to increase the importance of industry-specific shocks on the economy and thus to reduce synchronisation. Nevertheless, trade integration may also have a positive effect on business cycle synchronisation through its positive contribution to common aggregate demand shocks and productivity spillovers.[14] There is empirical evidence showing that, in the context of an integration process between countries with similar levels of development or similar factor endowments, the direct positive impact of trade on synchronisation usually dominates the negative effect of trade-induced specialisation.[15]

Increased financial integration in the EU is also likely to affect the business cycle synchronisation across Member States. However, in theory, the effect of intensified capital flows is twofold. On the one hand, freer capital flows have the potential to positively affect synchronisation owing to psychological

14 W. Gruben, J. Koo and E. Millis (2002), "How Much Does International Trade Affect Business Cycle Synchronization?", Federal Reserve Bank of Dallas Research Department Working Paper, 0203.

15 J. Imbs (2003), "Trade, Finance, Specialisation and Synchronization", CEPR Discussion Paper, 3779.

spillovers that raise the international correlation of developments on national financial markets. On the other hand, financial integration provides a means for cross-country risk-sharing that makes it possible to insure a country's national income against country-specific productivity shocks. The increased risk sharing would raise the business cycle synchronisation of GNP while the induced sectoral specialisation may lead to a decreased cyclical synchronisation of GDP.

Finally, an important feature of business cycles concerns the co-movement of different sectors within one country that occurs despite substantial differences in trend growth paths and degrees of volatility.[16] Sectoral co-movement may be related to aggregate shocks when sectors display similar reaction patterns. If sectoral co-movements are strong enough, individual sectors will display a common pattern despite the absence of any correlation across sector-specific shocks.[17] The extent to which economies are characterised by sectoral co-movement is of potential importance for business cycle synchronisation, as it would mitigate the negative impact of sectoral specialisation on the harmonisation of business cycles across EU countries.

Prominent explanations of sectoral co-movement stress either the sectoral linkages through a web of input-output relations or aggregate demand spillovers and trade externalities that underline the importance of sectoral shocks for disposable aggregate income.[18] In addition, frictions on capital, product and labour markets may also contribute to sectoral co-movement. For instance, when firms are paying efficiency wages, a sectoral shock is likely to have an impact upon the optimal wage-employment mix even in those sectors that are not directly affected by the shock. Similarly, when sectoral shocks affect the value of both tangible and intangible assets, a re-allocation process may be set off with repercussions for the aggregate economy.[19]

16 L. J. Christiano and T. J. Fitzgerald (1998), "The Business Cycle: It's Still a Puzzle", Economic Perspectives, Federal Reserve Bank of Chicago, Fourth Quarter.

17 R. E. Lucas Jr (1981), "Understanding Business Cycles", in Studies in Business-Cycle Theory, R. E. Lucas Jr (ed.), Cambridge, MA.

18 J. B. Long and C. I. Plosser (1983), "Real Business Cycles", The Journal of Political Economy, 91/1; K. M. Murphy, A. Shleifer and R. W. Vishny (1989) "Increasing Returns, Durables, and Economic Fluctuations", NBER Working Paper, 3014.

19 S. J. Davis, J. C. Haltiwanger and S. Schuh (1996), "Job Creation and Destruction", Cambridge, MA., pp. 106-108.

# 2 SECTORAL SPECIALISATION: CURRENT SITUATION AND EVOLUTION



During the past two decades, the construction of the Single Market and the inception of Economic and Monetary Union (EMU) has led to an increased integration of factor and product markets. This deepening of European economic integration is supposed to have induced significant sectoral re-allocations, resulting in a more efficient use of resources and fostering economic growth.

The present section examines the production structures in the EU and their dynamics over the last two decades. It seeks to compare the industrial structures and the speed of structural adjustment[20] in the EU and the United States. Finally, the analysis evaluates to what extent sectoral specialisation patterns and their dynamics have affected economic performance through their impact on aggregate labour productivity growth.

## 2.1 SECTORAL SPECIALISATION IN THE EURO AREA AND THE EU

This first sub-section looks at the production structures of EU countries and their dynamics over the last two decades. Table 1 provides a general overview of sectoral specialisation in EU countries and changes in their production structures over the last 20 years. In particular, it shows the shares in gross value added at constant prices of the main aggregate sectors (agriculture, manufacturing, business sector services and construction) for the years 1980, 1990 and 2001. Overall, it appears that the share of agriculture, manufacturing and construction have consistently decreased over time. The corollary of this pattern was a continuous increase in business sector services relative to the whole economy. However, the results for the individual countries with regard to the manufacturing sector provide a more mixed picture.

In order to obtain a more detailed picture regarding the relative specialisation of EU countries, Chart 3 plots the Krugman specialisation index[21] for the EU countries (for a discussion of the sectoral specialisation and industry concentration in Acceding Countries, see Box 2). In addition, Table 2 reports industry concentration indices across EU countries. The two indicators were calculated using gross value added at constant prices for the main aggregate sectors and the whole economy, as well as for different sub-periods between 1985 and 2001.

Overall, Chart 3 reveals that cross-country differences in sectoral specialisation have been rather limited in the EU[22]. The Krugman index reveals some cross-country heterogeneity in the degree of sectoral specialisation, with larger countries – on average – being usually less specialised with respect to the EU average, and smaller countries being relatively more specialised, with the exception of Germany and Spain that are relatively more specialised with respect to the EU and euro area average. This is probably due to the fact that large countries have a more diversified productive structure, reflecting, at least in part, the fact that scale economies may be exhausted for a larger number of industries. In addition, changes in sectoral specialisation across EU countries – when they happened – were relatively slow. It appears, therefore, that sectoral specialisation has been broadly unchanged when considering

20 Throughout this report the notions "sectoral re-allocation" and "structural adjustment" are used synonymously.

21 The Krugman specialisation index takes value zero if country I has an industrial structure identical to the rest of the EU, indicating that country I is not specialised, and takes a maximum value of 2 if it has no sectors in common with the rest of the EU, reflecting strong sectoral specialisation. The indicator can only be seen as a relative specialisation compared with a benchmark, which here is the EU; no absolute degree of specialisation can be assessed with this measure. It should be noted that the Krugman index has a tendency to under-represent the degree of specialisation of large countries; this is highlighted for instance when applying this index to EU regions (see for instance M. Hallet (2000) – "Regional specialisation and concentration in the EU" – Economic Paper 141, European Commission). See Annex 4.2.1.1 for details of the construction of this index.

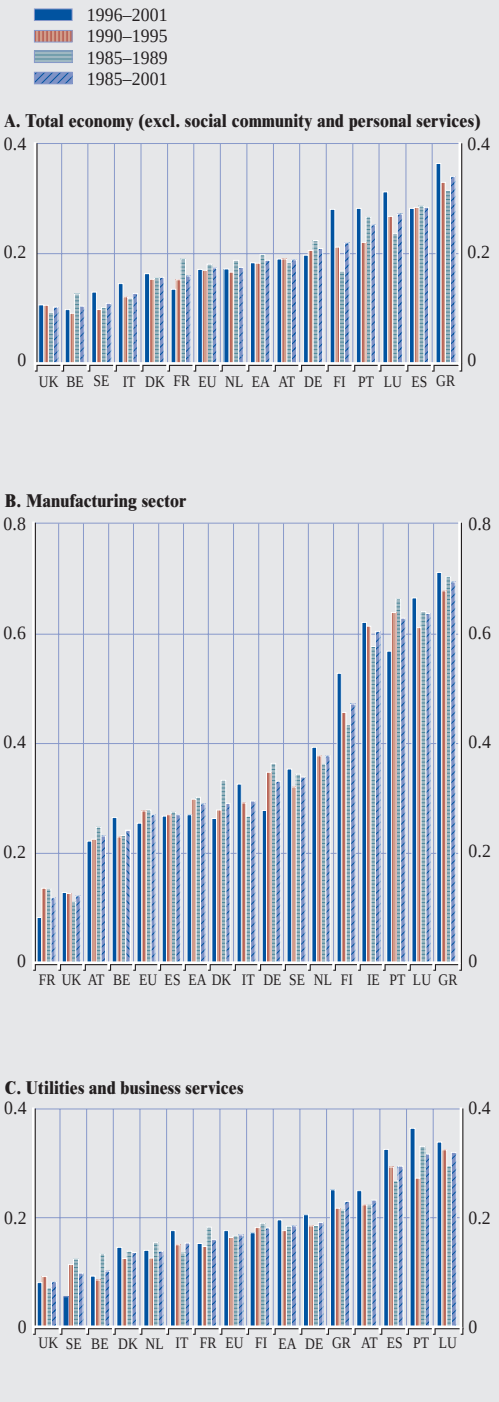
22 The indicator for the euro area presented in the above Chart is significantly lower than an average of US regions (see P. Krugman 1993, Geography and Trade, MIT Press Cambridge, p. 81). Moreover, comparing a selection of EU countries of similar size with US regions, Krugman finds that when indicators are constructed on a bilateral basis, they are systematically lower among European countries than among US regions, amounting to approximately 70% of US regional indicators.

## Table 1 Structure of value added at constant prices

(percentages of total value added)

| | Agriculture | Manufacturing | Business services | Construction | Other |
|---|---|---|---|---|---|
| **1980** | | | | | |
| Belgium | 1.4 | 19.9 | 43.0 | 6.9 | 28.8 |
| Germany | 1.5 | 28.0 | 36.6 | 8.6 | 25.4 |
| Greece | - | - | - | - | - |
| Spain | 7.4 | 19.9 | 44.9 | 6.9 | 20.8 |
| France | 3.6 | 21.5 | 43.7 | 7.0 | 24.2 |
| Ireland | 9.9 | - | - | - | - |
| Italy | 4.2 | 23.4 | 42.4 | 6.6 | 23.4 |
| Luxembourg | - | - | - | - | - |
| Netherlands | 2.7 | 17.5 | 41.3 | 7.9 | 30.6 |
| Austria | 2.5 | 20.9 | 39.9 | 8.7 | 28.0 |
| Portugal | 6.3 | 24.5 | 37.6 | 7.9 | 23.7 |
| Finland | 6.6 | 22.1 | 37.3 | 7.2 | 26.8 |
| euro area weighted average | 3.2 | 23.7 | 40.6 | 7.6 | 25.0 |
| Denmark | 2.8 | 18.3 | 43.9 | 6.4 | 28.5 |
| Sweden | 2.8 | 20.5 | - | 5.8 | - |
| United Kingdom | 2.1 | 24.6 | 42.2 | 5.2 | 25.9 |
| EU weighted average | 3.0 | 23.7 | 40.9 | 7.3 | 25.1 |
| **1990** | | | | | |
| Belgium | 1.4 | 21.5 | 44.4 | 5.3 | 27.4 |
| Germany | 1.4 | 26.1 | 41.5 | 6.8 | 24.1 |
| Greece | 8.5 | 14.7 | 49.4 | 7.9 | 19.5 |
| Spain | 5.9 | 18.5 | 44.8 | 8.0 | 22.8 |
| France | 3.2 | 18.3 | 48.3 | 6.7 | 23.4 |
| Ireland | 9.6 | 24.1 | 39.8 | 5.2 | 21.3 |
| Italy | 3.1 | 21.9 | 47.0 | 5.8 | 22.2 |
| Luxembourg | 1.0 | 14.5 | 49.1 | 6.7 | 28.7 |
| Netherlands | 3.3 | 17.9 | 43.2 | 6.3 | 29.2 |
| Austria | 2.3 | 20.7 | 44.2 | 7.0 | 25.9 |
| Portugal | 5.9 | 21.8 | 39.9 | 6.7 | 25.7 |
| Finland | 4.7 | 21.7 | 41.0 | 6.7 | 25.8 |
| euro area weighted average | 2.9 | 21.8 | 44.6 | 6.5 | 24.2 |
| Denmark | 3.4 | 16.9 | 45.9 | 5.1 | 28.7 |
| Sweden | 2.8 | 19.7 | 40.7 | 5.5 | 31.3 |
| United Kingdom | 2.0 | 22.6 | 45.0 | 6.0 | 24.4 |
| EU weighted average | 2.8 | 21.8 | 44.6 | 6.4 | 24.5 |
| **2001** | | | | | |
| Belgium | 1.5 | 20.6 | 46.3 | 4.9 | 26.6 |
| Germany | 1.2 | 20.1 | 48.0 | 4.8 | 25.8 |
| Greece | 8.1 | 12.4 | 54.8 | 7.6 | 17.1 |
| Spain | 4.0 | 18.7 | 45.7 | 8.1 | 23.5 |
| France | 3.1 | 19.2 | 48.7 | 4.3 | 24.6 |
| Ireland | 4.9 | 37.0 | 37.8 | 5.2 | 15.1 |
| Italy | 3.1 | 21.2 | 50.3 | 5.0 | 20.5 |
| Luxembourg | 0.6 | 11.5 | 56.3 | 5.6 | 26.1 |
| Netherlands | 3.0 | 16.9 | 49.6 | 5.2 | 25.3 |
| Austria | 2.4 | 21.2 | 46.7 | 7.1 | 22.6 |
| Portugal | 4.6 | 20.4 | 43.4 | 6.9 | 24.7 |
| Finland | 3.7 | 28.8 | 41.2 | 4.0 | 22.3 |
| euro area weighted average | 2.5 | 19.8 | 48.2 | 5.3 | 24.1 |
| Denmark | 3.7 | 16.6 | 48.4 | 4.3 | 27.0 |
| Sweden | 2.1 | 24.4 | 44.7 | 4.0 | 24.8 |
| United Kingdom | 1.3 | 18.3 | 50.9 | 4.8 | 24.7 |
| EU weighted average | 2.4 | 19.7 | 48.5 | 5.2 | 24.3 |

**Chart 3 Krugman specialisation index**




Sources: OECD, NCBs and ECB calculations.
Note: See Annex 4.1.1 for data details. The figures for the EU and the euro area refer to weighted averages of country indices.

measures at the national level, while we note a slight upward trend towards the end of the 1990s in smaller EU countries or, where large countries are concerned, at the regional level[23].

By and large, the cross-country heterogeneity of the Krugman index remains when looking separately at the manufacturing sector and the utilities and business sector services. Comparing manufacturing with utilities and business sector services shows that EU countries tend to be more specialised within manufacturing.[24] While the degree of specialisation within manufacturing has tended to decrease over time, utilities and business sector services have shown a tendency to become more specialised, albeit at a lower level than in manufacturing. One reason for these stronger cross-country differences of the Krugman index in manufacturing could be the higher tradability of manufacturing products.

Specialisation is a driving force of industry concentration across countries, as shown in Table 2. This table presents Balassa indices[25] for all country-industry pairs on a disaggregated level. These indices reflect the weight of a sector in the production of a particular country, relative to the weight of that sector in total EU production. A value greater than one indicates a relative specialisation of a country in a particular industry. Based on these Balassa indices, (relative) industry concentration can be assessed, calculating the weighted standard deviation across countries (last column in Table 2): the higher the indicator

23 See Hallet (1999), op. cit. Hallet uses the Eurostat REGIO database. Maps 1 and 2 in an annex of the paper illustrate the point. For instance, the pace of increase in the specialisation index is in the same range for, say, Finland and Ireland on the one hand, and nine out of the 22 French regions on the other.

24 Partly, this difference in the cross-country variance of the Krugman indicator between manufacturing and business sector services can be related to a different degree of sectoral detail: while 11 manufacturing sectors were available, only eight utilities and business sector services were taken into account for the Krugman indicator in the third column of Chart 3.

25 After B. Balassa (1965), "Trade liberalization and 'revealed' comparative advantage", The Manchester School of Economic and Social Sciences, no 33, pp. 99-123.

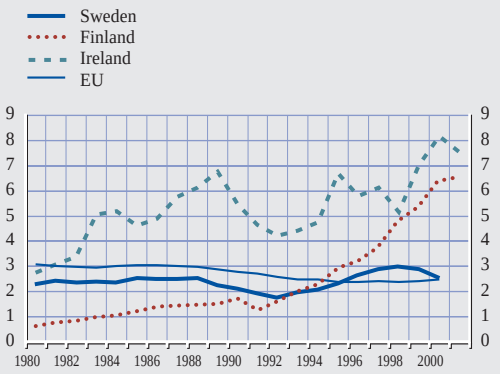
Box 1

## THE EVOLUTION OF THE ICT MANUFACTURING SECTORS IN IRELAND, FINLAND AND SWEDEN

Among the most notable changes in European industrial structure during the 1990s was the expansion of the information and communication technology (ICT) sectors in Ireland, Finland and, to a somewhat lesser extent, Sweden. The ICT sector tends to be characterised by the production of technologically intensive, high value added goods and, accordingly, is usually associated with strong productivity growth. This box presents some stylised facts relating to the expansion of the technology sectors in these countries as well as a description of some of the factors underpinning these developments[1]. Some of the spillover effects of the technology booms in Ireland, Finland and Sweden are also discussed.

Chart Share of ICT manufacturing sectors, gross value added as % of total manufacturing GVA

(current prices)




Source: NCBs.

The Chart shows the evolution of the share of gross value added for ICT manufacturing sectors in total manufacturing gross value added since 1980. The relative importance of the ICT manufacturing sectors in Ireland, Finland and Sweden relative to the European average is evident, although the share in Sweden has declined relative to the average in more recent years. It is also clear that the three countries have experienced quite different paths of development. In Ireland, there has been an expansion of the sector, from a high base, since the 1980s. The ICT sector in Finland started from a low base in the 1980s but expanded extremely rapidly during the 1990s. The sector developed less spectacularly in Sweden, although the share of the technology sectors also increased during the 1990s.

Table A gives some indication of the composition of the technology sectors across the three countries. Most of the activity in Finland is concentrated in the production of telecommunications products, and one company (Nokia) dominates. In Sweden the telecommunications sector also dominates, centred on one individual company (Ericsson), but there is more diversity than in Finland. In Ireland there is considerable diversity across all sub-components of the overall ICT sector, including computers, telecommunications and medical, precision and optical instruments.

The development of the ICT sector in Ireland was driven by inward direct investment by US companies. In 2000, the latest year for which details of ownership by sector are available, US firms accounted for around 85% of the total net output of the Irish ICT sector. A number of factors have made the Irish economy an attractive location for US multinationals in technology-intensive sectors, including generous corporate tax incentives, the development of the European

1 Note that the ICT-sector here is defined as the sum of sectors 30 to 33, which is a broader definition than the one used, for instance, by the OECD. A lack of data availability meant it was necessary to keep the definition of the ICT-sector on a two-digit level.

**Table A Composition of the ICT Sectors of Finland, Sweden and Ireland**

(percentages of total ICT GVA)

| | Office machinery and computers (30) | Electrical machinery and apparatus (31) | Radio, television and communication equipment (32) | Medical precision and optical instruments (33) |
|---|---|---|---|---|
| Finland | 0.1 | 12.3 | 78.3 | 9.3 |
| Sweden | 4.1 | 26.2 | 45.6 | 24.1 |
| Ireland | 30.6 | 13.3 | 34.3 | 21.8 |
| EU | 7.2 | 39.4 | 29.9 | 23.4 |

Source: NCBs.
Note: The composition of the ICT sector in Sweden is given for 2000, 2001 proving atypical owing to the effects of the slump in the telecommunications sector.

single market, the availability of a young, relatively well-educated workforce, a favourable regulatory environment for business as well as the language. In Finland the development of home-grown technology met with huge international demand in the 1990s. Supply conditions were facilitated by spare (labour) resources, particularly engineers, in the mid-1990s when Finland was in deep recession. The Swedish economy was also in recession in the early 1990s. With its high levels of technical expertise, gained through the development of telecom equipment and defence technology, Sweden was also well placed to benefit from the ICT boom of the 1990s.

**Table B R&D Intensities of the Technology Sectors**

| | Ireland | Finland | Sweden |
|---|---|---|---|
| R&D Intensity | 1.4 | 7.6 | 9.1 |

Source: NCBs.
Note: Business R&D expenditure as a % of total value added in 2001.

The R&D intensity of the technology sectors gives some insight into whether key functions are located in each country. In Ireland, for example, because most output is produced by US firms, the R&D intensity of the ICT sector is low for this sector, accounting for only 1.4% of output compared with an OECD average of 5.6% (see Table B). Both in Sweden and Finland R&D intensity is higher than the OECD average. The Finnish government has used horizontal state aid mainly to promote investment in research and development.

There is some evidence of spillover effects of the technology boom to the rest of the economy. In Ireland, the expansion of the ICT sector contributed to strong aggregate productivity growth during the late 1990s. There is also some evidence of beneficial linkages between the foreign-owned ICT sector and indigenous industry (as measured by expenditure on Irish raw materials and services as a percentage of sales) and increased start-ups of Irish tech firms, often by entrepreneurs in the software sector with experience in US multinational firms. In Finland, although the technology sector is very concentrated, it has added to the diversity of the economy as a whole and has reduced the dependence on forestry products. Empirical studies indicate that R&D has advanced the aggregate level of productivity in Finland. The advances are largest in the traded sectors and are typically brought about by plant level changes in the operation of existing companies. Geographically, labour productivity growth has been concentrated on the main business regions. In Sweden, other sectors of the economy have benefited from the telecom boom. The rapid growth of the internet coincided with and contributed to this boom.

The downturn in the global ICT sector since 2001 has had an effect on economic performance. Output and employment fell sharply in Ireland, but a buffer was provided for the economy, initially at least, by the continued strong performance of the chemicals sector and robust growth in domestic demand in 2001. In Finland, the downturn in global telecommunications demand has been associated with a slowdown in the previously rapid growth of the industry, but there are no signs of stagnation. The dominant company, Nokia, has managed to sustain good profitability with only minor layoffs. In Sweden, the contribution of the telecom product industry to GDP growth was negative in 2001 and 2002.

is, the more concentrated an industry is across countries[26].

Overall, the results indicate that in the period 1985-1989 production was in general not very concentrated across EU countries, with utilities and business sector services being less

26 M. Amiti (1997), "Specialisation patterns in Europe", CEP Discussion Paper, no 363, p. 6. The Balassa indices can be used either way: when the weighted standard deviation is calculated across industries (weighted by the industry shares), an index of country specialisation can be derived; calculating the standard deviation across countries (weighted by country shares) allows to draw conclusions about the relative concentration of industries. In a sense, (relative) industry concentration is the flip side of country specialisation.

