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The EU Economy: 2007 Review

MOVING EUROPE'S PRODUCTIVITY FRONTIER

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The EU economy: 2007 review

Moving Europe's productivity frontier

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Chapter 1

Productivity trends in Europe: finally turning the corner?

Summary

The simultaneous occurrence of low output and productivity growth in the first half of this decade gave rise to concerns about the health of the EU and euro-area economies. Although the European economies' improved capacity to create new jobs was a welcome development, the downside was that it occurred against a background of falling productivity growth.

Along with the recovery in economic activity, productivity growth has seen a revival since mid-2005 in both the EU and the euro area. This has led commentators to conclude that the protracted period of slow productivity growth in the EU might have come to an end. However, since labour productivity growth is known to be subject to cyclical variations, the recent acceleration may reflect mainly cyclical factors rather than an improvement in the underlying trend.

The purpose of this chapter is to shed some light on this issue, exploiting available data on quarterly labour productivity for the larger euro-area Member States up to the first quarter of 2007. As the emphasis lies on data timeliness some compromise had to be accepted regarding the sector breakdown, which exists only at a highly aggregated level.

One of the main findings of the chapter is that trend productivity growth in the euro area saw a fairly sustained decline from the mid-1990s on. This is a common feature across sectors and Member States, although developments in manufacturing and trade services, from a sector perspective, and in Germany and Italy, from a country perspective, seem to have dominated the overall picture. There is moreover some evidence that sectoral composition effects played a role in the productivity slowdown, with lower-productivity sectors such as trade services having grown faster than higher-productivity sectors. Moreover, while there does not seem to exist a trade-off between employment growth and productivity growth in the longer term, there are indications that exceptionally buoyant employment growth maytemporarily lower productivity growth, as appears to have happened in Italy and Spain, particularly in the construction sector.

The trend decline in productivity growth seems to have come to a halt in the early years of this decade and this again is a development shared by most sectors and Member States. Actual data suggests a significant pick-up in labour productivity growth since mid-2005, which also took place against the background of fast and accelerating employment growth. While the quickening pace of productivity growth was fairly general across countries and sectors, a significant part of the acceleration at the euro-area level seems to be due to developments in the private business sector in Germany.

However, if the cyclical component is eliminated from from productivity growth, little of this acceleration remains. Thus it is clear that a large part of the apparent acceleration must be attributed to the cyclical upswing which the euro-area economy has enjoyed in this period. Neither estimates of trend productivity using filtering techniques nor statistical tests of structural shifts provide conclusive evidence of a strengthening of trend productivity growth in the past years. These results are corroborated by estimates of trend growth of total factor productivity which indicate that, to date, there is little evidence in favour of a pick-up in this component of labour productivity growth.

This might be simply due to the fact that the pick-up in productivity growth is too recent for statistical procedures to be able to detect underlying structural changes. As a matter of fact, evidence of the rise in productivity growth in the US from the mid-1990s on was available only several years after the turn-around.

In conclusion, while the slowdown of trend productivity growth from the mid-1990s on appears to have bottomed out, further data is needed to assess whether the recent pick-up in actual productivity growth is due also to changes in the underlying trend.

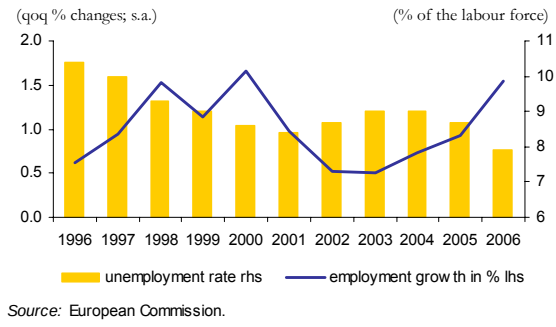
1. Introduction

The economies of the EU and the euro area have experienced a robust economic upturn since mid-2005, with GDP in 2006 growing by around 3% over the preceding year. This was the best performance since the boom in 1999-2000, lifting the growth rate above those of both the US and Japan for the first time in a number of years (see Graph 1.1.2). Moreover, in the face of surging oil prices, consumer price inflation remained moderate.

Short-term indicators point to a deceleration in the