**Table 2 Balassa and concentration indices**

(1985-1989)

| | BE | DE | GR | ES | FR | IE | IT | LU | NL | AT | PT | FI | DK | SE | UK | std. dev. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total manufacturing** | **0.97** | **1.21** | **0.74** | **0.87** | **0.85** | **1.27** | **0.99** | **0.70** | **0.81** | **0.94** | **1.04** | **1.01** | **0.80** | **0.94** | **1.02** | **0.04** |
| Food products, beverages and tobacco | 1.09 | 0.71 | 1.68 | 1.45 | 1.24 | 2.73 | 0.76 | 0.94 | 1.36 | 1.11 | 1.61 | 0.85 | 1.49 | 0.70 | 1.12 | **0.10** |
| Textiles, textile products, leather and footwear | 0.85 | 0.57 | 3.21 | 1.27 | 1.06 | 0.60 | 1.94 | 0.43 | 0.44 | 1.14 | 3.58 | 0.81 | 0.71 | 0.25 | 0.94 | **0.22** |
| Wood and products of wood and cork | 0.63 | 0.79 | 1.45 | 1.44 | 0.86 | 0.41 | 1.22 | - | 0.63 | 2.35 | 1.72 | 2.80 | 1.34 | 1.65 | 0.74 | **0.15** |
| Pulp, paper, paper products, printing and publishing | 0.72 | 0.82 | 0.62 | 1.02 | 0.98 | 0.83 | 0.69 | 0.74 | 1.32 | 0.92 | 1.10 | 2.86 | 1.50 | 2.07 | 1.27 | **0.13** |
| Rubber, plastics and fuel products | 0.94 | 0.97 | 2.39 | 1.06 | 0.92 | 0.53 | 1.29 | 2.16 | 0.80 | 0.62 | 0.46 | 0.67 | 1.04 | 0.84 | 1.03 | **0.07** |
| Chemicals and chemical products | 1.58 | 0.96 | 0.66 | 1.06 | 1.01 | 1.77 | 0.88 | 0.49 | 1.74 | 0.65 | 0.95 | 0.67 | 0.72 | 0.75 | 1.00 | **0.07** |
| Other non-metallic mineral products | 0.94 | 0.79 | 1.16 | 1.48 | 1.08 | 0.82 | 1.22 | 1.81 | 0.94 | 1.64 | 1.73 | 0.83 | 1.10 | 0.64 | 0.89 | **0.07** |
| Basic metals and fabricated metal products | 1.32 | 0.94 | 0.67 | 1.01 | 1.08 | 0.33 | 1.09 | 2.86 | 0.96 | 1.21 | 0.43 | 0.76 | 0.71 | 1.05 | 1.02 | **0.04** |
| Machinery and equipment | 0.75 | 1.38 | 0.23 | 0.48 | 0.81 | 0.94 | 0.89 | 0.67 | 0.81 | 0.95 | 0.36 | 0.84 | 1.04 | 1.01 | 0.90 | **0.08** |
| Transport equipment | 1.05 | 1.32 | 0.28 | 0.95 | 1.02 | 0.16 | 0.72 | 0.10 | 0.42 | 0.47 | 0.32 | 0.56 | 0.33 | 1.43 | 0.96 | **0.07** |
| Manufacturing NEC; recycling | 0.89 | 0.88 | 1.08 | 1.06 | 0.99 | 0.93 | 1.13 | 0.27 | 1.73 | 1.38 | 0.76 | 0.81 | 1.67 | 0.52 | 0.97 | **0.07** |
| *Low technology intensity* | 1.00 | 0.66 | 2.27 | 1.38 | 1.17 | 1.90 | 1.22 | 0.67 | 1.00 | 1.12 | 2.37 | 0.84 | 1.19 | 0.52 | 1.05 | **0.10** |
| *Medium-low technology intensity* | 0.75 | 0.83 | 0.86 | 1.09 | 0.97 | 0.80 | 0.88 | 0.50 | 1.33 | 1.24 | 1.10 | 2.32 | 1.52 | 1.60 | 1.12 | **0.09** |
| *Medium-high technology intensity* | 1.15 | 0.92 | 1.19 | 1.12 | 1.04 | 0.48 | 1.16 | 2.50 | 0.92 | 1.15 | 0.71 | 0.75 | 0.87 | 0.91 | 1.00 | **0.04** |
| *High technology intensity* | 1.00 | 1.27 | 0.34 | 0.72 | 0.90 | 0.94 | 0.85 | 0.48 | 0.92 | 0.76 | 0.48 | 0.74 | 0.79 | 1.05 | 0.94 | **0.05** |
| **Business sector services and utilities** | **1.03** | **0.97** | **1.16** | **1.09** | **1.10** | **-** | **1.08** | **1.09** | **1.01** | **1.05** | **0.95** | **0.97** | **1.05** | **-** | **1.03** | **0.02** |
| Electricity, gas and water supply | 1.22 | 1.07 | 0.71 | 1.20 | 0.85 | - | 0.98 | 0.60 | 0.91 | 1.20 | 1.39 | 1.06 | 0.81 | - | 0.98 | **0.04** |
| Construction | 0.79 | 1.19 | 1.12 | 1.03 | 0.88 | - | 0.89 | 1.02 | 1.04 | 1.11 | 1.21 | 1.11 | 0.93 | - | 0.88 | **0.04** |
| Wholesale and retail trade | 1.21 | 0.93 | 1.06 | 0.98 | 0.81 | - | 1.13 | 0.94 | 1.18 | 1.10 | 1.48 | 1.09 | 1.19 | - | 0.95 | **0.04** |
| Hotels and restaurants | 0.52 | 0.54 | 2.31 | 2.22 | 1.03 | - | 1.13 | 0.96 | 0.61 | 1.43 | 1.01 | 0.56 | 0.52 | - | 1.05 | **0.17** |
| Transport and storage | 1.01 | 0.74 | 0.77 | 1.15 | 0.85 | - | 1.19 | - | 1.13 | 1.20 | 1.05 | 1.65 | 1.16 | - | 1.16 | **0.06** |
| Post and telecommunications | 1.09 | 1.14 | 0.89 | 0.88 | 0.90 | - | 0.67 | - | 1.12 | 1.12 | 0.89 | 0.86 | 0.87 | - | 1.14 | **0.04** |
| Financial intermediation | 0.85 | 0.86 | 0.66 | 1.20 | 1.05 | - | 0.94 | 3.15 | 1.10 | 1.08 | 0.76 | 0.93 | 1.07 | - | 1.04 | **0.06** |
| Real estate, renting and business activities | 0.98 | 1.09 | 0.91 | 0.65 | 1.16 | - | 0.90 | 0.90 | 0.85 | 0.67 | 0.60 | 0.81 | 0.92 | - | 0.96 | **0.04** |

concentrated than manufacturing industries. Within the former, hotels and restaurants and financial intermediation were particularly concentrated across EU countries. With regard to the manufacturing sectors, Balassa indices for products in low technology intensity sectors showed relatively higher values in Portugal, Greece and Ireland. By contrast, medium-high and high technology intensity industries had relatively higher Balassa indices in Sweden, Luxembourg and Germany during the same period. At the end of the 1990s, products in low technology intensity sectors remained relatively more concentrated than industries in medium-high and high technology intensity industries. For the former, Balassa indices had some importance in Portugal and Greece and to a lesser extent in Italy and Spain. Balassa indices in medium-low technology intensity industries had been relatively higher in Scandinavian countries as well as in Austria, the Netherlands and Portugal during the 1980s and the 1990s. Medium-high technology intensity industries showed more important Balassa indices in Luxembourg over the two periods, and to a lesser extent in Austria, Italy and Spain. Finally, values for the Balassa index in high technology intensity industries were relatively higher in Germany and Sweden during the 1980s, while this group was joined by Ireland and to a lesser extent Belgium and the UK at the end of the 1990s and the beginning of the 2000s. In some countries, such as Ireland and Finland (see Box 1 for a discussion of the evolution of the ICT sector in Ireland, Finland and Sweden), there has been a particularly rapid

**Table 2 Balassa and concentration indices (cont')**

(1996-2001)

| | BE | DE | GR | ES | FR | IE | IT | LU | NL | AT | PT | FI | DK | SE | UK | std. dev. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total manufacturing** | **1.02** | **1.05** | **0.63** | **0.94** | **0.94** | **1.42** | **1.06** | **0.60** | **0.84** | **1.01** | **1.03** | **1.35** | **0.81** | **1.17** | **0.96** | **0.03** |
| Food products, beverages and tobacco | 1.06 | 0.78 | 1.97 | 1.29 | 1.12 | 1.47 | 0.83 | 0.60 | 1.57 | 1.04 | 1.25 | 0.69 | 1.54 | 0.63 | 1.12 | 0.07 |
| Textiles, textile products, leather and footwear | 1.22 | 0.45 | 3.81 | 1.39 | 0.87 | 0.28 | 2.49 | 1.45 | 0.43 | 0.81 | 3.94 | 0.37 | 0.56 | 0.18 | 0.83 | 0.32 |
| Wood and products of wood and cork | 0.67 | 0.97 | 1.33 | 1.14 | 0.68 | 0.30 | 1.25 | 0.00 | 0.61 | 2.26 | 2.04 | 2.28 | 1.17 | 1.97 | 0.56 | 0.14 |
| Pulp, paper, paper products, printing and publishing | 0.76 | 0.82 | 0.67 | 0.93 | 0.91 | 1.13 | 0.74 | 0.62 | 1.38 | 1.03 | 1.09 | 2.49 | 1.14 | 1.76 | 1.32 | 0.11 |
| Rubber, plastics and fuel products | 0.87 | 0.97 | 1.18 | 1.23 | 1.10 | 0.32 | 1.07 | 2.68 | 0.80 | 1.27 | 0.41 | 0.60 | 0.88 | 0.56 | 1.08 | 0.05 |
| Chemicals and chemical products | 1.84 | 0.96 | 0.58 | 0.83 | 1.00 | 3.24 | 0.79 | 0.63 | 1.50 | 0.58 | 0.61 | 0.54 | 1.16 | 0.83 | 1.05 | 0.14 |
| Other non-metallic mineral products | 1.00 | 0.90 | 1.41 | 1.63 | 0.97 | 0.53 | 1.30 | 1.77 | 0.84 | 1.30 | 2.37 | 0.56 | 0.96 | 0.38 | 0.73 | 0.10 |
| Basic metals and fabricated metal products | 1.16 | 1.04 | 0.67 | 0.98 | 0.99 | 0.20 | 1.17 | 2.62 | 0.91 | 1.19 | 0.44 | 0.84 | 0.81 | 1.02 | 0.87 | 0.04 |
| Machinery and equipment | 0.65 | 1.23 | 0.32 | 0.60 | 0.93 | 1.04 | 0.90 | 0.47 | 0.76 | 0.99 | 0.44 | 1.45 | 1.05 | 1.28 | 0.99 | 0.06 |
| Transport equipment | 0.99 | 1.35 | 0.44 | 1.14 | 1.09 | 0.16 | 0.55 | 0.05 | 0.44 | 0.56 | 0.87 | 0.34 | 0.32 | 1.21 | 1.03 | 0.08 |
| Manufacturing NEC; recycling | 0.76 | 0.74 | 1.82 | 1.16 | 1.06 | 0.64 | 1.28 | 0.91 | 1.83 | 1.40 | 1.16 | 0.60 | 1.55 | 0.53 | 0.95 | 0.09 |
| *Low technology intensity* | 1.11 | 0.67 | 2.57 | 1.32 | 1.04 | 1.08 | 1.37 | 0.88 | 1.20 | 0.97 | 2.12 | 0.58 | 1.22 | 0.48 | 1.03 | 0.10 |
| *Medium-low technology intensity* | 0.75 | 0.82 | 1.05 | 1.02 | 0.91 | 0.89 | 0.95 | 0.59 | 1.38 | 1.30 | 1.25 | 1.99 | 1.24 | 1.49 | 1.12 | 0.07 |
| *Medium-high technology intensity* | 1.05 | 0.99 | 0.96 | 1.18 | 1.01 | 0.30 | 1.17 | 2.48 | 0.87 | 1.24 | 0.83 | 0.72 | 0.86 | 0.77 | 0.90 | 0.04 |
| *High technology intensity* | 1.02 | 1.20 | 0.41 | 0.78 | 0.98 | 1.38 | 0.79 | 0.42 | 0.87 | 0.79 | 0.58 | 0.97 | 0.91 | 1.16 | 1.01 | 0.04 |
| **Business sector services and utilities** | **0.98** | **1.00** | **1.12** | **1.01** | **0.99** | **-** | **1.02** | **1.13** | **1.00** | **1.02** | **0.94** | **0.86** | **0.97** | **0.92** | **1.01** | **0.01** |
| Electricity, gas and water supply | 1.39 | 0.91 | 0.95 | 1.26 | 1.04 | - | 0.93 | 0.53 | 0.73 | 1.21 | 1.39 | 1.17 | 0.98 | 1.23 | 0.97 | 0.04 |
| Construction | 0.93 | 1.07 | 1.17 | 1.42 | 0.82 | - | 0.92 | 0.95 | 0.96 | 1.40 | 1.35 | 0.95 | 0.89 | 0.82 | 0.89 | 0.05 |
| Wholesale and retail trade | 0.94 | 0.89 | 1.19 | 1.00 | 0.92 | - | 1.18 | 0.85 | 1.25 | 1.12 | 1.44 | 1.01 | 1.24 | 1.05 | 1.03 | 0.04 |
| Hotels and restaurants | 0.60 | 0.45 | 2.61 | 2.79 | 1.02 | - | 1.35 | 0.74 | 0.73 | 1.48 | 1.02 | 0.67 | 0.66 | 0.60 | 0.99 | 0.24 |
| Transport and storage | 1.04 | 0.77 | 0.82 | 1.25 | 0.98 | - | 1.18 | - | 1.12 | 1.08 | 0.79 | 1.85 | 1.29 | 1.21 | 1.10 | 0.06 |
| Post and telecommunications | 0.85 | 1.13 | 1.01 | 0.89 | 0.93 | - | 0.74 | - | 1.05 | 0.88 | 1.08 | 1.16 | 0.88 | 1.02 | 1.25 | 0.04 |
| Financial intermediation | 1.14 | 1.01 | 0.79 | 0.91 | 0.82 | - | 1.10 | 3.76 | 1.06 | 1.23 | 1.39 | 0.80 | 0.91 | 0.98 | 1.11 | 0.09 |
| Real estate, renting and business activities | 1.05 | 1.17 | 0.77 | 0.65 | 1.17 | - | 0.87 | 0.74 | 0.91 | 0.70 | 0.56 | 0.90 | 0.94 | 1.03 | 0.96 | 0.05 |

Sources: OECD, European commission, NCBs and ECB calculations.
Note: For the industry classification, see Annex 4.1.1. For Greece the available series start in 1988 only. The standard deviation (std. dev.) refers to weighted figures (country weights).

change in the industry structure related to the increasing share of ICT in these countries.

Regarding utilities and business sector services, only hotels and restaurants and financial intermediation remained spatially concentrated during the second half of the 1990s. These results relate to the relative importance of Balassa indices in tourism in Spain, Austria, Italy and Greece[27] on the one hand and the strong weight of the financial sector in Luxembourg on the other hand. While changes in concentration are usually slow, they have been discernible for financial intermediation and construction in some countries. Where construction is concerned, this may reflect a strong need for infrastructures and the expansion of housing investment in some of these countries stemming partly from the decline in interest rates in these countries associated with the EMU process.

Comparing the two periods 1985-1989 and 1996-2001, manufacturing industry appears to be somewhat more evenly spread (standard deviation declines from 0.04 to 0.03). This reflects opposing forces at work at the sector levels. Sectors with a low to medium technology content and/or low growth prospects and highly tradable products have achieved productivity gains mainly through consolidation or concentration – this consolidation process making it possible to inject additional technological content. This has resulted in changes of concentration indices at the country level and in an increase in the standard deviation (see textiles, for example). On the other hand, sectors with fewer tradable goods – requiring proximity between the manufacturing base and the consumer markets – have remained more evenly spread (see food products, for example). The relative weight of the sectors with a location driven by the "home-market bias" has naturally increased faster in countries where this market segment was converging towards the average euro area pattern (see transport equipment in Spain and Portugal, for example). Finally, sectors with a high technology intensity are widespread across the euro area. This highlights the fact that the location of innovative sectors depends on multiple parameters, and that concentration dynamics usually do not shape emerging sectors, but play a greater part later, when the new sectors enter the maturity phase (for example, the standard deviation of "high tech intensity sectors" changed slightly from 0.05 to 0.04, reflecting the fact that ICT innovations shaped the 1990s more than the 1980s).

Similar developments have been experienced by some of the EU acceding countries, as described in Box 2.

27 Data for hotels and restaurants are missing for Greece for the 1980s.

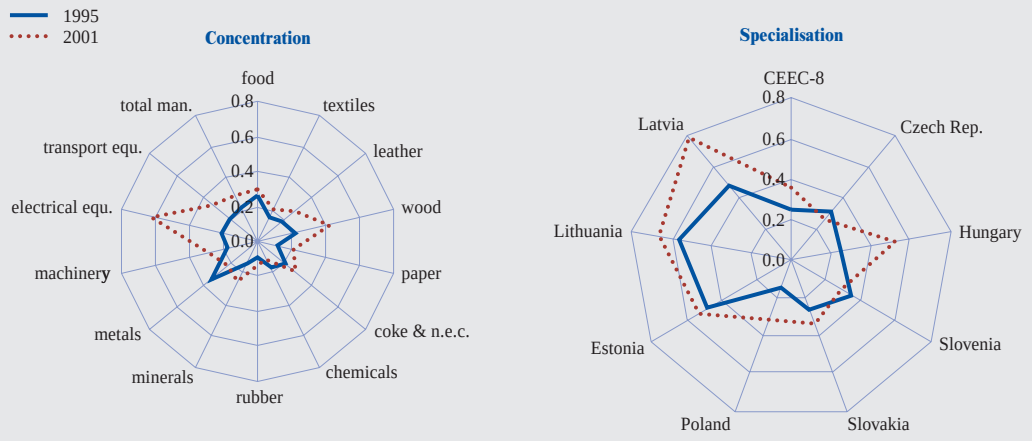
**Box 2**

### EVOLUTION OF SPECIALISATION AND CONCENTRATION IN THE NEW MEMBER STATES

Since the start of the transition in the late 1980s, the countries of central and eastern Europe have experienced fundamental restructuring processes leading to sectoral convergence towards western European patterns. Nevertheless, despite the relative and absolute decline of agricultural output and the increasing importance of services during the 1990s, the share of the primary (tertiary) sector is still higher (smaller) in the CEEC-8 than in the EU-15. The relative reduction of industrial production led to output shares matching those of the EU, with the exception of the higher shares in the Czech Republic.

Compared to the EU-15, specialisation is more pronounced in the CEEC-8. Mirroring western European development, the majority of CEECs became more specialised in the second half of the

**Specialisation and concentration of CEEC manufacturing industries**




Sources: wiiw Industrial Database; OeNB and wiiw calculations.
Note: In both cases a Krugman index is calculated (Midelfart-Knarvik et al., 2000) using real output data for eight acceding eastern European countries and 13 manufacturing industries defined at the NACE, rev. 1, 2-digit level (letter code). For reasons of data availability, the presentation of Chart 1 differs from the tables and figures in the main text.

1990s, notably Hungary, Latvia, Lithuania, and Poland (see left panel of Chart 1). The reasons for this differ across countries: Hungary has undergone substantial restructuring, which is strongly connected to the vast inflows of FDI into the country; in contrast, the increase in Poland is explained by its low initial degree of specialisation (by 2001, the degree of specialisation in Poland had reached the average CEEC-8 level, with a strong impact on the latter); meanwhile, the Baltic states increasingly specialised in the wood and plastic industries.

The concentration indices (see Chart above, right panel) reveal an increase in the regional concentration of manufacturing output in eastern Europe. In particular, the manufacturing of electrical and optical equipment, a typical technology and skill-intensive industry, has become strongly concentrated in Hungary. Its share of total CEEC-8 manufacturing output in this industry doubled from 23% in 1995 to 46% in 2001, while the share of this industry in total Hungarian manufacturing output increased from 8% to 31%. Thus, the manufacturing of electrical and optical equipment shows the highest degree of regional concentration in eastern Europe. The second-most concentrated industry is the wood industry, which has increasingly moved to the Baltic states and is still strongly concentrated in Poland. The transport industry has also become more concentrated, with production moving increasingly to Hungary and Slovakia. Only two industries have spread across the region: the metal industry, which was the most concentrated industry in 1995, ranked ninth in 2001, while the chemical industry, ranking sixth in 1995, was the least concentrated industry in 2001. This tallies with the lowest output growth rates for these industries in eastern Europe, apart from the absolute decline in the production of textiles.

Thus, a substantial amount of restructuring took place in the acceding countries, leading to greater similarities between them and the existing Member States. Convergence results from the relative decline of initially important, labour-intensive and low value added activities like the processing of food, textiles, metals and coke and the simultaneous expansion of initially less

important, more capital-intensive industries. A gradual upgrading of skills can be deduced from the increase of medium skill-intensive industries (plastics, paper, wood). CEECs also strengthened their comparative advantage in the production of motor vehicles. Moreover, there has been a strong rise in the output of the technology-driven electrical industry, which has more than tripled since 1995.

**References:**
K. H. Midelfart-Knarvik, H. G. Overmann, S. J. Redding and A. J. Venables (2000), "The Location of European Industry", Economic Papers 142, prepared for the Directorate-General for Economic and Financial Affairs, European Commission.
H. Handler (2003), ed., "Structural Reforms in the Candidate Countries and the European Union", Austrian Ministry for Economic Affairs and Labour, Economic Policy Section, Vienna.

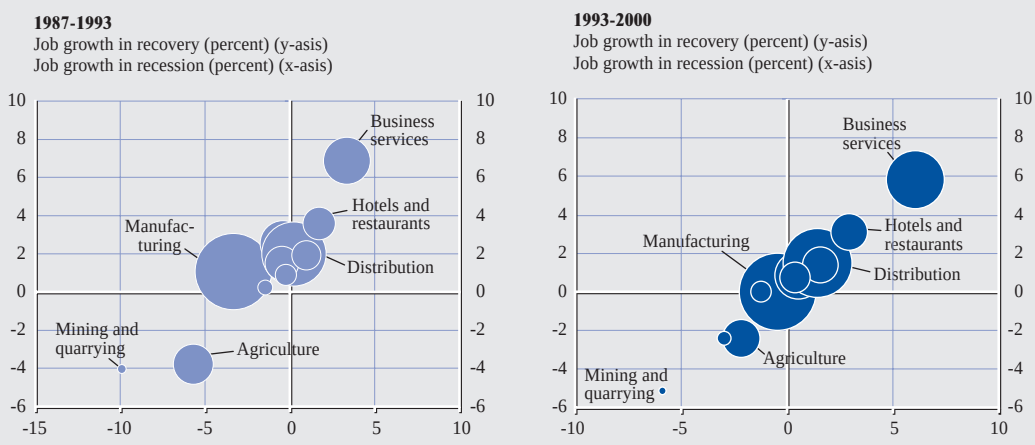
## 2.2 SECTORAL RE-ALLOCATION

Differences in specialisation patterns may be reflecting the variation in the speed of structural adjustment across EU countries or regions. Indeed, structural adjustment has been a continuous characteristic of the business cycles over the last 15 years for the euro area (see Chart 4). When accounting for employment gains and losses during booms and recessions in the two business cycle periods 1985-1993 and 1995-2000, the data indicate that there has been a continuous increase in the relative importance of the services sectors, while manufacturing, agriculture and mining and quarrying have lost weight in total employment. This gives an indication as to the importance of structural adjustments over the business cycle. Finally, the comparison of the cycle 1987-1993 with 1993-2000[28] shows that sectoral re-allocation has been a persistent feature of the euro area for the last two decades, contrary to the US experience where structural adjustment was mainly a feature of the 1990s[29].

28 Cycles have been determined on a trough-by-trough basis; for the period 1993-2000 the small sub-cycles 1993-1997 and 1997-1999 have been subsumed under one cycle encompassing the entire period (see also section 3.1 where the cyclical behaviour of euro area GDP is discussed in more detail).

29 See E. L. Groshen and S. Potter (2003) "Has Structural Change Contributed to a Jobless Recovery", Federal Reserve Bank of New York, Vol. 9, no 8 for a comparison with cyclical and structural job adjustments in the United States for the business cycles in the early 1980s and the late 1990s.

**Chart 4 Euro area business cycles and structural adjustment**



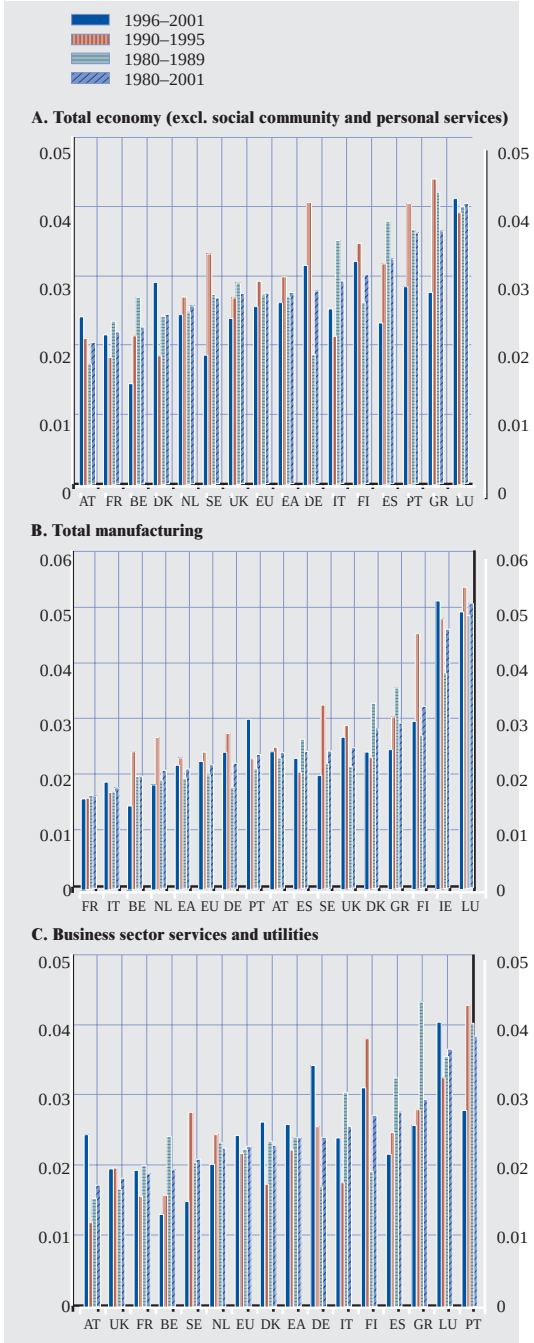

Sources: Eurostat, NCBs, ECB calculations.
Note: The size of the circles refer to the average share of the sector in the euro area over the indicated period. Sector names have been added only for selected sectors.

Moreover, an analysis of the speed of sectoral re-allocation could reveal information about the adaptability of production to changes in domestic and international demand. Chart 5 plots the Lilien indicator based on employment data, measuring the speed of structural adjustment across EU countries for the period 1980-2001. A relatively high value of this indicator indicates relatively rapid re-allocations across sectors.

The indicator reveals some cross-country heterogeneity that, after a peak at the beginning of the 1990s, then dipped again to below its initial value: the coefficient of variation increased from 0.233 to 0.268 during 1990-1995 and returned to 0.229 at the end of the 1990s, indicating a slowdown of sectoral re-allocation at the end of the 1990s in the more dynamic countries. During the 1980s, structural adjustments were particularly rapid in Luxembourg, Spain, Portugal, Greece and Italy, translating the impact of the EU accession for Greece, Portugal and Spain and a period of industrial restructuring in Italy. At the beginning of the 1990s, structural adjustment significantly accelerated compared with the EU average in Germany, Finland and Sweden, reflecting the impact of German re-unification and the strong economic recession, followed by important structural reforms in Finland and Sweden. At the end of the 1990s, sectoral re-allocations continued at a relatively higher rate in Luxembourg, Finland, Germany and Portugal, and accelerated in Denmark.

Comparing these results with the Krugman index presented earlier, it appears that the relatively rapid structural adjustments that have occurred in some countries (such as Luxembourg, Portugal, Greece and Finland) over the last 20 years have induced an increase in sectoral specialisation in these countries. This result seems to suggest that there were significant structural adjustments during the first half of the 1990s. It is important to bear in mind, however, that the speed of sectoral re-allocations as measured here may underestimate the actual extent of industrial restructuring: the

**Chart 5 Lilien indicator**




Sources: OECD, European commission, NCBs and ECB calculations.
Note: See Annex 4.2.1 for the calculation of the Lilien indicator. Data for Greece start from 1988, for Luxembourg from 1985 and for the Netherlands from 1987 for the whole economy. For reasons of data availability, the business sector services are composed of the three main aggregates for Belgium, Greece and the United Kingdom. The figures for the EU and the euro area refer to weighted averages of country indices.

Lilien indicator only partly reflects the adaptability of production in a country to changes in domestic and international demand, given that considerable adjustment occurred within, rather than between, sectors[30].

Comparing the speed of structural adjustments between manufacturing on the one hand and utilities and business sector services on the other, Chart 5 reveals that over the last 20 years sectoral re-allocations have been more rapid within manufacturing than within utilities and business sector services. Moreover, while structural adjustment significantly slowed during the 1990s within utilities and business sector services, it only slowed significantly from the end of the 1990s in manufacturing, after a strong acceleration at the beginning of the 1990s.

## 2.3 SECTORAL COMPOSITION AND PRODUCTIVITY

Sectoral specialisation and its evolution are likely to affect the labour productivity growth experienced by EU countries. This sub-section provides an overview of labour productivity growth across sectors and countries over the last 15 years for EU countries and for the United States. Moreover, it determines for the manufacturing sector the contribution to labour productivity growth of different sub-sectors, clustered as high, medium-high, medium-low and low technology intensity sectors. Finally, it determines to what extent aggregate labour productivity growth has been driven by shifts in sectoral composition, carrying out a shift-share analysis of labour productivity growth.

### 2.3.1 SECTORAL LABOUR PRODUCTIVITY DEVELOPMENTS

Table 3 shows labour productivity growth, measured as the gross value added at constant prices divided by total employment, for EU countries as well as the EU, the euro area and the United States over the period 1985-2001 and for the sub-periods 1985-1990 and 1996-2001. The table displays data for the aggregate economy, for the manufacturing sectors and for the utilities and business sector services. Caveats concerning the difficulties of measuring output in the service sectors must be borne in mind and caution is required when interpreting labour productivity growth developments in services, especially in some sub-sectors[31]. Moreover, given the lack of data availability, it was not possible to measure sectoral labour productivity per hours worked. Labour productivity growth may therefore be underestimated in some countries or sectors, where the proportion of part-time workers has increased notably[32].

The table reveals that differences in productivity growth seem to be as significant across sectors as across countries, meaning that country and sector characteristics are both important in determining labour productivity growth.

Regarding sectoral labour productivity developments of main aggregates in the EU (euro area), Table 3 shows that on average labour productivity growth performance was the highest in the electricity, gas and water supply sector when measured over the entire period. Moreover, labour productivity growth was on average twice as high in the manufacturing sector as it was in business sector services. Within the manufacturing sector, labour productivity growth was the highest in the high technology intensity sector, and here in particular in the "machinery and equipment" sector. The very high productivity growth in this sector in the United States further highlights the importance of ICT investment for productivity. Within business sector services, labour productivity growth was by far the highest in the post and telecommunications sector and, to a lesser extent, in the financial intermediation sector. Overall, in the EU and the euro area labour productivity growth in the network industries

30 See OECD (1987), "Structural adjustment and economic performance", Paris.
31 For more details on the measurement of real value added, see Annex 4.1.3.
32 See Box 3 for a discussion of this issue.

## Table 3 Labour productivity growth

(1985-1990)

| | BE | DE | GR | ES | FR | IE | IT | LU | NL | AT | PT | FI | DK | SE | UK | EU | EA | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total economy** | **2.0** | **1.6** | **-** | **1.3** | **2.3** | **3.5** | **2.0** | **4.4** | **0.7** | **2.6** | **4.1** | **3.1** | **1.3** | **1.5** | **1.3** | **1.7** | **1.8** | **1.0** |
| **Agriculture** | **2.7** | **6.6** | **-** | **4.9** | **4.5** | **-** | **4.4** | **0.2** | **5.4** | **3.5** | **6.3** | **6.0** | **6.6** | **5.8** | **1.3** | **4.8** | **5.0** | **1.8** |
| **Mining and quarrying** | **21.3** | **-1.2** | **-** | **3.2** | **-** | **-** | **5.6** | **18.3** | **0.3** | **3.1** | **-** | **14.3** | **18.4** | **4.0** | **5.8** | **3.0** | **2.1** | **6.9** |
| **Total manufacturing** | **3.3** | **1.2** | **-** | **2.8** | **3.0** | **4.0** | **2.9** | **6.6** | **1.6** | **3.5** | **3.5** | **4.8** | **0.3** | **1.9** | **4.0** | **2.4** | **2.2** | **2.6** |
| Food products, beverages and tobacco | 3.8 | 0.9 | - | 1.3 | 2.6 | 5.4 | 2.7 | 0.9 | 2.3 | 3.8 | 1.3 | 3.5 | 1.4 | -0.9 | 2.5 | 2.0 | 1.9 | -1.3 |
| Textiles, textile products, leather and footwear | 7.0 | 2.7 | - | 1.4 | 1.8 | 1.9 | 2.6 | 23.6 | -1.8 | 1.4 | 3.0 | 2.4 | 0.6 | 0.6 | 2.4 | 2.0 | 1.9 | 3.2 |
| Wood and products of wood and cork | 6.7 | 0.5 | - | 2.0 | 2.1 | 5.2 | 3.9 | - | 1.0 | 0.8 | 8.6 | 5.1 | -6.2 | 7.2 | 1.1 | 2.1 | 2.5 | 0.3 |
| Pulp, paper, paper products, printing and publishing | 6.2 | -0.1 | - | -1.3 | 3.6 | 7.7 | 3.0 | 5.7 | 1.4 | 5.5 | 0.0 | 4.1 | -3.0 | 2.1 | 4.9 | 2.1 | 1.6 | -0.7 |
| Rubber, plastics and fuel products | 2.4 | -0.7 | - | -5.9 | 1.1 | -0.5 | -5.4 | 10.3 | 2.6 | 3.0 | 7.3 | 6.0 | 0.6 | 6.6 | 1.6 | -0.7 | -1.2 | -1.5 |
| Chemicals and chemical products | 2.6 | 1.5 | - | 5.8 | 6.2 | 5.2 | 5.6 | 7.8 | 2.6 | 6.4 | 4.0 | 3.9 | 1.5 | 5.5 | 4.8 | 3.8 | 3.6 | 4.9 |
| Other non-metallic mineral products | 7.8 | 2.9 | - | 4.0 | 4.5 | -1.1 | 3.7 | 6.5 | 0.6 | 0.7 | 5.1 | 4.0 | 0.3 | 2.3 | 3.9 | 3.4 | 3.4 | 2.6 |
| Basic metals and fabricated metal products | 2.6 | 1.7 | - | 2.7 | 4.6 | 3.6 | 3.3 | 5.0 | 1.4 | 1.0 | 10.7 | 5.9 | -0.4 | 2.1 | 2.3 | 2.7 | 2.8 | 1.8 |
| Machinery and equipment | 1.5 | 0.9 | - | 4.3 | 0.1 | 3.2 | 3.7 | 3.9 | 0.6 | 5.1 | 2.8 | 5.2 | 0.8 | 2.4 | 4.2 | 1.9 | 1.6 | 8.1 |
| Transport equipment | -0.5 | 0.6 | - | 8.4 | 3.0 | 4.1 | 5.3 | 8.2 | 1.8 | 0.5 | 8.0 | 3.7 | 2.6 | -3.5 | 8.5 | 3.3 | 2.4 | -1.9 |
| Manufacturing NEC; recycling | 2.9 | 1.5 | - | 4.6 | 5.5 | -3.8 | -1.5 | 4.1 | 2.8 | 8.0 | 1.4 | 4.1 | -0.9 | 3.8 | 2.9 | 2.2 | 2.2 | 1.1 |
| *Low technology intensity* | 5.2 | 1.6 | - | 1.6 | 2.7 | 5.0 | 2.9 | 9.1 | 1.5 | 3.1 | 2.2 | 3.9 | 1.5 | -0.1 | 2.7 | 2.2 | 2.1 | 0.5 |
| *Medium-low technology intensity* | 5.3 | 0.5 | - | 1.3 | 4.0 | 3.7 | 1.9 | 5.2 | 1.9 | 5.1 | 2.5 | 4.4 | -2.7 | 2.8 | 4.0 | 2.2 | 2.0 | -0.2 |
| *Medium-high technology intensity* | 3.4 | 1.4 | - | 1.3 | 3.7 | 0.8 | 1.4 | 6.4 | 1.6 | 1.2 | 7.5 | 5.5 | 0.0 | 3.2 | 2.5 | 2.1 | 2.0 | 1.0 |
| *High technology intensity* | 1.5 | 0.9 | - | 6.2 | 2.4 | 3.5 | 4.5 | 5.0 | 1.5 | 4.5 | 4.0 | 4.8 | 1.4 | 1.1 | 5.4 | 2.6 | 2.2 | 4.4 |
| **Electricity, gas and water supply** | **4.3** | **3.1** | **-** | **5.4** | **6.2** | **6.1** | **0.4** | **3.7** | **1.3** | **4.3** | **1.7** | **3.5** | **0.0** | **2.0** | **4.6** | **3.7** | **3.4** | **3.4** |
| **Construction** | **2.6** | **1.4** | **-** | **-0.2** | **2.7** | **-** | **2.9** | **1.4** | **0.6** | **1.3** | **4.7** | **1.6** | **1.1** | **0.9** | **1.7** | **1.4** | **1.6** | **-0.2** |
| **Business services** | **1.2** | **2.1** | **-** | **-0.2** | **1.8** | **-** | **1.7** | **4.0** | **-0.2** | **2.5** | **3.6** | **2.7** | **1.5** | **-** | **1.0** | **1.4** | **1.5** | **0.8** |
| Wholesale and retail trade; restaurants and hotels | -0.8 | 1.7 | - | -1.0 | 3.1 | - | 2.0 | 5.1 | 0.2 | 2.5 | 1.6 | 3.3 | -0.2 | - | 1.9 | 1.5 | 1.5 | 0.7 |
| Wholesale and retail trade | -1.1 | 2.2 | - | -1.4 | 4.7 | - | 2.7 | 4.9 | - | 3.6 | 2.1 | 3.5 | 0.0 | 2.4 | - | 2.0 | 2.1 | 0.6 |
| Restaurants and hotels | 1.9 | -0.6 | - | -0.4 | -3.7 | - | -0.9 | 4.4 | - | -0.4 | -0.1 | 2.6 | -1.1 | - | - | -1.0 | -1.4 | 1.9 |
| Transport and storage and communication | 3.5 | 2.2 | - | 3.2 | 4.6 | - | 4.0 | 10.9 | 2.3 | 3.1 | 5.5 | 4.1 | 4.5 | - | 2.7 | 3.2 | 3.3 | 1.8 |
| Transport and storage | - | 1.1 | - | 3.3 | 3.2 | - | 3.7 | - | 2.3 | 2.6 | 1.9 | 3.4 | 5.3 | - | - | 2.6 | 2.6 | 0.8 |
| Post and telecommunication | - | 3.9 | - | 1.5 | 7.3 | - | 5.3 | - | 1.7 | 4.4 | 15.9 | 6.9 | 3.5 | - | - | 4.6 | 4.8 | 3.3 |
| Finance, insurance, real estate and business services | 0.7 | 1.0 | - | -1.2 | -0.6 | - | -1.6 | -1.1 | -1.7 | 1.7 | 4.2 | 0.2 | 0.7 | -3.7 | -1.1 | -0.4 | -0.2 | -0.3 |
| Financial intermedistion | - | 2.7 | - | 5.3 | 1.5 | - | 3.5 | -0.3 | - | 2.4 | 18.5 | 5.2 | 3.6 | 0.9 | - | 2.0 | 2.9 | 0.5 |
| Real estate, renting and business activities | - | -0.1 | - | -5.2 | -1.6 | - | -3.7 | -2.1 | - | 1.2 | -4.7 | -1.9 | -0.5 | -5.1 | - | -1.5 | -1.7 | -0.9 |
| **Community social and personal services** | **1.0** | **-0.3** | **-** | **0.0** | **0.6** | **-** | **-0.9** | **4.3** | **0.5** | **0.1** | **1.4** | **0.6** | **0.0** | **-** | **0.1** | **0.0** | **-0.1** | **0.4** |

## Table 3 Labour productivity growth (cont')

(1996-2001)

| | BE | DE | GR | ES | FR | IE | IT | LU | NL | AT | PT | FI | DK | SE | UK | EU | EA | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total economy** | **1.5** | **2.2** | **3.0** | **0.5** | **1.2** | **3.8** | **0.8** | **1.7** | **0.8** | **1.6** | **2.3** | **2.4** | **1.7** | **2.4** | **1.5** | **1.4** | **1.4** | **1.7** |
| **Agriculture** | **4.8** | **2.5** | **2.4** | **0.1** | **3.1** | **-** | **2.9** | **-2.5** | **2.7** | **2.8** | **0.5** | **3.8** | **7.0** | **2.4** | **1.2** | **3.1** | **3.1** | **4.7** |
| **Mining and quarrying** | **0.7** | **-8.2** | **4.9** | **1.6** | **-** | **-** | **-2.7** | **6.8** | **2.6** | **4.9** | **-** | **-1.5** | **14.0** | **1.3** | **1.9** | **3.1** | **0.2** | **-1.0** |
| **Total manufacturing** | **3.9** | **1.7** | **2.5** | **0.7** | **4.2** | **9.3** | **1.5** | **2.4** | **2.0** | **4.1** | **3.4** | **5.6** | **4.6** | **6.3** | **2.1** | **2.6** | **2.6** | **3.5** |
| Food products, beverages and tobacco | -1.9 | -0.7 | 2.1 | 1.7 | -1.2 | 0.0 | 1.1 | -5.7 | 0.6 | 4.0 | 2.5 | 2.9 | 5.9 | 0.8 | -0.8 | 0.3 | 0.5 | -4.7 |
| Textiles, textile products, leather and footwear | 5.5 | 3.1 | 0.4 | 0.7 | 4.5 | 1.7 | 2.4 | 7.2 | 3.2 | 4.2 | 1.2 | -0.3 | 6.9 | 2.5 | 2.0 | 2.4 | 2.3 | 3.6 |
| Wood and products of wood and cork | 5.3 | 1.8 | 5.4 | -2.9 | 3.7 | -5.7 | 2.9 | - | -1.3 | 3.2 | 4.7 | 3.2 | 5.8 | 4.5 | 0.2 | 2.5 | 2.6 | -0.5 |
| Pulp, paper, paper products, printing and publishing | 2.4 | 1.7 | 3.3 | 0.6 | 2.8 | 11.8 | 2.8 | -3.3 | 2.8 | 5.9 | 3.5 | 2.8 | 2.6 | 5.6 | 0.6 | 2.6 | 3.2 | -0.9 |
| Rubber, plastics and fuel products | -1.8 | 4.3 | 1.4 | -0.8 | 0.0 | -3.8 | -2.1 | 5.0 | -1.1 | 7.1 | 3.5 | -0.6 | 4.7 | 2.2 | -0.3 | 0.6 | 0.6 | 0.7 |
| Chemicals and chemical products | 5.0 | 3.3 | 2.0 | 0.9 | 5.7 | 17.5 | 0.3 | 0.7 | 4.9 | 6.5 | 2.2 | 4.0 | 11.0 | 5.7 | 4.3 | 3.6 | 3.4 | 0.8 |
| Other non-metallic mineral products | 0.5 | 1.1 | 5.2 | 1.8 | 4.0 | 1.2 | 1.1 | -0.2 | 3.4 | 1.5 | 5.5 | 0.1 | -0.2 | 2.0 | 1.5 | 2.0 | 2.1 | 0.1 |
| Basic metals and fabricated metal products | 5.2 | 1.4 | 2.3 | 0.3 | 2.3 | 1.8 | 0.9 | 5.6 | 1.6 | 3.0 | 5.5 | 0.6 | 2.9 | 3.1 | 1.7 | 1.8 | 1.7 | 0.7 |
| Machinery and equipment | 7.9 | 1.7 | 6.9 | -0.6 | 8.2 | 5.8 | 0.9 | -1.2 | 1.9 | 3.3 | 3.1 | 12.9 | 2.7 | 11.7 | 4.4 | 4.8 | 4.6 | 11.6 |
| Transport equipment | 3.6 | 1.6 | 1.6 | 0.3 | 9.3 | 8.7 | 2.2 | -2.8 | 2.2 | 1.1 | 7.1 | 1.6 | 2.8 | 5.6 | 0.8 | 1.8 | 1.9 | 3.8 |
| Manufacturing NEC; recycling | 4.2 | -0.5 | 2.2 | 2.7 | -0.6 | -2.8 | 3.4 | -1.1 | 1.3 | 3.8 | 6.9 | 1.4 | 3.5 | -3.6 | -1.0 | 1.0 | 1.3 | 2.7 |
| *Low technology intensity* | 0.7 | 0.2 | 1.4 | 1.2 | 0.6 | 2.5 | 2.0 | 0.1 | 1.1 | 4.2 | 1.8 | 2.2 | 6.2 | 1.3 | 1.3 | 0.6 | 0.5 | -1.2 |
| *Medium-low technology intensity* | 3.4 | 1.2 | 3.3 | 0.8 | 1.9 | 8.1 | 3.0 | -2.4 | 1.8 | 4.7 | 3.8 | 2.4 | 3.3 | 4.2 | 0.1 | 1.6 | 1.9 | -0.1 |
| *Medium-high technology intensity* | 2.8 | 2.1 | 2.8 | 0.4 | 1.9 | 0.1 | 0.3 | 4.8 | 1.3 | 3.8 | 4.9 | 0.3 | 2.7 | 2.9 | 1.1 | 1.3 | 1.2 | 0.6 |
| *High technology intensity* | 5.7 | 1.8 | 3.8 | 0.0 | 7.7 | 11.2 | 1.0 | 0.0 | 2.8 | 3.5 | 3.4 | 10.7 | 5.3 | 9.1 | 3.5 | 3.5 | 3.4 | 7.9 |
| **Electricity, gas and water supply** | **5.5** | **5.0** | **8.2** | **6.2** | **2.5** | **6.7** | **4.5** | **2.7** | **2.3** | **4.1** | **17.8** | **4.5** | **-0.4** | **0.0** | **8.8** | **5.4** | **4.9** | **-0.9** |
| **Construction** | **2.0** | **1.1** | **4.1** | **-0.6** | **-1.4** | **-3.5** | **-0.5** | **2.7** | **0.4** | **1.6** | **-0.1** | **-2.6** | **-1.0** | **-0.3** | **0.9** | **-0.2** | **-0.3** | **-0.3** |
| **Business services** | **1.3** | **1.3** | **3.2** | **0.3** | **0.4** | **2.8** | **0.1** | **1.0** | **1.1** | **1.2** | **3.0** | **1.6** | **1.5** | **-** | **2.3** | **1.1** | **0.7** | **3.4** |
| Wholesale and retail trade; restaurants and hotels | -1.0 | -0.5 | 3.7 | -0.4 | 1.7 | - | 0.4 | 5.3 | 1.9 | 1.5 | 1.7 | 1.8 | 0.9 | - | 1.6 | 0.7 | 0.4 | 5.1 |
| Wholesale and retail trade | -1.4 | 0.1 | 4.2 | 0.2 | 1.9 | - | 0.6 | 6.6 | 2.2 | 1.4 | 1.1 | 2.3 | 1.1 | 2.8 | - | 1.0 | 0.8 | 5.4 |
| Restaurants and hotels | 1.4 | -2.8 | 2.5 | -1.6 | 0.8 | - | -0.3 | -0.9 | -0.3 | 2.0 | 4.6 | 0.1 | -0.4 | - | - | -0.9 | -0.7 | -1.7 |
| Transport and storage and communication | 3.7 | 8.8 | 10.3 | 2.8 | 4.8 | - | 2.8 | 3.8 | 3.3 | 1.6 | 3.4 | 4.9 | 4.1 | - | 4.0 | 5.1 | 5.3 | 2.4 |
| Transport and storage | - | 2.6 | 6.3 | 3.1 | 2.6 | - | 0.1 | - | 0.7 | 1.7 | -0.2 | 1.4 | 4.0 | - | - | 1.7 | 1.6 | 0.0 |
| Post and telecommunication | - | 17.3 | 14.6 | 5.7 | 9.2 | - | 9.7 | - | 7.9 | 2.1 | 6.8 | 13.9 | 4.7 | - | - | 11.0 | 11.7 | 4.5 |
| Finance, insurance, real estate and business services | 1.0 | -1.2 | -1.6 | -0.7 | -2.1 | - | -1.8 | -3.0 | -0.4 | -0.9 | 3.4 | -1.2 | -0.6 | 0.0 | 1.3 | -0.8 | -1.4 | 1.7 |
| Financial intermedistion | - | 4.1 | 0.7 | 4.9 | 0.1 | - | 1.0 | -0.4 | -1.9 | 3.4 | 18.1 | 4.1 | 3.9 | 5.4 | - | 1.9 | 2.7 | 5.6 |
| Real estate, renting and business activities | - | -2.7 | -2.4 | -2.7 | -2.8 | - | -2.6 | -5.5 | 0.0 | -2.7 | -4.3 | -2.4 | -2.0 | -1.2 | - | -1.8 | -2.6 | 0.2 |
| **Community social and personal services** | **-0.3** | **2.3** | **-1.6** | **0.3** | **0.1** | **-** | **0.1** | **2.1** | **-0.1** | **-1.7** | **-0.3** | **0.0** | **-0.6** | **0.1** | **0.2** | **0.6** | **0.7** | **-2.6** |

## Table 3 Labour productivity growth (cont')

(1985-2001)

| | BE | DE | GR | ES | FR | IE | IT | LU | NL | AT | PT | FI | DK | SE | UK | EU | EA | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total economy** | **1.7** | **2.0** | **1.9** | **1.0** | **1.5** | **3.4** | **1.5** | **2.5** | **0.8** | **2.2** | **2.8** | **3.0** | **1.6** | **2.1** | **1.9** | **1.7** | **1.6** | **1.4** |
| **Agriculture** | **4.3** | **6.2** | **4.1** | **3.0** | **4.5** | **-** | **5.0** | **0.7** | **3.5** | **4.8** | **4.4** | **5.0** | **6.9** | **3.0** | **1.6** | **4.7** | **4.9** | **2.1** |
| **Mining and quarrying** | **10.6** | **-0.4** | **2.8** | **4.3** | **-** | **-** | **3.1** | **8.3** | **2.9** | **2.3** | **-** | **5.8** | **14.0** | **2.9** | **9.7** | **6.7** | **4.2** | **3.6** |
| **Total manufacturing** | **3.3** | **2.0** | **0.9** | **1.9** | **3.5** | **5.1** | **2.3** | **4.5** | **2.6** | **3.7** | **3.2** | **5.5** | **2.1** | **4.4** | **3.0** | **2.6** | **2.6** | **3.2** |
| Food products, beverages and tobacco | 1.5 | 0.6 | 1.7 | 1.0 | 0.6 | 1.2 | 2.0 | -2.3 | 3.3 | 3.2 | 1.3 | 4.1 | 2.8 | 2.3 | 1.6 | 1.5 | 1.4 | -1.5 |
| Textiles, textile products, leather and footwear | 6.5 | 3.2 | 0.7 | 1.7 | 2.8 | 1.2 | 2.8 | 12.7 | 2.4 | 2.8 | 1.9 | 2.7 | 3.5 | 3.3 | 2.4 | 2.3 | 2.3 | 3.3 |
| Wood and products of wood and cork | 3.2 | 2.5 | 4.0 | -0.5 | 2.3 | 1.0 | 3.3 | - | 0.6 | 2.0 | 4.9 | 4.8 | 0.0 | 6.4 | 0.2 | 2.5 | 2.8 | -1.1 |
| Pulp, paper, paper products, printing and publishing | 3.9 | 1.2 | 1.0 | -0.2 | 2.7 | 7.1 | 2.3 | 0.1 | 2.6 | 5.1 | 2.2 | 4.3 | 0.0 | 4.0 | 2.0 | 2.1 | 2.2 | -0.8 |
| Rubber, plastics and fuel products | 1.1 | 1.3 | -8.0 | 0.6 | 2.9 | -1.7 | -1.9 | 7.5 | 1.7 | 8.4 | 3.0 | 3.0 | 0.1 | 1.4 | 1.1 | 1.0 | 1.0 | 1.4 |
| Chemicals and chemical products | 4.7 | 4.2 | 1.7 | 2.4 | 5.9 | 8.4 | 3.2 | 3.5 | 4.6 | 5.3 | 3.1 | 4.2 | 5.5 | 6.0 | 5.4 | 4.5 | 4.4 | 3.1 |
| Other non-metallic mineral products | 3.6 | 2.9 | 3.2 | 2.4 | 3.2 | 1.8 | 1.8 | 2.6 | 0.6 | 1.3 | 4.9 | 3.2 | 0.4 | 1.1 | 2.9 | 2.6 | 2.6 | 1.6 |
| Basic metals and fabricated metal products | 2.1 | 2.2 | -1.0 | 1.0 | 2.8 | 1.7 | 2.5 | 6.2 | 1.9 | 2.7 | 4.1 | 4.1 | 1.4 | 4.1 | 1.7 | 2.3 | 2.3 | 2.0 |
| Machinery and equipment | 3.1 | 1.9 | 5.2 | 3.6 | 4.5 | 4.2 | 2.4 | 0.1 | 2.8 | 3.8 | 3.6 | 8.1 | 2.1 | 5.8 | 4.3 | 3.3 | 3.1 | 9.4 |
| Transport equipment | 2.2 | 1.0 | 5.6 | 3.6 | 4.6 | 5.0 | 2.2 | -0.1 | 2.9 | 2.9 | 11.1 | 2.8 | 2.2 | 3.3 | 4.3 | 2.4 | 2.0 | 1.2 |
| Manufacturing NEC; recycling | 2.2 | 0.0 | 4.2 | 2.0 | 3.4 | -1.8 | 1.8 | 5.0 | 1.0 | 3.8 | 3.3 | 3.0 | 0.7 | 2.5 | 0.3 | 1.3 | 1.5 | 1.6 |
| *Low technology intensity* | 3.5 | 1.5 | 1.3 | 1.4 | 1.6 | 2.1 | 2.6 | 3.5 | 3.3 | 3.3 | 1.7 | 4.3 | 3.1 | 2.9 | 2.5 | 1.9 | 1.8 | 0.6 |
| *Medium-low technology intensity* | 3.3 | 1.2 | 3.1 | 0.6 | 2.9 | 4.5 | 2.4 | 1.3 | 1.8 | 3.9 | 2.9 | 4.3 | 0.2 | 4.0 | 1.4 | 1.8 | 1.9 | -0.4 |
| *Medium-high technology intensity* | 2.2 | 2.2 | -2.9 | 1.4 | 2.9 | 0.8 | 1.4 | 6.1 | 1.7 | 3.5 | 4.5 | 3.7 | 0.8 | 3.3 | 1.8 | 2.0 | 2.0 | 1.8 |
| *High technology intensity* | 3.6 | 2.1 | 3.6 | 3.2 | 4.8 | 6.2 | 2.6 | 1.8 | 3.3 | 3.9 | 4.7 | 7.0 | 3.3 | 5.1 | 4.6 | 3.3 | 3.0 | 5.9 |
| **Electricity, gas and water supply** | **5.1** | **4.4** | **5.1** | **4.6** | **3.8** | **1.2** | **2.5** | **4.2** | **2.9** | **3.4** | **7.6** | **5.4** | **2.3** | **1.3** | **8.6** | **4.8** | **4.0** | **1.8** |
| **Construction** | **1.0** | **0.4** | **0.1** | **0.2** | **0.9** | **-** | **0.8** | **0.9** | **-0.3** | **1.7** | **2.6** | **0.5** | **0.1** | **1.1** | **2.2** | **0.7** | **0.5** | **0.1** |
| **Business services** | **1.3** | **1.8** | **0.7** | **0.2** | **0.8** | **-** | **1.1** | **2.0** | **0.4** | **1.6** | **2.4** | **2.6** | **1.5** | **-** | **1.9** | **1.3** | **1.2** | **1.9** |
| Wholesale and retail trade; restaurants and hotels | -0.3 | 0.5 | 0.8 | -0.1 | 1.4 | - | 1.3 | 2.9 | 0.5 | 1.4 | 1.4 | 2.2 | 1.2 | - | 2.1 | 1.0 | 0.8 | 2.7 |
| Wholesale and retail trade | -0.4 | 1.2 | 1.8 | -0.1 | 2.3 | - | 1.8 | 3.6 | 0.9 | 1.9 | 1.7 | 2.4 | 1.5 | 3.0 | - | 1.5 | 1.3 | 2.8 |
| Restaurants and hotels | 0.8 | -3.0 | -1.3 | -0.5 | -2.1 | - | -0.8 | -0.3 | -1.9 | 0.1 | 0.2 | 1.5 | -0.3 | - | - | -1.3 | -1.5 | 1.0 |
| Transport and storage and communication | 2.9 | 5.6 | 5.5 | 3.1 | 3.5 | - | 3.7 | 8.7 | 2.8 | 2.3 | 5.2 | 4.6 | 3.9 | - | 3.8 | 4.0 | 4.0 | 2.4 |
| Transport and storage | - | 3.0 | 3.8 | 3.0 | 2.4 | - | 2.1 | - | 1.5 | 1.3 | 2.0 | 2.9 | 3.6 | - | - | 2.5 | 2.4 | 1.2 |
| Post and telecommunication | - | 9.5 | 7.5 | 3.8 | 5.8 | - | 8.0 | - | 5.4 | 4.9 | 11.1 | 9.3 | 5.3 | - | - | 6.9 | 7.1 | 4.0 |
| Finance, insurance, real estate and business services | 0.8 | -0.1 | -2.6 | -1.3 | -0.9 | - | -1.2 | -1.8 | -0.8 | 0.7 | 0.8 | 0.8 | 0.1 | -0.9 | 0.5 | -0.3 | -0.5 | 0.5 |
| Financial intermedistion | - | 3.0 | 1.1 | 1.6 | 0.2 | - | 2.2 | 0.6 | 0.0 | 3.0 | 11.7 | 3.9 | 2.1 | 3.0 | - | 1.4 | 2.1 | 2.7 |
| Real estate, renting and business activities | - | -1.3 | -4.2 | -2.7 | -1.4 | - | -2.5 | -4.3 | -1.0 | -0.5 | -5.3 | -0.2 | -0.7 | -1.8 | - | -1.1 | -1.6 | -0.5 |
| **Community social and personal services** | **0.5** | **0.8** | **-** | **0.3** | **0.2** | **-** | **-0.3** | **2.4** | **0.1** | **-0.4** | **0.4** | **0.3** | **0.4** | **-** | **1.0** | **0.4** | **0.3** | **-1.0** |

Sources: OECD, European commission, NCBs and ECB calculations.
Notes: The figure presents averages of real valued added per worker (annual percentage change) over the two sub-periods 1985-1990 and 1996-2001 and the period 1985-2001; data for Greece start only in 1988 and for the Netherlands in 1987. Figures for the EU and the euro area refer to country-weighted averages and do not include Greece, Ireland, Luxembourg and Sweden on account of missing sectors.

has tended to be greater than in the other sectors.

Moreover, the comparison between the two sub-periods 1985-1990 and 1996-2001 shows a slight tendency for manufacturing productivity to increase, with the exception of Spain, Portugal and the UK, while labour productivity developments in business sector services were much more diverse; the EU and euro area average for these sectors decreased despite the fact that labour productivity held up in these sectors for Belgium, Spain, the Netherlands and the UK.

**Box 3**

### PART-TIME EMPLOYMENT AND MEASUREMENT OF SECTORAL SPECIALISATION

One of the ways of assessing the extent of sectoral specialisation is the Lilien indicator, which measures the variation of the speed of structural adjustments. This measure is based on the number of persons employed per sector. In countries where part-time work is relatively abundant, the number of persons employed in a sector may not accurately represent the share of that sector in the total number of hours worked. This is because the measure does not take into account the possibly differing average number of hours worked across sectors. More specifically, counting heads instead of hours may overstate the weight of sectors where the number of hours worked is low and vice versa. Furthermore, if the evolution of working hours varies across sectors, sectoral labour productivity growth is likely to be distorted when measured as the number of persons employed rather than number of hours worked.

The extent of these potential measurement problems depends on the distribution of working hours across sectors. Distortions regarding the level of productivity are, ceteris paribus, likely to be larger in countries where part-time work is abundant in specific sectors than in countries where the number of hours worked does not vary significantly across economic sectors or in the course of time.

For most countries, detailed sectoral data on the number of hours worked is unavailable. Furthermore, comparing national data on hours worked is hampered by conceptual issues. SNA93 guidelines suggest the use of full-time equivalent employment for international comparisons. Full-time equivalent employment represents the actual (as opposed to contractual) number of hours worked, divided by the average actual annual hours worked in full-time jobs within each respective economic territory. This measure is less prone to errors than data on the total number of hours worked and insensitive to differences in the average actual annual hours

**Part-time work: deviation from full-time equivalent**

(1999, percentages)

| | Agriculture, hunting and forestry; fishing | Industry, including energy | Construction | Trade, repairs, hotels, transport | Financial intermediation; real estate | Other service activities | Total |
|---|---|---|---|---|---|---|---|
| Spain | -1 | -2 | 0 | -3 | -5 | -6 | -4 |
| France | -6 | -3 | -2 | -9 | -9 | -7 | -7 |
| Ireland | -7 | 0 | -3 | -3 | -11 | -12 | -6 |
| Italy | -7 | -3 | -4 | 6 | -7 | -8 | -4 |
| Netherlands | -21 | -9 | -4 | -23 | -17 | -23 | -18 |
| Austria | -12 | -4 | -1 | -10 | -19 | -8 | -8 |
| Portugal | -2 | -1 | 0 | 0 | -2 | -4 | -2 |

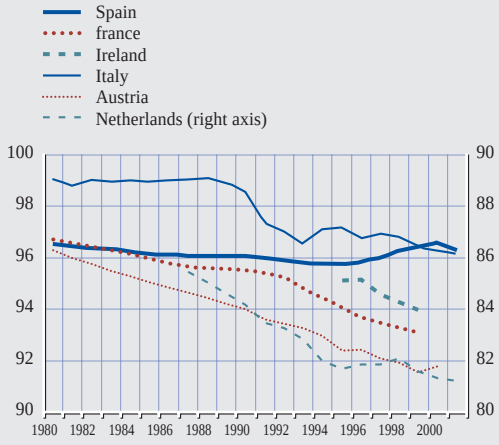
Sources: OECD, NCB calculations.
Note: Data for Portugal refer to 1998.

worked between countries. The OECD STAN database contains sectoral time series data on the number of persons employed and full-time equivalent employment for six sector aggregates.

Using data on full-time equivalent employment, a measure of part-time work per economic sector can be constructed. Table 1 depicts how much the average working week fell short of a full-time working week in several EU countries in 1999. Data on other countries were unavailable in the STAN database. Although in all countries the average working week is less than full-time, in most countries the average employee works more than 90% of a full-time week – indicating that part-time work is not widespread in those countries. One notable exception is the Netherlands, where the average employee works only 82% of a full-time week.

The table above also sheds light on sectoral differences in part-time work. Part-time work is virtually absent in the construction sector and in industrial sectors. In almost all countries, the average employee in these sectors works almost a full-time week. In the services sectors, on the other hand, part-time work is far more widespread.

**Average working week as percentage of FTE**




Sources: OECD, NCB calculations.

The chart depicts the development of the average working week as a percentage of full-time equivalent over the past two decades. The graph reveals a persistent downward trend in working hours in most countries, with Spain being the only country with a relatively stable average working week. The general downward trend indicates that part-time work has become increasingly more widespread in these countries in the past two decades.

To some extent, the rise in part-time work is the result of sectoral shifts. These economies have experienced a pronounced shift away from agriculture and manufacturing towards the services sectors, where the share of part-time work is relatively large. However, in most countries, this composition effect accounts for only a small part of the total increase in part-time work. Rather, the general increase in part-time work is explained by all sectors showing a persistent upward trend in the share of part-time workers.

The rise in part-time work over the past two decades provides a partial explanation for the persistent negative labour productivity growth in some sectors shown in Table 3 in the main text. However, other measurement errors, such as improperly accounting for increases in quality, are likely to also play a role. Although theoretical arguments favour the use of data on hours worked rather than the number of labourers, the gain in accuracy of the results is likely to be limited. First, sectoral differences in the extent of part-time work are persistent, implying that using data on hours worked is unlikely to qualitatively change the results. Second, any possible gains will have to be weighed against the lack of internationally comparable data on hours worked, and additional measurement errors that are introduced by these data. Of course, in countries where part-time work is relatively widespread, most notably the Netherlands, significant deviations from the reported results may be observed.

### 2.3.2 A SHIFT-SHARE ANALYSIS OF PRODUCTIVITY

In order to determine the impact of cross-country differences in specialisation patterns and structural adjustments on productivity growth, Table 4 shows the results from the shift-share analysis for EU countries as well as the EU as a whole, the euro area and the United States over the period 1985-2001, for manufacturing, utilities and business sector services as well as the aggregate economy. Total labour productivity (first column) is broken down[33] into productivity developments within a sector ("Intra effect", second column) and a shift effect resulting from sectoral re-allocation towards sectors with higher labour productivity levels ("Shift effect", third column).

Looking at the results for the aggregate economy, the overwhelming share of productivity growth was accounted for by the intra effect, except in Greece and Luxembourg, where the shift effect was respectively more important or as important as the intra effect. Moreover, for all countries except the UK the shift effect has contributed positively to aggregate labour productivity growth, reflecting the general shift from manufacturing to services, with the level of labour productivity being in general higher in services.

As regards the manufacturing sector, the overwhelming share of labour productivity growth was again accounted for by the intra effect. Changes in the sectoral composition had a significant positive impact only in Ireland and – to a lesser extent – in Finland, possibly reflecting resource re-allocation towards the high-technology manufacturing sectors.

33 See Annex 4.2.1.3 for methodological details.

**Table 4 Shift-share analysis**

(1985-2001)

| | Total economy | | | Manufacturing | | | Utilities and Business sector services | | |
|---|---|---|---|---|---|---|---|---|---|
| | Produc-tivity | Intra effect | Shift effect | Produc-tivity | Intra effect | Shift effect | Produc-tivity | Intra effect | Shift effect |
| Belgium | 1.7 | 1.5 | 0.2 | 3.3 | 3.1 | 0.2 | 1.4 | 1.1 | 0.3 |
| Germany | 2.0 | 1.3 | 0.7 | 2.0 | 1.9 | 0.1 | 1.7 | 0.9 | 0.9 |
| Greece | 1.9 | 0.5 | 1.4 | 0.9 | 0.7 | 0.2 | 0.7 | -0.2 | 0.9 |
| Spain | 1.1 | 0.7 | 0.3 | 1.9 | 1.8 | 0.2 | 0.1 | 0.2 | -0.1 |
| France | 1.5 | 1.1 | 0.4 | 3.5 | 3.4 | 0.1 | 1.0 | 0.4 | 0.7 |
| Ireland | - | - | - | 5.1 | 4.0 | 1.1 | - | - | - |
| Italy | 1.5 | 0.9 | 0.6 | 2.3 | 2.1 | 0.2 | 1.1 | 0.4 | 0.7 |
| Luxembourg | 2.5 | 1.4 | 1.2 | 4.5 | 4.5 | 0.0 | 1.9 | 0.6 | 1.3 |
| Netherlands | 0.8 | 0.8 | 0.0 | 2.6 | 2.8 | -0.2 | 0.2 | 0.2 | 0.0 |
| Austria | 2.2 | 1.6 | 0.6 | 3.7 | 3.6 | 0.2 | 1.7 | 1.4 | 0.3 |
| Portugal | 2.8 | 2.0 | 0.8 | 3.2 | 3.2 | 0.0 | 2.6 | 2.2 | 0.5 |
| Finland | 3.0 | 2.7 | 0.3 | 5.5 | 5.0 | 0.4 | 2.5 | 2.0 | 0.5 |
| Denmark | 1.6 | 1.4 | 0.2 | 2.1 | 2.0 | 0.2 | 1.4 | 1.0 | 0.4 |
| Sweden | 2.1 | 1.5 | 0.6 | 4.4 | 4.3 | 0.1 | 1.3 | 0.4 | 0.8 |
| United Kingdom | 1.9 | 2.3 | -0.3 | 3.0 | 2.9 | 0.2 | 2.0 | 2.0 | 0.1 |
| euro area | 1.6 | 1.1 | 0.5 | 2.6 | 2.5 | 0.1 | 1.2 | 0.6 | 0.6 |
| European Union | 1.7 | 1.3 | 0.4 | 2.6 | 2.5 | 0.1 | 1.4 | 0.8 | 0.5 |
| United States | 1.4 | 1.3 | 0.1 | 3.2 | 3.1 | 0.1 | 1.7 | 1.4 | 0.3 |

Sources: OECD, European commission and ECB calculations.
Note: The analysis refers to the time period 1985-2001. For data availability reasons the business sector services are composed only of three main sub-sectors for Belgium and the United Kingdom; moreover, data for business sector services are not complete for Sweden. Data for the communication sector are missing for Luxembourg. The figures for the euro area and the EU refer to weighted averages; they do not include Greece, Ireland, Luxembourg and Sweden on account of missing sectors.

Utilities and business sector services, on the other hand, provide a more mixed picture. Overall, the intra effect was as important as the shift effect, mainly reflecting the major resource re-allocation towards the "real estate, renting and business activities" sector that occurred in most EU countries[34].

Taken together, the impact of structural adjustments on aggregate labour productivity growth in the aggregate economy as well as in its sectoral components appears to be limited. One possible explanation is that a large fraction of aggregate labour productivity growth is driven by what happens in each individual firm, whilst shifts in market shares from low to high-productivity firms across sectors play only a modest role[35], meaning that aggregate labour productivity growth is driven by a better resource allocation within sectors rather than between sectors.

## 2.4 EUROPE IN COMPARISON WITH THE UNITED STATES

Comparing the EU and the United States, Table 5 and Chart 7 show respectively the sectoral shares[36] in value added at constant prices and the Lilien indicator for the EU, the euro area and the United States for the periods 1985-1989 and 1996-2001. Looking at the results as shown in Table 5, the main differences with regard to the manufacturing sector have arisen from the low technology intensity sector – which is almost twice as small in the United States as in the EU

34 Results for Greece, the UK and Belgium are underestimated in this respect, on account of the lack of data for this sector.

35 OECD, "The role of policy and institutions for productivity and firms' dynamics: evidence from micro and industry data", 2002, EPC document.

36 See Chart 3 and footnote 21 for a more detailed comparison between sectoral specialisation in EU countries and specialisation in US regions.

**Table 5 Sectoral output shares**

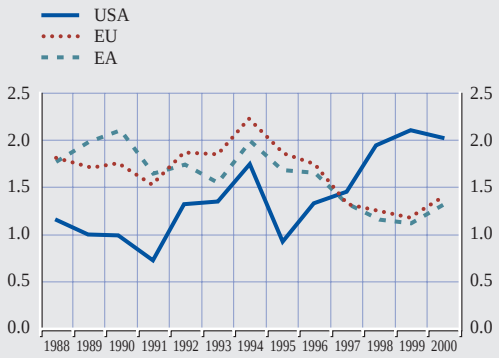
(percentages of total value added)

| | 1985-1989 | | | 1996-2001 | | |
|---|---|---|---|---|---|---|
| | USA | EU | EA | USA | EU | EA |
| **Total manufacturing** | **17.4** | **22.1** | **22.2** | **17.3** | **20.3** | **20.5** |
| Food products, beverages and tobacco | 1.9 | 2.6 | 2.6 | 1.3 | 2.4 | 2.3 |
| Textiles, textile products, leather and footwear | 0.8 | 1.7 | 1.7 | 0.6 | 1.2 | 1.2 |
| Wood and products of wood and cork | 0.8 | 0.5 | 0.5 | 0.5 | 0.4 | 0.5 |
| Pulp, paper, paper products, printing and publishing | 2.5 | 2.0 | 1.8 | 1.7 | 1.8 | 1.7 |
| Rubber, plastics and fuel products | 1.0 | 1.3 | 1.3 | 1.0 | 1.2 | 1.2 |
| Chemicals and chemical products | 1.9 | 2.1 | 2.1 | 1.9 | 2.2 | 2.1 |
| Other non-metallic mineral products | 0.5 | 1.1 | 1.1 | 0.4 | 1.0 | 1.0 |
| Basic metals and fabricated metal products | 2.0 | 2.9 | 2.9 | 1.8 | 2.6 | 2.7 |
| Machinery and equipment | 3.2 | 5.0 | 5.1 | 6.0 | 4.7 | 4.8 |
| Transport equipment | 2.5 | 2.2 | 2.3 | 1.9 | 2.1 | 2.1 |
| Manufacturing NEC; recycling | 0.6 | 0.9 | 0.9 | 0.6 | 0.8 | 0.8 |
| Low technology intensity | 2.8 | 4.3 | 4.3 | 1.9 | 3.5 | 3.5 |
| Medium-low technology intensity | 3.9 | 3.3 | 3.2 | 2.7 | 3.0 | 3.0 |
| Medium-high technology intensity | 3.4 | 5.2 | 5.3 | 3.2 | 4.8 | 5.0 |
| High technology intensity | 7.6 | 9.2 | 9.4 | 9.8 | 8.9 | 9.0 |
| **Electricity, gas and water supply** | **2.7** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** |
| **Construction** | **4.5** | **6.3** | **6.4** | **4.0** | **5.4** | **5.5** |
| **Business sector services** | **48.9** | **43.6** | **43.4** | **54.4** | **47.4** | **47.2** |
| Wholesale and retail trade | 16.4 | 11.2 | 11.2 | 19.0 | 11.5 | 11.4 |
| Hotels and restaurants | 0.8 | 2.9 | 2.9 | 0.8 | 2.5 | 2.5 |
| Transport and storage | 2.8 | 4.1 | 4.0 | 3.2 | 4.5 | 4.4 |
| Post and telecommunications | 3.0 | 1.9 | 1.9 | 3.7 | 2.9 | 2.8 |
| Financial intermediation | 7.3 | 5.5 | 5.5 | 7.8 | 5.7 | 5.6 |
| Real estate, renting and business activities | 18.5 | 17.9 | 18.0 | 19.8 | 20.4 | 20.6 |

Sources: OECD, NCBs and ECB calculations.
Note: Data represent output shares based on value added at constant prices. The EU aggregate does not include Greece, Ireland, Luxembourg and Sweden on account of missing sectors. The figures for the EU and the euro area refer to weighted averages.

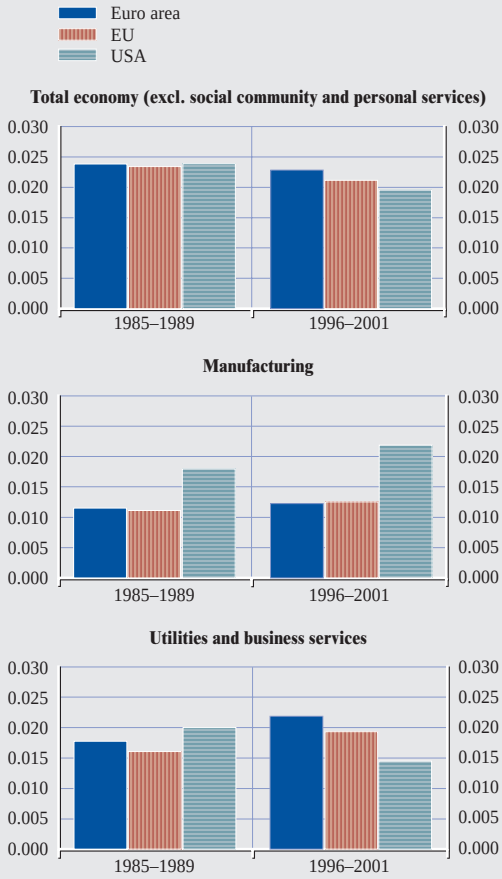
**Chart 6 Aggregate labour productivity growth developments: Europe versus the United States**

(three-year moving averages)




Sources: OECD, NCBs and ECB calculations.

**Chart 7 Lilien indicator for Europe and the United States**




Sources: OECD, NCBs and ECB calculations.
Note: The figures for the euro area and the EU refer to weighted averages; they do not include Greece, Ireland and Luxembourg on account of missing sectors.

– as well as from the high technology intensity sector. Indeed, while in the 1980s the weight of the high technology intensity manufacturing sector was lower in the United States compared with the EU, it turned higher at the end of the 1990s thanks to a much more rapid expansion of the high technology intensity manufacturing sector in the United States. The weight of the high technology intensity sector in the EU has even tended to decrease over the last 15 years. Regarding business sector services, the main difference has arisen from the wholesale and retail trade, the output share of which is on average 5-8 percentage points higher in the United States than in the EU, depending on the period.

As regards the differences in aggregate labour productivity developments (see Table 3), the EU has enjoyed a stronger increase over the period 1985-2001 than the United States. However, the comparison of long-run averages hides the slowdown of labour productivity increases in the EU and the euro area in the second half of the 1990s compared with a substantial pick-up of labour productivity growth rates in the United States over the same period (see Chart 6). This growing difference of aggregate productivity developments between the United States and the EU/euro area in the second half of the 1990s is partly explained by a stronger labour productivity performance in the wholesale and retail trade and financial intermediation, two ICT-using services sectors that – taken together – account for about 17% of total gross value added in the euro area and almost 27% of total gross value added in the United States.[37]

Looking at the disaggregated level in manufacturing and business sector services, labour productivity growth in both sectors was

37 See B. van Ark, R. Inklaar, and R. H. McGuckin (2003), "ICT and productivity in Europe and the United States. Where do the differences come from?", University of Groningen, mimeo and European Commission (2003), The EU Economy: 2003 Review, Brussels.

significantly higher in the United States than in the EU, mainly reflecting the stronger performance of both the high-technology manufacturing sectors and the wholesale and retail sectors. However, the EU has enjoyed higher rates of productivity growth in network industries than the United States. In general, differences in productivity performance between the EU and the United States may be partly related to methodological problems, which are beyond the scope of this report. These problems include finding a comparable definition of output (i.e., for example, the treatment of IT goods as input or output) and inputs (i.e., for example, hours worked or persons), problems of deflation (in particular of goods with rapid changes in quality), and difficulties in choosing the appropriate exchange rate or purchasing power parity[38].

Looking at the speed of structural adjustments as shown in Chart 7, it appears that – compared with the end of the 1980s and compared with the EU – the speed of sectoral re-allocation in the United States slowed significantly at the end of the 1990s, both for the aggregate economy as well as for the utilities and business sector services. However, over the entire period the speed of structural adjustments within the manufacturing sector remained remarkably higher in the United States than in the EU.

## 2.5 CONCLUSION

The EU and the euro area are characterised by cross-country heterogeneity as regards the degree of sectoral specialisation. However, in comparison with other economic areas of similar size – such as for instance the United States – the degree of sectoral specialisation of the EU/euro area remains limited. In addition, changes in sectoral specialisation have been rather slow. Nevertheless, there was a trend towards more pronounced sectoral specialisation towards the end of the 1990s.

The results for the speed of structural adjustments as measured by the Lilien indicator seem to indicate significant sectoral re-allocations in some countries in the first half of the 1990s.

As a general trend, sectoral re-allocation has taken place towards business sector services and – at least in some EU countries – towards a specialisation in relatively high-technology industries as measured by the Krugman index. Across the EU, business sector services such as hotels and restaurants and financial intermediation but also – in some countries – construction, became more spatially concentrated, partly reflecting country characteristics.

The analysis of labour productivity developments indicates that both sectoral re-allocation and developments within individual sectors have been important in shaping aggregate labour productivity growth, with the bulk of labour productivity increases coming from intra-sector developments. In comparison with the United States, the EU and the euro area have not systematically under-performed over the last two decades; however, the gap did widen at the end of the 1990s. This growing difference in aggregate productivity developments between the United States and the EU/euro area in the second half of the 1990s is partly explained by stronger labour productivity performance in the wholesale and retail trade and financial intermediation. Moreover, the divergence may be partly related to methodological problems, such as finding a comparable definition of output, problems of deflation of goods with rapid changes in quality, and difficulties in choosing the appropriate exchange rate or purchasing power parity. The available data indicate that, in

38 See, for instance, the discussion in F. Vijselaar and R. Albers (2002), "New technologies and productivity growth in the euro area", ECB Working Paper, no 122; D. Jorgenson (2003), "Information technology and the G7 economies", http://post.economics.harvard.edu/faculty/jorgenson/papers/handbook_extract_3.pdf; R. J. Gordon (2002), "Two centuries of economic growth: Europe chasing the American frontier", http://faculty-web.at.northwestern.edu/ economics/gordon/355.pdf; Deutsche Bundesbank (2000), "Problems of international comparisons of growth", Monthly Bulletin, August, p. 8 and the references therein.

manufacturing as well as in business sector services, the US labour productivity growth rate is on average higher than in the EU or in the euro area over the entire period. In particular, as regards the manufacturing sector, this may be related to a more pronounced shift of resources across manufacturing sectors towards more productive uses.

# 3 SECTORAL COMPOSITION AND BUSINESS CYCLES

Sectoral composition influences the characteristics of an economy's (aggregate) business cycle – such as its length and amplitude – and may affect the transmission of shocks in various ways. This section aims at providing indications of the extent to which business cycle developments over the period 1980-2001 were driven by changes in the sectoral composition in EU countries. This section also aims at evaluating to what extent the business cycle – in particular the synchronisation of cycles – in EU countries was driven by developments within sectors rather than by an aggregate change of the economic dynamics. However, it is more the different characteristics of sectors – and their evolution – that are of importance for the explanation of business cycle dynamics than the change in EU countries' sectoral composition.

The importance of sectoral specialisation for EU countries' business cycles is discussed in four steps. First, the general characteristics of the euro area/EU business cycle are presented. Second, sectoral volatility is analysed and its evolution over time discussed; this may be related to the change in sectoral composition as one possible force for changes in aggregate behaviour. Third, business cycle synchronisation is discussed, both from an aggregate and a sectoral point of view and the different contributions from sectoral cyclical convergence will be analysed. Finally, the issue of sectoral co-movement – i.e. the phenomenon of sectors moving up and down simultaneously – will be presented.

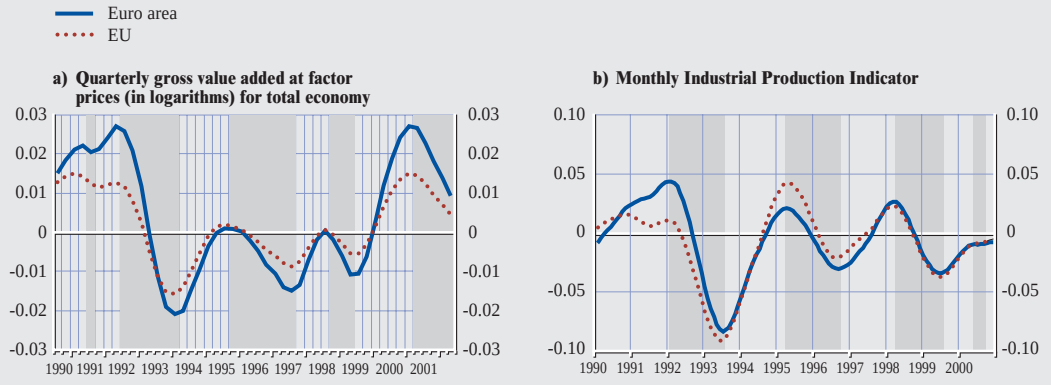
## 3.1 SECTORAL DETERMINANTS OF THE EURO AREA CYCLE

Economic activity in the euro area as well as in the EU as a whole was characterised during the 1990s by a succession of three relatively short-lived cycles,[39] with the EU cycle being somewhat less volatile than the euro area cycle, at least at the start of the 1990s. In particular, three full peak-to-peak cycles can be identified for the euro area countries during the 1990s (see Chart 8, left panel)[40]:

39 The discussion in this section focuses on the 1990s only for comparative purposes, given the absence of sufficient data for the 1980s.

40 See also the article entitled "Characteristics of the euro area business cycle in the 1990s" in the July 2002 issue of the ECB's Monthly Bulletin.

**Chart 8 The EU and euro area business cycle in the 1990s**




Sources: Eurostat, NCB, ECB calculations.
Notes: For data availability reasons, the euro area aggregate comprises Belgium, Germany, Spain, France, Finland, the Netherlands, Italy and Austria. The EU aggregate includes, in addition to these euro area countries, Denmark, Sweden and the UK. Data range from 1990 to 2001 for the quarterly indicator and from 1990 to 2000 for the monthly industrial production indicators.

– a first cycle from the peak in the first quarter of 1992 to the peak in the first quarter of 1995;
– a cycle in the mid-1990s from the peak in the first quarter of 1995 to the peak in the first quarter of 1998;
– a third cycle in the late 1990s from the peak in the first quarter of 1998 to the peak in the third quarter of 2000.

The business cycle in industry followed this pattern closely, albeit with a more pronounced amplitude (see Chart 8, right panel).

While industry seems to be an important factor in shaping the aggregate business cycle, other sectors may contribute as well, both directly through their particular sectoral volatility or indirectly through sectoral linkages. Decomposing the EU-wide variance of gross value added growth[41] by sector can hence be used to assess the relative importance of sectoral volatility compared with sectoral linkages. Whereas variances are used to measure sectoral volatility, covariances measure the cross-sectoral impact of volatility. Table 6 presents the decomposition of the overall variance of the growth rate of value added using the following sectoral breakdown of quarterly gross value added figures[43] (available from Eurostat) which will be used throughout the remainder of this section:

41 See Annex 4.2.2.2 for a discussion of the sectoral decomposition of aggregate volatility.
42 See Annex 4.1.2 for the availability of quarterly and monthly data that have been used for this chapter.

**Table 6 The EU business cycle and its sectoral components**

(Percentages of euro area-wide variance of quarterly gross value added explained by sectoral volatility (variance-covariance of quarterly sectoral gross value added)).

| Variances | | | | | |
|---|---|---|---|---|---|
| 1988-2002 | | 1993-1997 | | 1998-2002 | |
| Industry | 11.1 | Industry | 11.5 | Industry | 12.6 |
| Trade | 8.3 | Trade | 8.7 | Trade | 7.0 |
| Construction | 4.7 | Construction | 5.8 | Business activities | 5.2 |
| Business activities | 4.5 | Business activities | 4.5 | Construction | 3.2 |
| Public services | 2.4 | Public services | 2.6 | Public services | 2.3 |
| Agriculture | 1.9 | Agriculture | 1.6 | Finance | 1.8 |
| Finance | 1.5 | Finance | 1.1 | Agriculture | 1.6 |
| Total | 34.4 | Total | 35.9 | Total | 33.6 |
| **Covariances** | | | | | |
| 1988-2002 | | 1993-1997 | | 1998-2002 | |
| Industry - Trade | 6.6 | Industry - Trade | 6.8 | Industry - Trade | 7.0 |
| Construction - Trade | 4.0 | Construction - Trade | 5.1 | Industry - Bus. act. | 4.5 |
| Industry - Construction | 3.9 | Industry - Construction | 4.4 | Industry - Construction | 3.9 |
| Industry - Bus. act. | 3.9 | Trade - Bus. act. | 3.6 | Trade - Bus. act. | 3.5 |
| Agriculture - Industry | 3.6 | Construction - Bus. act. | 3.5 | Industry - Pub. serv. | 3.5 |
| Trade - Bus. act. | 3.5 | Industry - Bus. act. | 3.4 | Agriculture - Industry | 3.4 |
| Trade - Pub.serv. | 3.0 | Trade - Pub. serv. | 3.3 | Construction - Trade | 3.1 |
| Construction - Bus. act. | 2.9 | Agriculture - Industry | 3.1 | Trade - Pub. serv. | 3.1 |
| Agriculture - Trade | 2.8 | Agriculture - Trade | 2.8 | Finance - Bus. act. | 3.0 |
| Industry - Pub. serv. | 2.6 | Industry - Pub. serv. | 2.4 | Bus. serv. - Pub. serv. | 2.4 |
| Trade - Finance | 2.3 | Trade - Finance | 2.2 | Construction - Bus. act. | 2.2 |
| Finance - Bus. act. | 2.2 | Construction - Pub. serv. | 2.0 | Industry - Finance | 2.2 |
| Industry - Finance | 2.1 | Finance - Bus. act. | 2.0 | Agriculture - Trade | 2.1 |
| Agriculture - Bus. act. | 1.9 | Industry - Finance | 1.8 | Trade - Finance | 1.9 |
| Bus. act. - Pub. serv. | 1.8 | Agriculture - Bus. act. | 1.7 | Agriculture - Construction | 1.6 |
| Agriculture - Construction | 1.8 | Bus. act. - Pub. serv. | 1.6 | | |
| Total | 48.9 | Total | 49.7 | Total | 47.5 |

Sources: Eurostat, NCBs, ECB calculations
Countries: Belgium, Germany, Denmark, Spain, France, Italy, Netherlands, Austria, Finland.

– *agriculture;*
– industry including energy (hereafter *industry*);
– *construction*;
– trade, restaurants, transport and communication (*trade*);
– finance and insurance (*finance*);
– real estate, renting and business activities (*business activities*);
– community, social and personal services (*public services*).

Confirming the initial remarks, Table 6 shows that the variance of *industry* consistently accounted for the largest share of the overall variance between 1988-2002 followed by the variances of *trade*, *construction* and *business activities*. These last two service sectors are less volatile[43] than *industry* (partly on account of the absence of the inventory cycle) and have been rapidly expanding their share of total value added since the 1980s. By contrast, *agriculture* and *finance*, despite having the highest degree of relative volatility per country (as will be discussed below, see Table 7), contribute little to EU-wide volatility. This is possibly related to the fact that these last two sectors are relatively more exposed to country-specific fluctuations.

The analysis looks in particular at the sub-periods 1993-97 to capture the effect of the Single Market and 1998-2002 to capture the effect of the introduction of the single currency. We find that only very little change occurred between these two sub-periods, with the seven sectors considered contributing slightly less to the overall variance of the euro area cycle in the period 1998-2002. In addition, the covariance of *industry* and *trade* and *industry* and *business activities* has tended to become more important between these two periods, partly due to the increased linkages between these two sectors as a result of the outsourcing of many services from manufacturing.

The sectoral breakdown of aggregate volatility for the euro area cycle supports the view that sectoral composition is important for the analysis of aggregate volatility. In particular, the strong differences in the contributions of *industry* compared with *business activities* and *public services* may give rise to country-specific business cycle patterns that are determined in part by differences in sectoral composition.

## 3.2 SECTORAL VOLATILITY

Differences in volatility across countries and sectors are a characteristic element of aggregate business cycles. Documenting the sectoral sources of aggregate fluctuations in EU countries can therefore provide information about the driving forces for business cycles. This section focuses on comparing the relative sectoral volatility across EU countries over the period 1980-2001 on the basis of the disaggregation into seven main sectors, as described above. Moreover, in the light of the important sectoral changes that some EU countries have undergone over the last two decades, the impact of change in sectoral composition in EU countries on the change of aggregate production volatility is also documented[44].

### 3.2.1 RELATIVE VOLATILITY AND ITS EVOLUTION OVER TIME

In order to calculate the relative volatility of the sectoral indicators with respect to each country's total GDP volatility, the business cycle component was extracted from aggregate and sectoral gross value added.[45] As can be seen from Table 7, substantial differences exist between sectors, with *agriculture* and *finance* being the most volatile sectors, followed by *construction*. Service sectors such as *trade* and *business activities* show minor volatility, with the notable exception of the UK where volatility in *trade* almost reaches the level of volatility experienced in *agriculture*.

43 For sectoral relative volatility measures, see Table 7.
44 See Annex 4.2.2 for the methodology that was used to extract the business cycle components.
45 Volatility measures were constructed on the basis of an 11-quarter symmetric rolling window.

**Table 7 Relative volatility**

(1980-2001, in percentage points)

| | Agriculture | Industry | Construction | Trade | Finance | Business activities | Public services | Country average | Country *std. dev.* |
|---|---|---|---|---|---|---|---|---|---|
| Belgium | 22.3 | 4.6 | 15.8 | 2.1 | 18.9 | 2.1 | 0.6 | 4.4 | *2.0* |
| Denmark | 12.2 | 5.2 | 21.0 | 3.5 | 18.3 | 2.2 | 0.7 | 4.8 | *2.1* |
| Germany | 10.4 | 4.3 | 4.9 | 2.8 | 6.4 | 1.4 | 0.3 | 3.0 | *0.8* |
| Greece | na | na | na | na | na | na | na | na | *na* |
| Spain | 18.0 | 1.8 | 10.9 | 1.1 | 11.7 | 2.1 | 0.5 | 3.4 | *1.8* |
| France | 11.6 | 3.5 | 12.2 | 3.4 | 8.8 | 1.4 | 0.4 | 3.3 | *1.2* |
| Ireland | na | na | na | na | na | na | na | na | *na* |
| Italy | 22.4 | 5.3 | 6.9 | 1.6 | 4.9 | 1.5 | 0.3 | 3.5 | *1.6* |
| Luxembourg | na | na | na | na | na | na | na | na | *na* |
| Netherlands | 8.5 | 2.9 | 10.3 | 4.2 | 7.0 | 3.2 | 0.4 | 3.5 | *1.0* |
| Austria | 24.6 | 4.1 | 10.3 | 1.7 | 5.3 | 2.3 | 1.4 | 3.7 | *1.5* |
| Portugal | na | na | na | na | na | na | na | na | *na* |
| Finland | 5.7 | 2.3 | 6.0 | 2.1 | 8.6 | 0.5 | 0.3 | 2.2 | *0.8* |
| Sweden | 7.0 | 4.9 | 4.4 | 1.4 | 17.2 | 2.0 | 0.4 | 3.1 | *1.4* |
| United Kingdom | 7.3 | 2.3 | 2.5 | 6.8 | 6.6 | 3.3 | 1.2 | 3.3 | *0.7* |
| EU average | 13.7 | 3.8 | 5.5 | 2.6 | 8.2 | 1.7 | 0.6 | | |
| *std. dev.* | *18.2* | *0.5* | *10.4* | *0.7* | *5.7* | *0.2* | *0.1* | | |

Sources: Eurostat, NCBs, ECB calculations.
Note: The table reports the variance of the business cycle component of the logarithm of sectoral gross value added divided by the variance of the business cycle component of the logarithm of total gross value added. Country and EU averages and standard deviations refer to weighted values.

In addition, important cross-country differences exist, as indicated by the EU-wide standard deviation of relative volatility measures. Variation[46] is strongest in *agriculture*, *construction* and *finance*. Overall, however, country differences seem to be more important than sectoral differences, as indicated by the country-specific standard deviations of relative volatility across sectors.

A comparison of the relative volatility measure between the 1980s and the 1990s also reveals a substantial decrease in sectoral volatility, at least for some countries (see Table 8). Most notably, sectoral volatility has decreased in *construction*, with the exception of Spain, France and Italy where an important increase was detected. The decrease in volatility was less pronounced in *agriculture*, where Belgium and the UK experienced increasing volatility. In the remaining sectors, changes in sectoral volatility were either more country-specific (such as in *finance*) or barely discernible, owing mostly to the already low levels during the 1980s, especially in the services sectors.

Although there have been some differences in sectoral volatility, the impact of sectoral specialisation in the EU is likely to be rather limited given that differences in the sectoral composition of countries are moderate.

### 3.2.2 RELATIVE VOLATILITY IN MANUFACTURING

The level of aggregation used for the business cycle analysis in this section hides an important degree of sectoral heterogeneity at a more detailed level of disaggregation. In particular, manufacturing sectors can be further characterised on the basis of their technological intensity.[47] This, in turn, is likely to have a bearing on the business cycle characteristics at the disaggregated level.

46 Regarding trade, the particularly high volatility in the UK has a decisive impact on the standard deviation.

47 The analysis in this section has been carried out on the basis of monthly industrial production indices. These monthly industrial production indicators for manufacturing sectors have been grouped according to the same principles as those applied for annual data in the preceding chapter. See Annex 4.1.1 for more details on how manufacturing sectors have been aggregated.

**Table 8 Evolution of relative volatility**

(1980-2001, in percentage points)

| | Agriculture | | Industry | | Construction | | Trade | | Finance | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s |
| Belgium | 21.2 | 23.8 | 6.7 | 3.6 | 28.7 | 8.2 | 1.7 | 2.2 | 37.4 | 8.5 |
| Denmark | 11.5 | 13.6 | 4.1 | 7.4 | 21.1 | 20.8 | 3.0 | 4.3 | 19.9 | 14.8 |
| Germany | 25.1 | 3.6 | 4.9 | 4.7 | 5.7 | 5.1 | 2.6 | 2.9 | 5.6 | 8.1 |
| Greece | na | na | na | na | na | na | na | na | na | na |
| Spain | 21.4 | 14.8 | 1.4 | 2.3 | 10.9 | 11.3 | 1.2 | 1.0 | 14.8 | 9.3 |
| France | 13.7 | 9.8 | 1.8 | 4.9 | 3.9 | 19.0 | 3.3 | 3.4 | 6.1 | 10.4 |
| Ireland | na | na | na | na | na | na | na | na | na | na |
| Italy | 39.7 | 15.4 | 4.4 | 5.7 | 4.6 | 9.9 | 1.0 | 2.0 | 12.4 | 3.6 |
| Luxembourg | na | na | na | na | na | na | na | na | na | na |
| Netherlands | na | 8.0 | na | 2.6 | na | 5.8 | na | 3.9 | na | 3.5 |
| Austria | na | 24.5 | na | 3.7 | na | 8.8 | na | 1.7 | na | 5.6 |
| Portugal | na | na | na | na | na | na | na | na | na | na |
| Finland | 4.2 | 7.8 | 1.3 | 3.4 | 6.4 | 6.1 | 2.3 | 2.0 | 7.3 | 11.0 |
| Sweden | 14.5 | 2.5 | 5.4 | 5.1 | 4.7 | 3.7 | 2.0 | 0.9 | 19.1 | 33.8 |
| United Kingdom | 5.7 | 12.6 | 2.0 | 3.2 | 2.5 | 2.4 | 7.7 | 3.7 | 5.2 | |
| EU average | 20.5 | 10.9 | 3.6 | 4.5 | 4.9 | 6.4 | 2.4 | 2.6 | 9.6 | 9.2 |
| *std. dev.* | *4.8* | *7.4* | *1.7* | *0.5* | *18.9* | *2.9* | *1.4* | *0.3* | *40.3* | *1.7* |

| | Business activities | | Public services | | Country average | *Country std. dev.* | Country average | *Country std. dev.* |
|---|---|---|---|---|---|---|---|---|
| | 1980s | 1990s | 1980s | 1990s | 1980s | *1980s* | 1990s | *1990s* |
| Belgium | 3.4 | 1.4 | 0.7 | 0.7 | 6.7 | *3.8* | 3.0 | *1.3* |
| Denmark | 1.2 | 4.4 | 0.6 | 0.9 | 4.3 | *2.2* | 5.7 | *1.9* |
| Germany | 1.2 | 1.5 | 0.3 | 0.3 | 3.3 | *1.2* | 3.1 | *0.8* |
| Greece | na | na | na | na | na | *na* | na | *na* |
| Spain | 3.9 | 0.4 | 0.4 | 0.7 | 3.9 | *2.1* | 3.1 | *1.6* |
| France | 1.3 | 1.5 | 0.5 | 0.4 | 2.4 | *1.0* | 4.0 | *1.7* |
| Ireland | na | na | na | na | na | *na* | na | *na* |
| Italy | 0.3 | 1.3 | 0.4 | 0.4 | 3.8 | *2.8* | 3.5 | *1.3* |
| Luxembourg | na | na | na | na | na | *na* | na | *na* |
| Netherlands | na | 1.3 | na | 0.4 | na | *na* | 2.6 | *0.7* |
| Austria | na | 2.4 | na | 1.4 | na | *na* | 3.5 | *1.5* |
| Portugal | na | na | na | na | na | *na* | na | *na* |
| Finland | 0.3 | 0.8 | 0.1 | 0.5 | 1.8 | *0.7* | 2.7 | *1.0* |
| Sweden | 2.3 | 4.1 | 0.3 | 0.9 | 3.7 | *1.6* | 4.2 | *2.5* |
| United Kingdom | 3.1 | 3.9 | 1.0 | 1.7 | 3.1 | *0.7* | 4.0 | *1.0* |
| EU average | 1.6 | 1.8 | 0.6 | 0.8 | | | | |
| *std. dev.* | *0.9* | *0.4* | *0.1* | *0.1* | | | | |

Sources: Eurostat, NCBs, ECB calculations.
Notes: The table shows – for the sub-periods 1980-1990 and 1991-2001 – the variance of the business cycle component of the logarithm of sectoral gross value added divided by the variance of the business cycle component of the logarithm of total gross value added. The EU average only includes Belgium, Denmark, Germany, Spain, France, Italy, Finland, Sweden and the UK to guarantee comparability between the 1980s and 1990s.

When analysing the relative volatility of manufacturing sectors classified by their technological intensity, there seems to be a stronger volatility in high-tech and medium to high-tech sectors than in low and medium to low-tech sectors, which holds true across all EU countries (see Table 9 below). On the one hand, it should be noted that owing to the important differences in the volatility of manufacturing production across EU countries (in comparison with the EU cycle), the absolute volatility in these sectors may differ to a certain extent. On the other hand, given the differences of relative volatility across manufacturing sectors, the variation of manufacturing volatility across EU countries can be related, partly, to differences regarding EU countries' manufacturing specialisation, as reported in the preceding section.

**Table 9 Relative volatility in manufacturing**

(1990-2000)

| | High-tech industries | Medium-high-tech industries | Medium-low-tech industries | Low-tech-industries | Manufacturing rel. to euro area | Manufacturing rel. to EU |
|---|---|---|---|---|---|---|
| Belgium | 1.38 | 3.06 | 1.08 | 0.37 | 0.79 | 0.75 |
| Denmark | 2.11 | 1.86 | 1.52 | 0.93 | - | 1.01 |
| Germany | 1.77 | 0.99 | 0.55 | 0.54 | 1.83 | 1.73 |
| Greece | 3.32 | 1.51 | 2.90 | 1.50 | 0.46 | 0.44 |
| Spain | 2.01 | 2.05 | 0.69 | 0.76 | 1.48 | 1.41 |
| France | 1.75 | 2.24 | 0.65 | 0.35 | 0.78 | 0.74 |
| Ireland | na | na | na | na | na | na |
| Italy | 2.26 | 1.32 | 0.74 | 0.63 | 1.36 | 1.29 |
| Luxembourg | na | na | na | na | na | na |
| Netherlands | 3.04 | 3.37 | 0.32 | 0.25 | 0.63 | 0.60 |
| Austria | na | na | na | na | na | na |
| Portugal | na | na | na | na | na | na |
| Finland | 1.45 | 1.25 | 1.90 | 0.24 | 6.60 | 6.26 |
| Sweden | 1.13 | 2.04 | 1.20 | 0.45 | - | 4.78 |
| United Kingdom | 1.42 | 2.18 | 0.81 | 0.84 | - | 1.19 |
| Euro area average | 2.12 | 1.98 | 1.10 | 0.58 | - | - |
| *std. dev.* | *0.71* | *0.87* | *0.87* | *0.41* | - | - |
| EU average | 1.97 | 1.99 | 1.12 | 0.62 | - | - |
| *std. dev.* | *0.69* | *0.73* | *0.74* | *0.37* | - | - |

Sources: Eurostat, NCBs, ECB calculations.
Notes: Business cycle components were extracted from monthly industrial production indices as available in the short-term statistics database. The last two columns represent the relative volatility of a country's industrial production with respect to the volatility of industrial production in the euro area and the EU.

Overall, one can conclude that a further specialisation in high and medium to high-tech industries, as is currently underway in some EU countries, could contribute to a rise in the volatility of the manufacturing sector as a whole, notwithstanding any potential positive role in increasing potential output growth or productivity. However the current figures should not be extrapolated because the observed level of volatility in emerging high-tech sectors should normally decline when the innovation wave reaches maturity.

### 3.2.3 SECTORAL COMPOSITION AND AGGREGATE VOLATILITY

In order to calculate the impact of sectoral change during the last two decades on changes in the volatility of the aggregate business cycles, aggregate volatility was decomposed into its sectoral contributions.[48] When fixing sectoral shares both at their initial level in 1982:Q2 and at their final level in 2001:Q1, the impact of sectoral change on aggregate volatility can be assessed (see Chart 9).

Interestingly, despite much cross-sectoral diversity in relative volatility, sectoral changes seem to have played only a limited role in explaining the change in aggregate volatility, confirming earlier studies that claim that the change in aggregate volatility has been a cross-sectoral phenomenon.[49] For instance, in France, Austria and – to some extent – Italy, sectoral re-allocations seem to have contributed to reduced aggregate fluctuations (albeit on a small scale) during the 1990s. However, the general movement of business cycle volatility was significantly more important in all three countries than sectoral re-allocations.

For Germany, an impact of the change in sectoral composition following reunification can be detected in the data, albeit on a small scale. Here, aggregate output volatility was

48 See C. Buch, J. Doepke and C. Pierdzioch, "Business Cycle Volatility in Germany", German Economic Review, forthcoming.
49 T. Dalsgaard, J. Elmeskov and C.-Y. Park (2002), "Ongoing changes in the business cycle – evidence and causes", OECD Economics Department Working Paper 315.

## Chart 9 Sectoral shifts and volatility

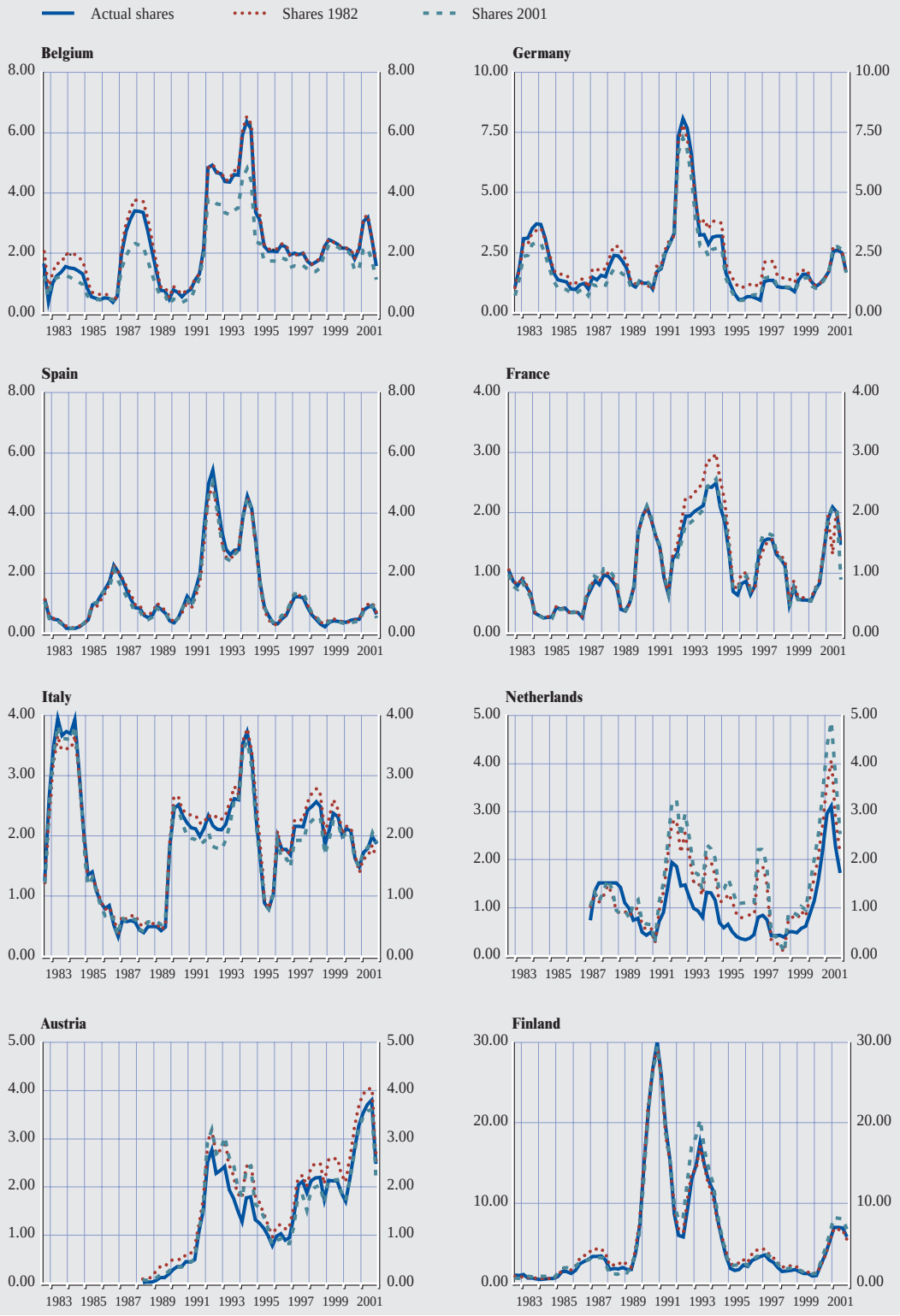
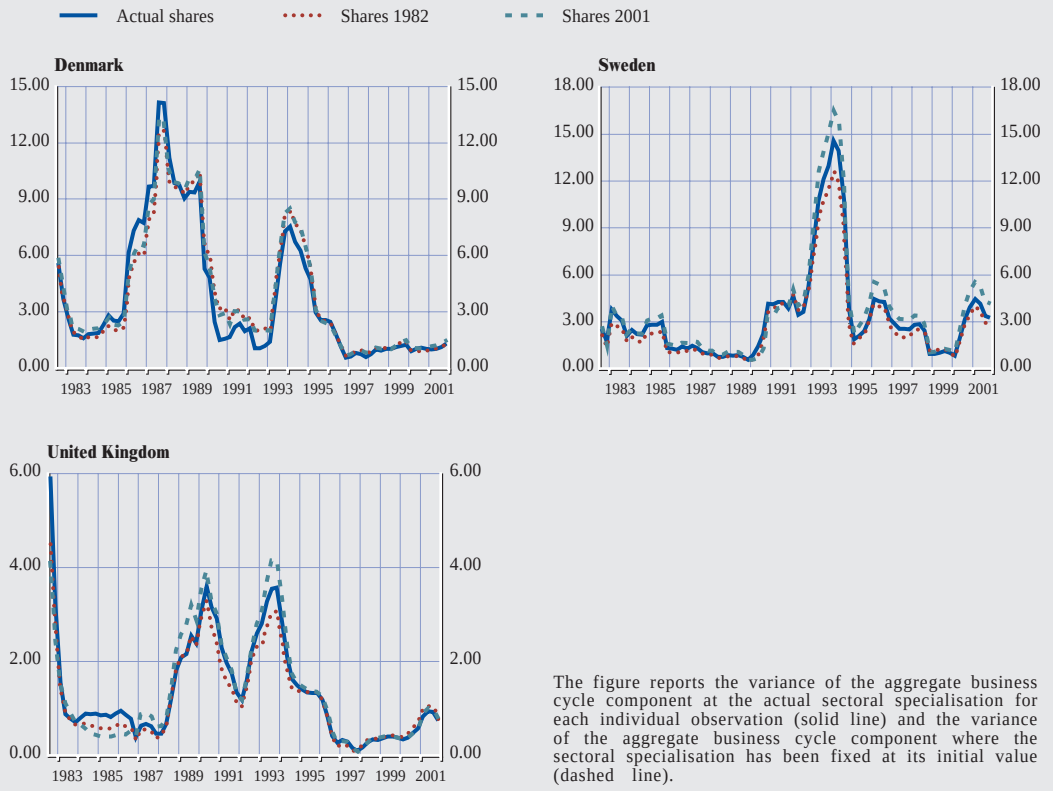


**Chart 9 Sectoral shifts and volatility (cont'd)**




The figure reports the variance of the aggregate business cycle component at the actual sectoral specialisation for each individual observation (solid line) and the variance of the aggregate business cycle component where the sectoral specialisation has been fixed at its initial value (dashed line).

Sources: Eurostat, NCBs, ECB calculations.
Note: See Annex 4.2.2.2 for a discussion of the underlying methodology and a presentation of volatility developments using the same scale for all countries.

almost consistently lower over the period after 1991 following the increased weight of low-volatility business sector services. Finally, Sweden seems to have experienced a slight increase of its aggregate volatility, mainly on account of a slightly increasing share of *industry* in its final output.

## 3.3 BUSINESS CYCLE SYNCHRONISATION ACROSS EU COUNTRIES: SECTORAL ORIGINS

Business cycle synchronisation relates to the degree of co-movement of aggregate production across a group of countries. Analysing the synchronisation of business cycles at the sectoral level is relevant in this respect, given that changes in the composition of output could have impacted upon business cycle synchronisation. Nevertheless, additional factors may offset the negative impact of sectoral specialisation on the harmonisation of business cycles, as will be discussed in the next section.[50]

50 It is, however, not clear how precisely convergence between business cycles should be assessed. Different suggestions have been put forward, including increased bivariate correlations, decreased cyclical disparity or emerging common factors that drive individual countries' business cycles. Using the business cycle components presented in the preceding section, bivariate correlations have been preferred here. For an overview of measures of business cycle synchronisation, see M. Massmann and J. Mitchell (2002), "Have UK and euro zone business cycles become more correlated?", National Institute Economic Review, 182. For a recent analysis of the factors driving business cycle synchronisation in G7 countries, see A. Monfort, J.-P. Renne, R. Rüffer and G. Vitale (2003), "Is economic activity in the G7 synchronised? Common shocks versus spillover effects", CEPR Discussion Paper, 4119.

**Chart 10** Business cycle synchronisation

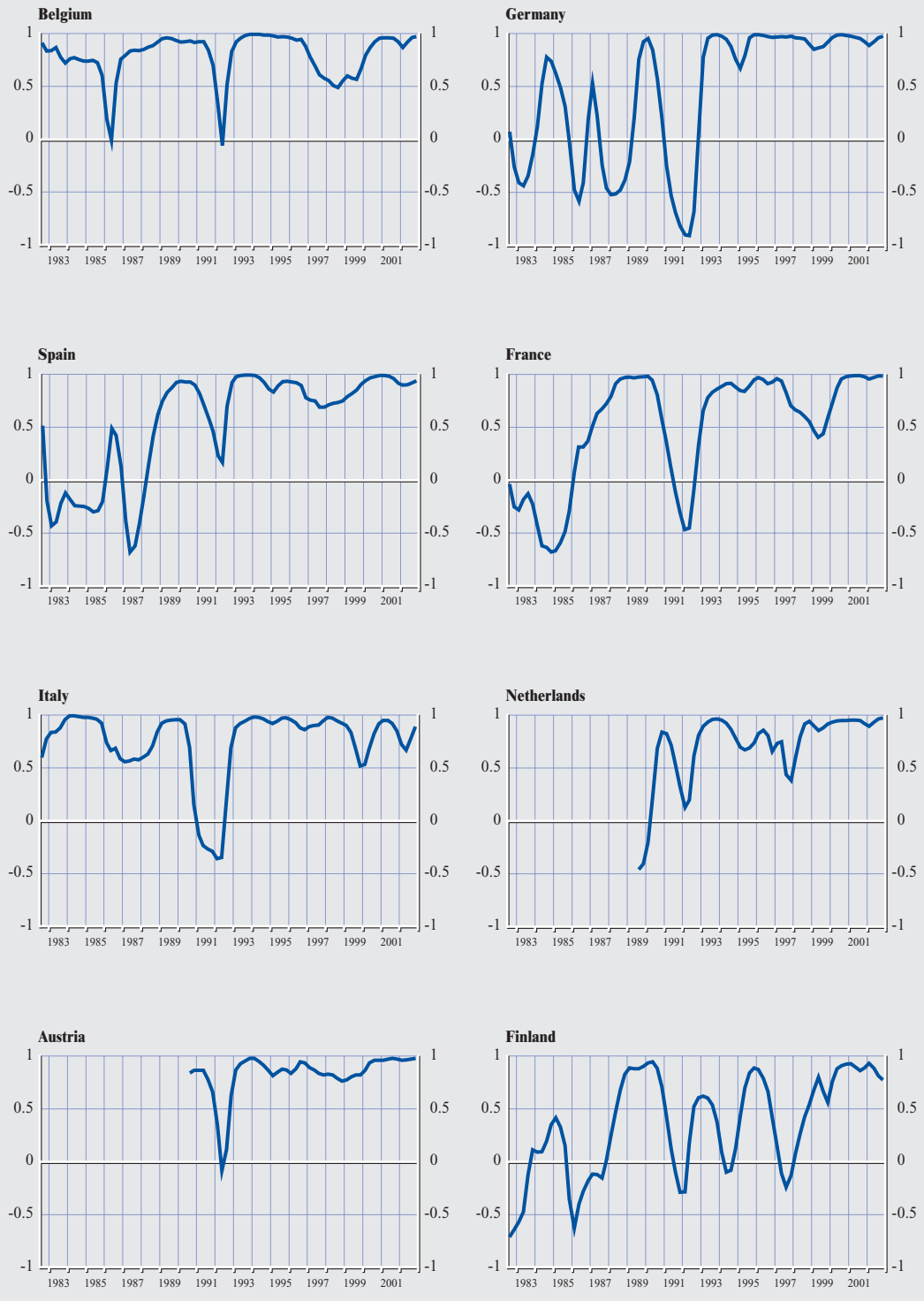
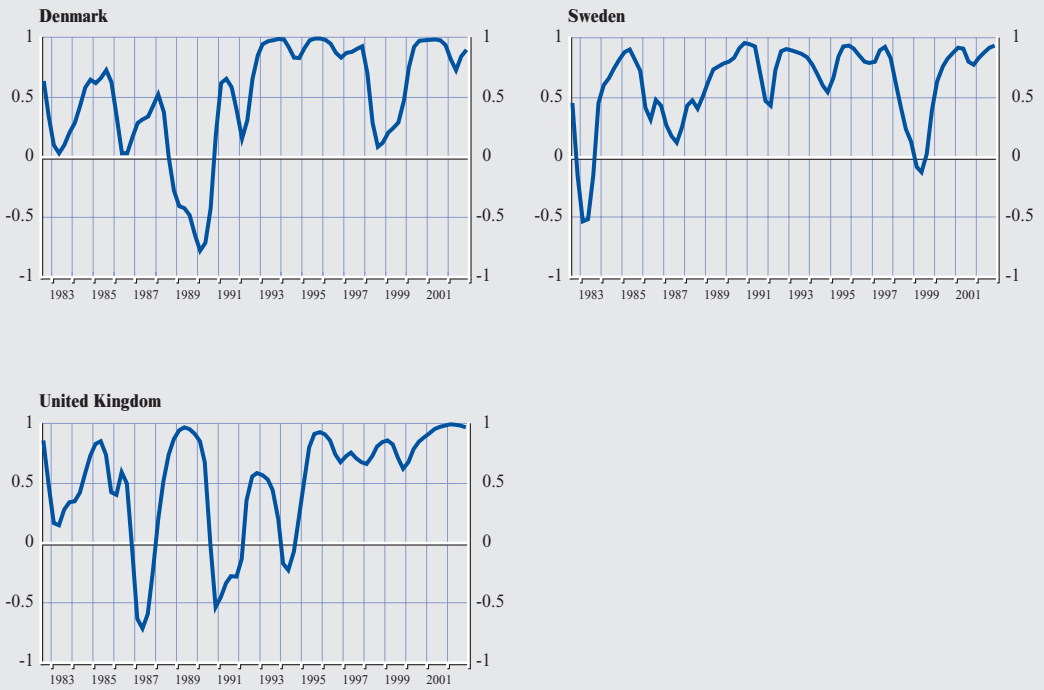


Chart 10 Business cycle synchronisation




Sources: Eurostat, NCBs, ECB calculations.
Note: Business cycle correlation is measured by the correlation coefficient of an 11-quarter rolling window between the business cycle component of each individual country and the (available) business cycle component for the rest of the EU countries (applying country weights to each individual EU country business cycle component).

### 3.3.1 AGGREGATE VERSUS SECTORAL BUSINESS CYCLE SYNCHRONISATION

Measuring business cycle correlations for each available country against the average cycle of the remaining EU countries, Chart 10 gives an overview of the evolution of business cycle synchronisation.

The Chart confirms earlier analyses in this area showing that business cycle synchronisation increased at the beginning of the 1990s and continued throughout the decade, despite a short period of relatively lower synchronisation in the aftermath of the Asian and Russian crises (1997 and 1998) that affected Germany relatively more strongly than the other EU countries.[51] This de-synchronisation was particularly important for some smaller EU countries (Denmark, Sweden), where even some divergence was observed in 1997, but also for countries like France and Italy, albeit on a smaller scale.

Similarly to the aggregate business cycle, synchronisation can also be measured on the sectoral level, as presented in Table 10. In this table, correlation coefficients for each sector between individual countries and the EU countries average are presented:

51 This also holds true for those EU countries for which the analysis could not be carried out on account of missing data. Looking at annual data over a longer period, Belo (2001) detects cyclical convergence for Ireland, Portugal and Greece over the period 1960-1999 yielding qualitatively speaking the same conclusions as in this report; F. Belo (2001), "Some facts about the cyclical convergence in the euro zone", Banco de Portugal Working Paper, 7-01.

**Table 10 Aggregate and sectoral business cycle synchronisation**

(in percentages)

| | 1990s | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Aggregate | Agriculture | Industry | Construction | Trade | Finance | Business activities | Public services |
| Belgium | 0.81 | 0.20 | 0.72 | 0.49 | 0.59 | -0.42 | 0.35 | -0.16 |
| Germany | 0.83 | 0.50 | 0.81 | 0.23 | 0.38 | -0.19 | 0.27 | -0.09 |
| Greece | na | na | na | na | na | na | na | na |
| Spain | 0.86 | -0.15 | 0.73 | 0.35 | 0.82 | -0.27 | 0.09 | 0.03 |
| France | 0.77 | 0.57 | 0.79 | 0.45 | 0.46 | 0.18 | 0.24 | -0.06 |
| Ireland | na | na | na | na | na | na | na | na |
| Italy | 0.83 | 0.50 | 0.86 | 0.08 | 0.68 | 0.56 | 0.12 | 0.34 |
| Luxembourg | na | na | na | na | na | na | na | na |
| Netherlands | 0.82 | 0.42 | 0.76 | 0.36 | 0.65 | 0.02 | 0.36 | -0.15 |
| Austria | 0.85 | 0.22 | 0.90 | 0.51 | 0.34 | 0.37 | 0.24 | 0.45 |
| Portugal | na | na | na | na | na | na | na | na |
| Finland | 0.54 | -0.36 | 0.68 | -0.04 | 0.63 | 0.37 | -0.15 | 0.23 |
| Denmark | 0.78 | -0.22 | 0.62 | 0.66 | 0.03 | 0.22 | 0.16 | -0.15 |
| Sweden | 0.71 | -0.03 | 0.76 | 0.38 | 0.61 | 0.21 | 0.25 | 0.17 |
| United Kingdom | 0.68 | 0.53 | 0.43 | 0.54 | 0.16 | 0.60 | 0.33 | 0.12 |
| | 1980s | | | | | | | |
| Belgium | 0.78 | 0.16 | 0.86 | 0.18 | 0.36 | -0.09 | 0.48 | -0.02 |
| Germany | 0.00 | 0.16 | 0.37 | 0.36 | -0.21 | -0.56 | -0.52 | -0.27 |
| Greece | na | na | na | na | na | na | na | na |
| Spain | 0.18 | -0.19 | -0.14 | 0.16 | 0.35 | -0.12 | -0.38 | 0.23 |
| France | 0.22 | 0.23 | 0.62 | 0.34 | 0.34 | 0.18 | 0.24 | 0.24 |
| Ireland | na | na | na | na | na | na | na | na |
| Italy | 0.66 | 0.42 | 0.51 | 0.22 | 0.62 | 0.48 | -0.14 | 0.51 |
| Luxembourg | na | na | na | na | na | na | na | na |
| Netherlands | na | na | na | na | na | na | na | na |
| Austria | na | na | na | na | na | na | na | na |
| Portugal | na | na | na | na | na | na | na | na |
| Finland | 0.16 | 0.02 | 0.46 | 0.40 | 0.48 | 0.61 | 0.19 | -0.24 |
| Denmark | 0.19 | 0.37 | 0.34 | -0.09 | 0.18 | 0.66 | 0.42 | 0.35 |
| Sweden | 0.51 | 0.05 | 0.57 | 0.08 | 0.50 | 0.32 | -0.16 | -0.11 |
| United Kingdom | 0.31 | 0.22 | 0.43 | 0.45 | 0.77 | 0.36 | 0.24 | 0.33 |

Sources: Eurostat, NCBs, ECB calculations.
Note: The table shows averages of correlation coefficients of the aggregate and the sectoral business cycle components across countries using an 11-quarter rolling window; averages were calculated with respect to the periods 1981-1990 and 1991-2001.

Compared with the aggregate synchronisation, convergence at the sectoral level appears to be much less important. While *industry* synchronisation follows a similar pattern to that for the aggregate level, mainly on account of its higher degree of openness and international links, *trade* has been synchronised with the remaining EU countries only in some countries, such as Belgium, Finland (only during the 1990s), Spain, the Netherlands, Italy and Sweden. *Construction* and *finance* seem to have followed a more heterogeneous synchronisation pattern, with some periods where *construction* was following similar paths in EU countries and others where it diverged across EU countries.

### 3.3.2 BUSINESS CYCLE SYNCHRONISATION: SECTORAL ORIGINS

Given the large differences in synchronisation across different sectors, it can be estimated to what extent the different sectors have contributed to aggregate business cycle synchronisation. Table 11 gives an overview of

**Table 11 Sector contributions to business cycle convergence of EU countries**

| | 1980-2001 | 1980-1990 | 1991-2001 | 1980-1986 | 1986-1991 | 1991-1996 | 1996-2001 |
|---|---|---|---|---|---|---|---|
| Agriculture | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Industry | + | + | + | + | + | + | + |
| Construction | + | + | 0 | + | + | 0 | 0 |
| Trade | + | + | + | + | + | + | + |
| Finance | 0 | – | + | 0 | – | 0 | + |
| Business activities | + | + | + | 0 | + | + | 0 |
| Public services | 0 | 0 | 0 | 0 | 0 | + | 0 |

Sources: Eurostat, NCBs, ECB calculations.
Notes: Estimates are based on fixed effects (within) estimations with an AR(1) disturbance. See Annex 4.2.2.3 on the way the table has been set up.
+ : Sectoral contribution to business cycle convergence significant at the 5% level.
– : Sectoral contribution to business cycle divergence significant at the 5% level.
0 : No significant sectoral contribution to business cycle convergence.

the different sectoral contributions across EU countries to business cycle convergence among member countries between 1980-2001.

The table indicates whether sectoral cyclical convergence has contributed (indicated by "+") or not ("0") to business cycle synchronisation across EU countries; in two cases a contribution to business cycle *divergence* is indicated ("-"). As can be seen from the table, *industry* and *trade* have contributed consistently to business cycle convergence throughout the entire period, while *finance* contributed mainly at the end of the 1990s to business cycle synchronisation. *Construction* and *business activities*, on the other hand, contributed only in two sub-periods, while *agriculture* and *public services* contributed significantly to business cycle synchronisation only in one sub-period.

Estimations for the sectoral contributions for the four sub-periods show that business cycle convergence was strongest during the early 1980s and the early 1990s, when almost all sectors contributed to aggregate business cycle synchronisation.

### 3.4 SECTORAL CO-MOVEMENTS

Despite persistent differences in sectoral specialisation, the preceding sections documented business cycle synchronisation among EU countries. One explanation may be the existence of co-movements of different sectors. Following earlier research[52], this section aims at identifying the importance of sectoral co-movement in EU countries and its evolution over the period 1980-2001.

Sectoral co-movement can mitigate the negative impact of sectoral specialisation on the harmonisation of business cycles across EU countries. Following earlier work by Christiano and Fitzgerald (1998), sectoral co-movements were determined for a subset of countries in order to evaluate to what extent different sectors move together over the period under consideration. In turn, this will also provide a different angle for assessing which of the sectors contributed most to aggregate business cycle synchronisation during the last decade. Table 12 gives an overview of the evolution of business cycle co-movements between 1980-90 and 1991-2001.

Across the board, the sectors *industry* and *trade* (with Belgium being the only exception) contributed the most to sectoral co-movements, while *agriculture* and – to a lesser extent – *finance* saw relatively low sectoral co-movement. *Construction* was more varied, closely following the aggregate business cycle

52 L. J. Christiano and T. J. Fitzgerald (1998), "The Business Cycle: It's Still a Puzzle", Economic Perspectives, Federal Reserve Bank of Chicago, Fourth Quarter.

**Table 12 Sectoral co-movement**

(in percentage points)

| | Agriculture | | Industry | | Construction | | Trade | | Finance | | Public services | | Business activities | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s | 1980s | 1990s |
| Belgium | 0.29 | 0.21 | 0.78 | 0.74 | 0.17 | 0.73 | 0.21 | 0.47 | 0.04 | 0.06 | 0.62 | 0.77 | 0.20 | 0.32 |
| Denmark | 0.24 | 0.08 | 0.63 | 0.69 | 0.66 | 0.41 | 0.52 | 0.52 | 0.63 | 0.17 | 0.23 | 0.35 | 0.12 | 0.26 |
| Germany | 0.04 | 0.27 | 0.78 | 0.79 | 0.35 | 0.23 | 0.75 | 0.83 | 0.05 | 0.12 | 0.36 | 0.67 | 0.28 | 0.44 |
| Greece | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Spain | 0.29 | 0.10 | 0.77 | 0.83 | 0.50 | 0.78 | 0.65 | 0.77 | 0.34 | 0.51 | 0.27 | 0.41 | 0.49 | 0.68 |
| France | 0.16 | 0.15 | 0.69 | 0.72 | 0.49 | 0.67 | 0.95 | 0.64 | 0.35 | 0.00 | 0.78 | 0.78 | 0.12 | 0.17 |
| Ireland | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Italy | 0.36 | 0.65 | 0.91 | 0.72 | 0.04 | 0.33 | 0.79 | 0.92 | 0.33 | 0.05 | 0.50 | 0.37 | 0.05 | 0.31 |
| Luxembourg | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Netherlands | na | 0.09 | na | 0.37 | na | 0.51 | na | 0.94 | na | 0.19 | na | 0.48 | na | 0.00 |
| Austria | na | 0.03 | na | 0.73 | na | 0.43 | na | 0.69 | na | 0.05 | na | 0.47 | na | 0.25 |
| Portugal | na | na | na | na | na | na | na | na | na | na | na | na | na | na |
| Finland | 0.32 | 0.65 | 0.86 | 0.81 | 0.82 | 0.19 | 0.98 | 0.93 | 0.80 | 0.38 | 0.47 | 0.62 | 0.81 | 0.39 |
| Sweden | 0.32 | 0.32 | 0.72 | 0.89 | 0.69 | 0.77 | 0.45 | 0.96 | 0.44 | 0.41 | 0.22 | 0.42 | 0.55 | 0.40 |
| United Kingdom | 0.14 | 0.14 | 0.94 | 0.78 | 0.98 | 0.89 | 0.82 | 0.25 | 0.42 | 0.73 | 0.78 | 0.94 | 0.90 | 0.93 |
| EU average | 0.24 | 0.29 | 0.79 | 0.78 | 0.52 | 0.56 | 0.68 | 0.70 | 0.38 | 0.27 | 0.47 | 0.59 | 0.39 | 0.43 |

Sources: Eurostat, NCBs, ECB calculations.

Notes: The table reports the share of the variance of the business cycle component of each sector explained by the aggregate business cycle for the periods 1980-1990 and 1991-2001. Formally: $Var\left(\hat{\beta}_1 BC_f^{AG} + \hat{\beta}_2 BC_c^{AG} + \hat{\beta}_3 BC_l^{AG}\right) / Var\left(BC^{Sector\,i}\right)$ where $\hat{\beta}_1, \hat{\beta}_2$ and $\hat{\beta}_3$ are the estimated coefficients of the impact of the aggregate business cycle component at lags -1, 0, and 1 ( $BC_f^{AG}$ , $BC_c^{AG}$ and $BC_l^{AG}$ ) on the business cycle component of sector *i*, i.e. $BC_t^{Sector\,i} = \hat{\beta}_1 BC_{t+1}^{AG} + \hat{\beta}_2 BC_t^{AG} + \hat{\beta}_3 BC_{t-1}^{AG} + \varepsilon_t$ .[1] One lead and one lag are included in order to take short sectoral leads or lags into account. The EU average only includes Belgium, Denmark, Germany, Spain, France, Italy, Finland, Sweden and the UK to guarantee comparability between the 1980s and 1990s.

1 As stressed by Christiano and Fitzgerald (1998), op. cit., measuring co-movements of n different series by computing the correlation of each series with an aggregated one can lead to an over-optimistic interpretation in terms of synchronisation. However, the risk is played down when n increases. Here, n=7 (number of sectors) seems sufficient to prevent biased interpretations.

in the UK and – to a lesser extent – Spain and Sweden, while showing very low co-movement in Germany and Italy. *Public services* are generally characterised by relatively modest co-movement, with the exception of the UK, while co-movement for *business activities* was modest only in certain countries (Denmark, Italy and Sweden) but relatively high in others (UK, Belgium and France).

There was some increase in co-movement in the 1990s compared with the previous decade in Belgium, Germany, Spain and Sweden, while in the remaining countries the evolution was more differentiated. In some cases, there was even a marked decline in sectoral co-movement, indicating special factors influencing the particular evolution in this sector. For instance, *trade* and *finance* in France, *trade* in the UK, *finance* in Italy and *construction* in Finland moved further away from the aggregate business cycle in the 1990s than they were in the 1980s.

## 3.5 CONCLUSION

Sectors are characterised by substantial heterogeneity regarding their short-term output volatility. Moreover, important changes in sectoral output volatility have been documented in this section. As these sectoral characteristics are of potential importance for the pattern of aggregate business cycle behaviour among EU countries, it has been evaluated to what extent these characteristics – together with different patterns of sectoral specialisation across EU countries – have influenced business cycle developments of Member States and business cycle synchronisation across the euro area and the EU.

While consistent and significant differences in sectoral volatility have been documented, changes in the sectoral composition have played only a minor role in influencing aggregate volatility. Rather, decreased aggregate output volatility has been driven by across-the-board decreases of sectoral output volatility, even though individual sectors, and services in particular – such as *business activitie*s and *finance* – have seen particularly important developments in declining output volatility.

Moreover, business cycle synchronisation has increased over the last two decades following more pronounced economic integration, mainly in some of the business services sectors. In particular, it has been shown that the more exposed sectors have contributed to increased business cycle synchronisation across Member States.

In addition, part of the increase in business cycle synchronisation has been brought about by an increase in the similarity of sectoral dynamics (sectoral co-movement), which is likely to mitigate the effect of sector-specific shocks on country volatility profiles. This has helped to reduce the influence of cross-country differences in sectoral specialisation on EU countries' business cycle developments. Hence, despite the fact that sectoral specialisation exposes member countries to different asymmetric shocks that have the potential to cause country-specific business cycle patterns, economic integration and sectoral co-movement have contributed to a convergence towards a common business cycle across euro area countries, and to a lesser extent, also across EU countries.

# 4 ANNEXES

## 4.1 ANNEX 1: DATA ISSUES

### 4.1.1 ANNUAL DATA

Annual sectoral value added and employment data were collected on the basis of the OECD Structural Analysis (STAN) database (cut-off date: September 2003) and supplemented where appropriate with input from NCBs. The following two tables summarise the data issues related to sectoral annual data used in the report. Table 13 and Table 14 provide information on data availability and sources of value added at constant price and employment variables. A list of the sectors used to calculate the different indicators presented in Section 2 is also provided, as well as the definition used to proxy low, medium-low, medium-high and high technology intensity classification.

Caveats concerning the difficulties of measuring output in the service sector must be borne in mind and caution is required when interpreting the different indicators in services. Indeed, financial intermediation output estimates are based on indicators of revenues, stock market volume traded, issues of stocks and bonds, mutual fund sales, some volume indices such as the number of cheque account transactions, and employment. In real estate and business activities, output estimates are based on occupancy rates and number of rooms, final consumption expenditure of households on dwelling rent, and VAT statistics from real estate agencies.

The 11 sectors used for the whole economy are the following: agriculture; mining; manufacturing; electricity, gas and water; and

**Table 13 Value added at constant prices**

| Country | Period | Sources | Comments |
|---|---|---|---|
| Belgium | 1980-2001 | OECD STAN, National Accounts Institute | |
| Germany | 1980-2001 | OECD STAN database | Data prior to 1991 are calculated using West German sectoral growth data. |
| Greece | 1985-2001 | OECD STAN database & SBS Eurostat database | Data for some disaggregated business sector services are available only from 1995. |
| Spain | 1980-2001 | OECD STAN database | |
| France | 1980-2000 | OECD STAN database | Data for manufacturing are available only from 1985. |
| Ireland | 1985-2000 | SBS Eurostat database | Data are available only for the manufacturing sectors. |
| Italy | 1980-2001 | OECD STAN database | |
| Luxembourg | 1985-2001 | National Statistical Office | Real value added data are based on annually re-weighted chained Fisher indices. |
| Netherlands | 1980-2001 | OECD STAN database | Data for some disaggregated business sector services are available only from 1985. |
| Austria | 1980-2001 | OECD STAN database | |
| Portugal | 1980-1999 | OECD STAN database | |
| Finland | 1980-2001 | OECD STAN database | |
| Denmark | 1980-2001 | OECD STAN database | |
| Sweden | 1985-2001 | OECD STAN database & SBS Eurostat database | Data for some disaggregated business sector services are available only from 1993. |
| United Kingdom | 1980-2001 | OECD STAN database | |
| United States | 1980-2001 | OECD STAN database | Real value added data are based on annually re-weighted chained Fisher indices. |

**Table 14 Employment**

| Country | Period | Sources | Comments |
|---|---|---|---|
| Belgium | 1980-2000 | OECD STAN, National Accounts Institute | Data for the business sector services are available only for the main business sector service aggregates. |
| Germany | 1980-2001 | OECD STAN database | Data prior to 1991 are calculated using West German sectoral growth data. |
| Greece | 1985-2001 | OECD STAN database & SBS Eurostat database | Data for some disaggregated business sector services are available only from 1995. |
| Spain | 1980-2001 | OECD STAN database | |
| France | 1980-2000 | OECD STAN database | |
| Ireland | 1985-2000 | SBS Eurostat database | Data are available only for the manufacturing sectors |
| Italy | 1980-2001 | OECD STAN database | |
| Luxembourg | 1985-2001 | National Statistical Office | |
| Netherlands | 1980-2001 | OECD STAN database | Data for some disaggregated business sector services are available only from 1987. |
| Austria | 1980-2001 | OECD STAN database | |
| Portugal | 1980-1999 | OECD STAN database | |
| Finland | 1980-2001 | OECD STAN database | |
| Denmark | 1980-2001 | OECD STAN database | |
| Sweden | 1985-2001 | OECD STAN database & SBS Eurostat database | |
| United Kingdom | 1980-2001 | OECD STAN database | Data for the business sector services are available only for the main business sector service aggregates. |
| United States | 1980-2001 | OECD STAN database | |

construction, together with six business sector services: wholesale and retail trade; hotels and restaurants; transport and storage; post and telecommunications; financial intermediation; and real estate, renting and business activities.

The 11 sectors used for the manufacturing sector are the following: food products, beverages and tobacco; textiles, textile products, leather and footwear; wood and products of wood and cork; pulp, paper and paper products; rubber, plastics and fuel products; chemicals and chemical products; other non-metallic mineral products; basic metals and fabricated metal products; machinery and equipment; transport equipment; manufacturing NEC, recycling.

For reasons of data availability – no three-digit level sectoral data were available on a cross-country comparable basis – the following classification was applied to proxy the standard OECD distinction[53] between low, medium-low, medium-high and high technology intensity sectors:

- low technology classification: food products, beverages and tobacco; textiles, textile products, leather and footwear.
- medium-low classification: wood and products of wood and cork; pulp, paper and paper products; manufacturing NEC, recycling.
- medium-high classification: rubber, plastics and fuel products; other non-metallic mineral products; basic metals and fabricated metal products.

53 T. Hatzichronoglou, 1997, "Revision of the high-technology sector and product classification", OECD STI-Working Paper, no 1997/2. This classification is based on the empirical observation of a relatively stable relationship between the industry a firm belongs to and its R&D expenditures across countries and time.

– high technology classification: chemicals and chemical products; machinery and equipment; transport equipment.

### 4.1.2 SHORT-TERM INDICATORS

The analysis in Section 3 was based on sectoral gross value added figures at constant prices available from Eurostat. Data is in general available for the entire period 1980:Q1-2001:Q4. Exceptions are the Netherlands (1987:Q1-2001:Q4), Austria (1988:Q1-2001:Q4) and Portugal (1995:Q1-2001:Q4). Given the limited information available for Portugal it has not been included in the analysis, while the Netherlands and Austria have only been included for the 1990s. Moreover, data for Germany were extended backwards, applying West German growth rates before 1991; this has been usually accounted for by presenting cross-country averages before and after 1991.

Finally, no quarterly sectoral value added data were available for Greece, Ireland and Luxembourg. In order to separate finance and insurance (ISIC Code 65-67) from real estate, renting and business activities (ISIC Code 70-74), the aggregate quarterly information available from Eurostat was disaggregated using annual value added at current prices shares for the two sectors that were provided in the annual database used for Section 2.

The analysis in Sub-section 3.2.2 of Section 3 was based on monthly industrial production indicators available from Eurostat. Comparable data on the two-digit level of ISIC-Revision 3 is in general available for the entire period Jan 1990 - Dec 2001. Exceptions are the Netherlands, for which sectors 32 (manufacture of radio, television and communication equipment and apparatus) and 33 (manufacture of medical, precision and optical instruments, watches and clocks) are missing, and Finland for which sectors 16 (manufacture of tobacco products) and 30 (manufacture of office machinery and computers) are missing. Data for Greece for sector 30 (manufacture of office machinery and computers) were dropped as no data for this sector was available before Jan 1995. Data for the remaining countries were either not available for the entire period or too many sectors were missing.

In order to be able to aggregate data from individual manufacturing sectors into the four manufacturing aggregates, the individual industrial production series were converted into sectoral value added at constant prices by multiplying the indices with the value added at base year (base year = 2000 for all series).

### 4.1.3 THE COMPUTATION OF REAL VALUE INDICES

Throughout this report, real value added levels were computed based on volume indices calculated at 1995 prices. The three exceptions are Luxembourg, Sweden and the United States which, in the 1990s, switched from a "fixed weight" Laspeyres index measure to a chain-weighted index.

The main problem with calculating real value added GDP using a particular base year is that sectors exposed to rapidly declining relative prices for their output (e.g. the IT-producing sectors) are given a disproportionate weight in total GDP. This is due to the well observed fact that the quantities produced by these same sectors also tend to grow at relatively faster rates, so the further back the base year taken the greater their weight in total GDP in the years after the base year. Shifting the base year forwards every few years to alleviate the problem would still result in an underestimation of the relative weight of these sectors in the previous years.

Chained-weighted indices continually update the prices used to calculate real value added by equalising real and nominal value added at some base year and then chaining this value forwards and backwards using the growth rates of the corresponding aggregate of real value added. In the United States, chain-weighted growth rates are calculated as the geometric average of the

gross growth rates of a Paasche and a Laspeyres index, whereas in Luxembourg and Sweden they are calculated just on the basis of the Laspeyres index. To take the United States as an example, the formula used is the following:

$$Q(t) = Q(t-1)\left|\sqrt{\frac{\sum_{i=1}^{n} P_i(t)Q_i(t)}{\sum_{i=1}^{n} P_i(t)Q_i(t-1)}}\right| \times \left|\sqrt{\frac{\sum_{i=1}^{n} P_i(t-1)Q_i(t)}{\sum_{i=1}^{n} P_i(t-1)Q_i(t-1)}}\right|$$

Where $Q_i$ is the output of sector *i* and $P_i$ is the price of the good produced by sector *i*. As shown, the price weights constantly move with *t*, so the growth rate of the chain aggregate will be the same as that of the fixed-weight aggregate only if relative prices do not change. If they do, then chain aggregates will grow faster after the fixed-weight base year and fixed-weight aggregates will grow faster before the base year.

The main drawback of using chain-weighted indices is that aggregate GDP can no longer be interpreted as the sum of its various sub-components because the price deflators differ among the series. The size of the error depends on the size of the relative price changes between the sectors that were added up, which might also be affected by the length of the time series and the particular time period chosen.

## 4.2 ANNEX 2: METHODOLOGY

### 4.2.1 INDICATORS FOR SECTORAL SPECIALISATION AND RE-ALLOCATION

#### 4.2.1.1 SECTORAL SPECIALISATION AND CONCENTRATION

Sectoral specialisation is measured by the Krugman index, which is defined as follows:

$$K_k(t) = \sum_i \left| V_k^i(t) - \overline{V}^i(t) \right|$$

where $V_k^i(t)$ is the share of sector *i* in country *k* at time *t* based on gross value added at constant prices, and $\overline{V}^i(t)$ is the share of sector *i* in the European union less country i.

The concentration index (also called the Balassa index[54]) is defined as follows:

$$I_k^i(t) = \frac{x_k^i(t)}{X_{EU}^i(t)} \Big/ \frac{x_k(t)}{X_{EU}(t)}$$

where $x_k^i(t)$ is gross value added in constant prices in country *k* and sector *i*, and $X_{EU}^i(t)$ is gross value added in constant prices in the EU and sector *i*.

#### 4.2.1.2 SECTORAL RE-ALLOCATION AND THE LILIEN INDICATOR

In order to measure the speed of sectoral re-allocation of employment, the Lilien[55] indicator was used. The Lilien indicator is defined as

$$\sigma = \left| \left[ \sum_i \frac{x_{it}}{X_t} (\Delta \log x_{it} - \Delta \log X_t)^2 \right]^{1/2} \right|,$$ where $x_{it}$ is employment in sector *i*.

#### 4.2.1.3 THE SHIFT-SHARE ANALYSIS

A shift-share analysis decomposes the aggregate growth rate into the weighted growth rates of its individual components and the change that has taken place between components. Formally, the method for aggregate labour productivity growth applied here was as follows:

$$\frac{\Delta P}{P} = \sum_i \left[ \frac{\overline{S}_i \Delta P_i}{P_i} + \frac{\overline{P}_i \Delta S_i}{P_i} \right],$$

where $P_i$ is labour productivity in sector i, $S_i$ is the employment share in sector i and a bar denotes a two-period average. The first term (intra effect) is the contribution from productivity growth within individual industries (weighted by the share of these

54 After B. Balassa (1965), "Trade liberalization and 'revealed' comparative advantage", The Manchester School of Economic and Social Sciences, no 33, pp. 99-123.

55 D. M. Lilien (1982), "Sectoral Shifts and Cyclical Unemployment", Journal of Political Economy, no 90/4, pp. 777-793.

## Table 15 Business cycle component- sensitivity analysis

| | Agriculture | | | | | |
|---|---|---|---|---|---|---|
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 16,68 | [14,80; 20,24] | 18,82 | [15,90; 28,34] | 16,80 | [14,22; 20,97] |
| Denmark | 10,79 | [9,42; 46,96] | 9,94 | [9,24; 37,18] | 12,60 | [9,60; 76,32] |
| Germany | 8,92 | [5,28; 10,31] | 19,80 | [9,81; 22,80] | 3,41 | [2,82; 4,75] |
| Greece | na | | na | | na | |
| Spain | 15,75 | [13,93; 23,86] | 17,74 | [14,96; 36,35] | 13,30 | [12,02; 15,30] |
| France | 9,45 | [6,32; 14,15] | 10,66 | [6,67; 19,02] | 8,41 | [5,56; 10,42] |
| Ireland | na | | na | | na | |
| Italy | 15,29 | [4,59; 904,16] | 19,73 | [6,81; 985,21] | 10,31 | [2,13; 813,83] |
| Luxembourg | na | | na | | na | |
| Netherlands | 6,93 | [6,89; 211,88] | na | | 6,76 | [6,76; 168,75] |
| Austria | 23,44 | [23,44; 33,35] | na | | 24,31 | [24,31; 30,00] |
| Portugal | na | | na | | na | |
| Finland | 4,99 | [4,46; 10,08] | 3,71 | [3,35; 9,38] | 6,99 | [6,13; 12,76] |
| Sweden | 6,48 | [3,62; 8,37] | 13,38 | [3,20; 18,84] | 3,38 | [3,05; 4,57] |
| United Kingdom | 6,26 | [4,48; 7,69] | 4,68 | [2,61; 5,76] | 11,36 | [10,08; 13,84] |
| | **Industry** | | | | | |
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 4,75 | [4,39; 5,82] | 6,86 | [6,71; 8,33] | 3,80 | [3,49; 5,22] |
| Denmark | 4,88 | [4,56; 6,47] | 3,98 | [3,22; 5,03] | 6,81 | [5,45; 9,47] |
| Germany | 3,73 | [3,06; 4,47] | 4,42 | [2,85; 4,68] | 4,24 | [3,62; 5,31] |
| Greece | na | | na | | na | |
| Spain | 1,72 | [1,67; 2,94] | 1,33 | [1,33; 2,87] | 2,15 | [2,00; 3,04] |
| France | 3,28 | [3,28; 6,44] | 1,79 | [1,76; 6,24] | 4,55 | [4,55; 6,58] |
| Ireland | na | | na | | na | |
| Italy | 5,14 | [5,14; 11,14] | 4,78 | [4,78; 13,11] | 5,49 | [5,49; 8,95] |
| Luxembourg | na | | na | | na | |
| Netherlands | 2,54 | [2,54; 13,60] | na | | 2,29 | [2,29; 11,36] |
| Austria | 4,07 | [1,82; 4,49] | na | | 3,71 | [1,83; 4,17] |
| Portugal | na | | na | | na | |
| Finland | 2,19 | [2,05; 2,46] | 1,29 | [1,20; 1,47] | 3,39 | [3,25; 3,81] |
| Sweden | 4,92 | [2,76; 4,92] | 5,43 | [2,42; 5,65] | 4,73 | [3,21; 4,73] |
| United Kingdom | 2,17 | [2,04; 2,39] | 1,91 | [1,73; 2,16] | 2,96 | [2,91; 3,06] |
| | **Construction** | | | | | |
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 16,08 | *[14,62; 19,71]* | 28,74 | *[28,66; 35,20]* | 8,04 | *[7,04; 10,14]* |
| Denmark | 21,58 | *[18,90; 23,48]* | 22,13 | *[14,36; 29,20]* | 20,35 | *[15,27; 32,51]* |
| Germany | 13,61 | *[12,37; 21,68]* | 28,32 | *[28,00; 32,77]* | 4,75 | *[3,23; 12,36]* |
| Greece | na | | na | | na | |
| Spain | 10,43 | *[10,22; 11,24]* | 10,34 | *[9,52; 10,97]* | 10,82 | *[10,82; 12,48]* |
| France | 11,88 | *[7,55; 13,15]* | 4,05 | *[2,63; 4,05]* | 18,55 | *[11,46; 21,17]* |
| Ireland | na | | na | | na | |
| Italy | 7,16 | *[4,23; 8,73]* | 3,64 | *[1,99; 4,43]* | 10,65 | *[6,65; 12,54]* |
| Luxembourg | na | | na | | na | |
| Netherlands | 8,69 | *[6,60; 19,96]* | na | | 4,81 | *[3,41; 11,16]* |
| Austria | 8,19 | *[5,31; 54,72]* | na | | 6,57 | *[3,00; 56,41]* |
| Portugal | na | | na | | na | |
| Finland | 5,93 | *[5,64; 19,78]* | 6,14 | *[6,04; 21,81]* | 6,43 | *[5,60; 19,36]* |
| Sweden | 4,26 | *[1,59; 4,32]* | 4,59 | *[0,90; 4,68]* | 4,16 | *[2,49; 4,35]* |
| United Kingdom | 2,43 | *[2,39; 2,60]* | 2,44 | *[2,39; 2,64]* | 2,36 | *[2,35; 2,46]* |

**Table 15 Business cycle component- sensitivity analysis (cont')**

| | Retail | | | | | |
|---|---|---|---|---|---|---|
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 2,06 | *[1,92; 2,24]* | 1,48 | *[1,37; 2,29]* | 2,32 | *[1,99; 2,40]* |
| Denmark | 3,23 | *[2,86; 4,21]* | 2,85 | *[2,08; 4,29]* | 4,05 | *[4,05; 5,36]* |
| Germany | 2,89 | *[2,85; 2,94]* | 2,83 | *[2,82; 3,50]* | 3,04 | *[2,52; 3,12]* |
| Greece | na | | na | | na | |
| Spain | 1,02 | *[0,95; 4,87]* | 1,12 | *[1,09; 5,29]* | 0,94 | *[0,84; 4,54]* |
| France | 3,45 | *[2,24; 3,55]* | 3,29 | *[2,36; 3,48]* | 3,58 | *[2,13; 3,59]* |
| Ireland | na | | na | | na | |
| Italy | 1,55 | *[1,55; 3,84]* | 1,10 | *[1,04; 3,36]* | 2,00 | *[2,00; 4,37]* |
| Luxembourg | na | | na | | na | |
| Netherlands | 4,23 | *[4,16; 4,72]* | na | | 3,94 | *[3,90; 4,43]* |
| Austria | 1,76 | *[1,32; 1,76]* | na | | 1,76 | *[1,14; 1,80]* |
| Portugal | na | | na | | na | |
| Finland | 2,12 | *[1,87; 2,12]* | 2,28 | *[1,78; 2,28]* | 2,08 | *[1,93; 2,12]* |
| Sweden | 1,38 | *[0,61; 1,38]* | 1,95 | *[0,63; 1,97]* | 1,13 | *[0,57; 1,19]* |
| United Kingdom | 6,54 | *[6,54; 7,43]* | 7,42 | *[7,40; 8,70]* | 3,12 | *[3,12; 3,38]* |
| | **Finance** | | | | | |
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 19,47 | *[16,30; 22,86]* | 36,54 | *[30,90; 53,50]* | 9,42 | *[6,53; 10,18]* |
| Denmark | 18,13 | *[11,73; 21,02]* | 20,13 | *[11,74; 26,34]* | 13,79 | *[11,68; 14,26]* |
| Germany | 6,20 | *[3,39; 6,24]* | 5,30 | *[2,14; 5,82]* | 8,20 | *[5,01; 8,20]* |
| Greece | na | | na | | na | |
| Spain | 10,75 | *[8,94; 12,76]* | 13,39 | *[10,64; 18,90]* | 8,37 | *[7,07; 8,88]* |
| France | 8,56 | *[5,58; 10,17]* | 6,20 | *[3,90; 6,26]* | 9,90 | *[6,53; 12,61]* |
| Ireland | na | | na | | na | |
| Italy | 4,70 | *[3,04; 5,27]* | 5,82 | *[3,52; 9,04]* | 3,45 | *[2,20; 3,52]* |
| Luxembourg | na | | na | | na | |
| Netherlands | 6,33 | *[6,22; 7,53]* | na | | 3,27 | *[3,11; 3,79]* |
| Austria | 5,13 | *[1,40; 6,02]* | na | | 5,47 | *[1,71; 6,23]* |
| Portugal | na | | na | | na | |
| Finland | 7,92 | *[6,41; 10,50]* | 7,00 | *[4,67; 8,76]* | 9,90 | *[8,81; 13,43]* |
| Sweden | 16,62 | *[4,53; 17,32]* | 18,92 | *[2,80; 22,36]* | 13,94 | *[6,13; 14,78]* |
| United Kingdom | 6,42 | *[6,32; 6,88]* | 5,16 | *[5,04; 5,60]* | 10,63 | *[9,74; 11,14]* |
| | **Business services** | | | | | |
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 2,05 | *[1,78; 2,27]* | 3,00 | *[2,37; 3,85]* | 1,35 | *[1,11; 1,56]* |
| Denmark | 2,12 | *[2,12; 2,67]* | 1,05 | *[0,99; 1,68]* | 4,44 | *[3,89; 4,44]* |
| Germany | 1,40 | *[0,92; 1,44]* | 1,12 | *[0,59; 1,33]* | 1,55 | *[1,17; 1,55]* |
| Greece | na | | na | | na | |
| Spain | 1,76 | *[1,50; 2,82]* | 3,19 | *[2,59; 6,43]* | 0,38 | *[0,29; 0,44]* |
| France | 1,38 | *[1,00; 1,41]* | 1,29 | *[0,96; 1,45]* | 1,46 | *[1,04; 1,48]* |
| Ireland | na | | na | | na | |
| Italy | 1,50 | *[1,01; 1,68]* | 1,50 | *[0,95; 1,82]* | 1,31 | *[0,98; 1,39]* |
| Luxembourg | na | | na | | na | |
| Netherlands | 3,07 | *[3,05; 3,22]* | na | | 2,38 | *[2,22; 2,55]* |
| Austria | 2,17 | *[0,63; 2,66]* | na | | 2,24 | *[0,75; 2,70]* |
| Portugal | na | | na | | na | |
| Finland | 0,52 | *[0,45; 0,65]* | 0,30 | *[0,28; 0,50]* | 0,83 | *[0,66; 0,96]* |
| Sweden | 1,83 | *[0,75; 2,16]* | 2,21 | *[0,63; 2,76]* | 1,58 | *[0,88; 1,81]* |
| United Kingdom | 3,23 | *[3,22; 3,41]* | 3,04 | *[3,03; 3,35]* | 3,87 | *[3,45; 3,87]* |

**Table 15 Business cycle component- sensitivity analysis (cont')**

| | Public services | | | | | |
|---|---|---|---|---|---|---|
| | 1980-2001 | | 1980-1991 | | 1991-2001 | |
| Belgium | 0,66 | *[0,58; 1,07]* | 0,69 | *[0,69; 1,36]* | 0,71 | *[0,51; 0,97]* |
| Denmark | 0,67 | *[0,67; 0,95]* | 0,53 | *[0,49; 0,92]* | 0,95 | *[0,92; 1,36]* |
| Germany | 0,28 | *[0,19; 0,31]* | 0,33 | *[0,15; 0,33]* | 0,35 | *[0,25; 0,38]* |
| Greece | na | | na | | na | |
| Spain | 0,51 | *[0,47; 0,60]* | 0,29 | *[0,21; 0,57]* | 0,58 | *[0,56; 0,61]* |
| France | 0,41 | *[0,38; 0,46]* | 0,70 | *[0,60; 0,77]* | 0,28 | *[0,25; 0,34]* |
| Ireland | na | | na | | na | |
| Italy | 0,32 | *[0,30; 0,34]* | 0,31 | *[0,24; 0,42]* | 0,33 | *[0,30; 0,38]* |
| Luxembourg | na | | na | | na | |
| Netherlands | 0,41 | *[0,41; 3,66]* | na | | 0,41 | *[0,41; 3,46]* |
| Austria | 1,33 | *[0,36; 1,35]* | na | | 1,31 | *[0,38; 1,33]* |
| Portugal | na | | na | | na | |
| Finland | 0,28 | *[0,23; 0,28]* | 0,08 | *[0,05; 0,08]* | 0,35 | *[0,31; 0,39]* |
| Sweden | 0,32 | *[0,28; 2,25]* | 0,24 | *[0,12; 2,16]* | 0,34 | *[0,31; 2,34]* |
| United Kingdom | 1,21 | *[1,17; 1,21]* | 1,02 | *[0,91; 1,02]* | 1,71 | *[1,71; 1,76]* |

Sources: Eurostat, NCBs, ECB calculations.

industries in total employment). The second term (shift-effect) reflects the ability of a country to move resources from low to high-productivity sectors.

### 4.2.2 INDICATORS FOR BUSINESS CYCLE ANALYSIS

#### 4.2.2.1 EXTRACTING BUSINESS CYCLE COMPONENTS

There are several competing approaches on how to measure the business cycle.[56] While potential output growth measures would in principle be available, band-pass filters provide a more flexible treatment of short-term fluctuations and have been extensively used in the literature. In this report, the business cycle component was calculated using a band-pass filter with the Burns-Mitchell parameter set at 6, 32, 12, i.e. the business cycle component contains all fluctuations with a period of between 1.5 and 8 years.[57] As band-pass filters require the loss of data at the beginning and the end of the series, the quarterly gross value added series were extended by three years backward and forward in time using an AR(5) process. The business cycle component for the monthly data presented in 3.2.2 was constructed using a similar methodology by applying a band-pass filter with parameters 18, 96, and 36 on the monthly real industrial production values, including all fluctuations with a period between 1.5 and 8 years in the monthly business cycle component.

In order to evaluate the sensitivity of the results with respect to the chosen window, the series were filtered using different parameter settings, ranging from 1 year to 11 years, thereby covering all standard business cycle lengths (i.e. Kitchin-cycles with a periodicity of approximately 3 years and Juglar-cycles with a periodicity of 7-11 years) but leaving out the seasonal fluctuations. The results of the minimum and maximum values for relative sectoral output volatility that the selection of different periods yield are presented in Table 15. The sensitivity analysis shows that, while the use of different parameters for the band-pass filter will have an impact on the volatility measure, the sensitivity of the measured relative volatility remains limited with respect to the

56 For an overview of the different approaches used to determine potential output, see C. Giorno, P. Richardson, D. Roseveare and P. van den Noord (1995), "Estimating potential output, output gaps and structural budget balances", OECD Economics Department Working Paper, 152.

57 Compared with other available filters, the Baxter-King filter, which is now widely used in the field, has simultaneous advantages in that it removes the unit root, respects the phase and isolates cycle frequencies without re-weighting past frequencies (see the discussion in A.-M. Agresti and B. Mojon (2001), "Some stylised facts on the euro area business cycle", ECB Working Paper no 95, Appendix 1).

## Chart 11 Sectoral shifts and volatility (rescaled)

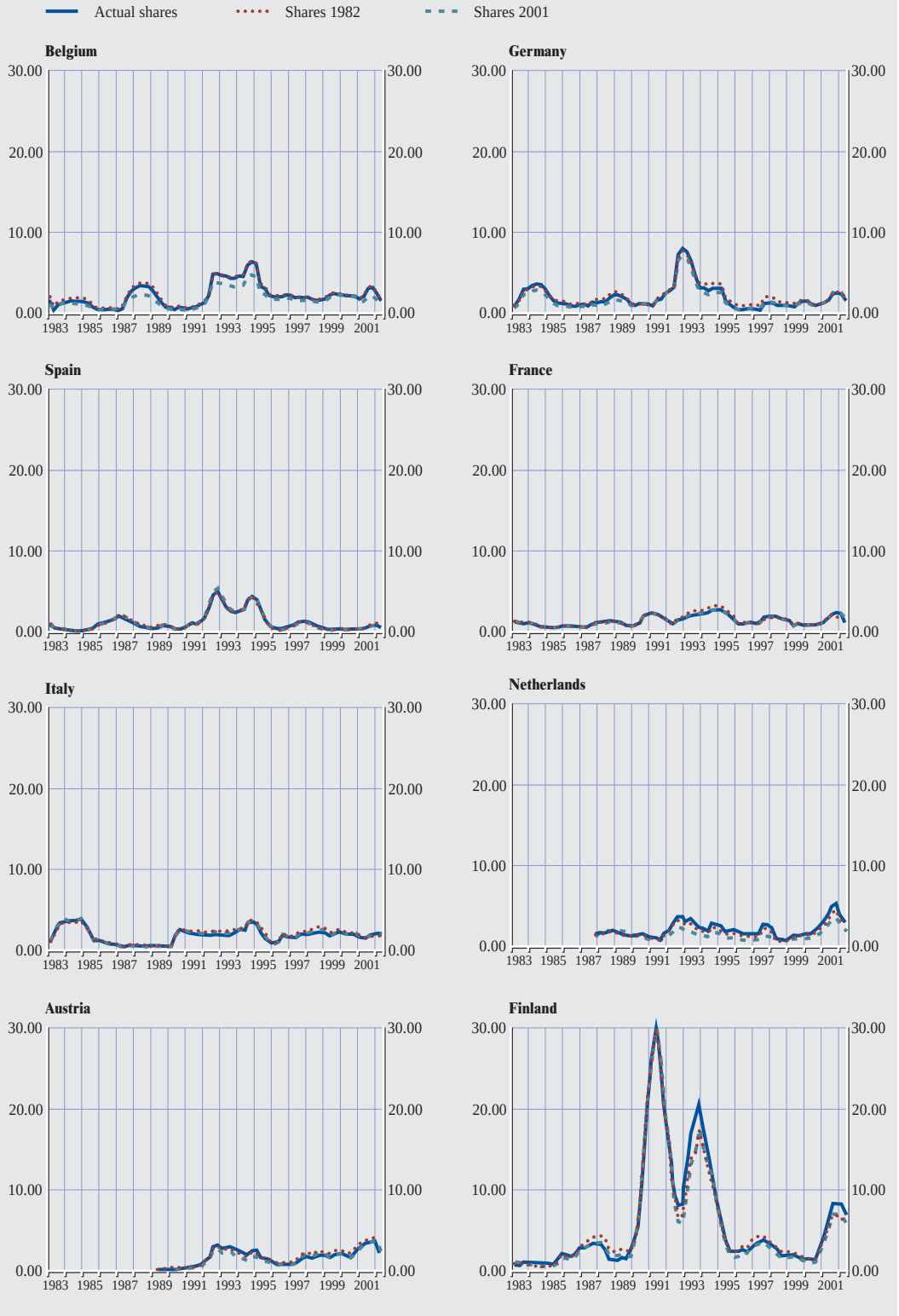
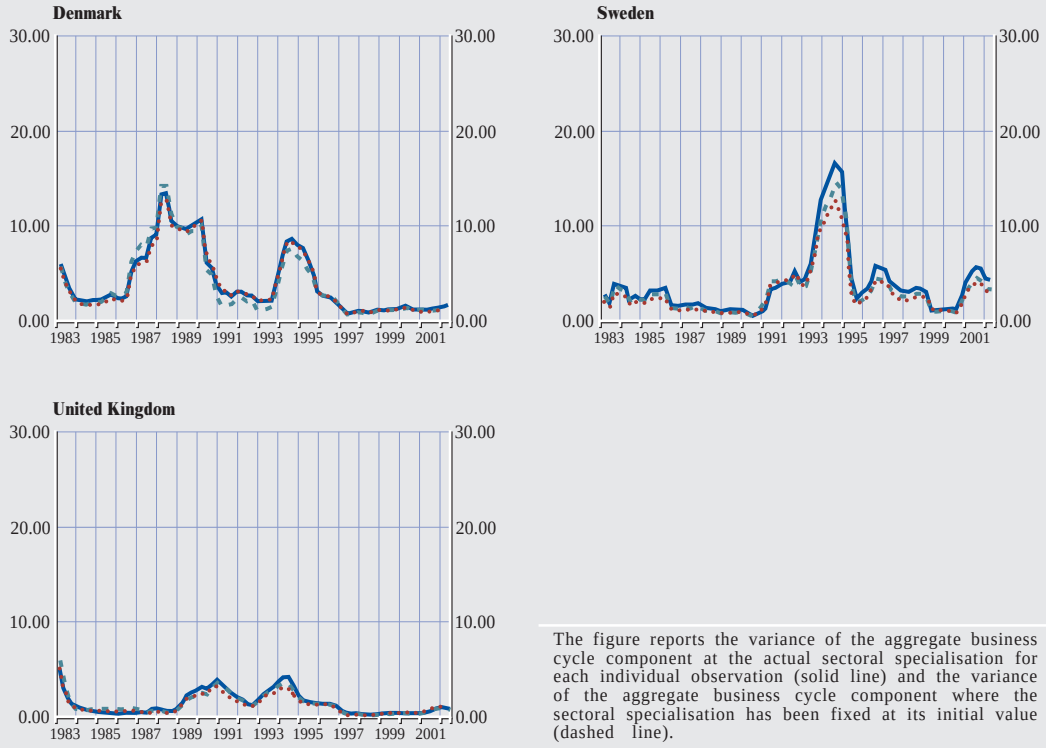


**Chart 11 Sectoral shifts and volatility (rescaled) (cont'd)**




The figure reports the variance of the aggregate business cycle component at the actual sectoral specialisation for each individual observation (solid line) and the variance of the aggregate business cycle component where the sectoral specialisation has been fixed at its initial value (dashed line).

Sources: Eurostat, NCBs, ECB calculations.
Note: See Annex 4.2.2.2 for a discussion of the underlying methodology and a presentation of volatility developments using the same scale for all countries.

chosen filter parameters, except for *agriculture* where very strong reactions can be detected.

### 4.2.2.2 SECTORAL DECOMPOSITION OF AGGREGATE VOLATILITY

The decomposition in Table 6 and the assessment in Chart 9 follow the formula for the variance of joint distributions:

$$Var[ax+by+c] = a^2 Var[x] + b^2 Var[y] + 2abCov[x,y]$$

In order to facilitate cross-country comparability, Chart 9 has been reproduced in Chart 11, using the same scale for all countries.

### 4.2.2.3 SECTORAL DETERMINANTS OF BUSINESS CYCLE SYNCHRONISATION

The results in Table 11 were established by running the following regression:

$$\rho_{k,t} = \alpha_k + \sum_i \beta_i \rho_{i,k,t} + \varepsilon_{i,k,t}$$

where $\rho_{k,t}$ represents the synchronisation coefficient of country $k$ at time $t$ and $\rho_{i,k,t}$ represents the synchronisation coefficient of industry $i$ in country $k$ at time $t$. The regression coefficients were estimated using the within-estimator with country-fixed effects, $\alpha_k$, and accounting for serial correlations of the synchronisation coefficients as described by Baltagi and Wu (1999)[58]. Results were reported according to whether the $\beta_i$ were found to be statistically significant at the 5% level or not.

58 B. H. Baltagi and P. X. Wu (1999), "Unequally spaced panel data regressions with AR(1) disturbances", Econometric theory, 15, pp. 814-823.

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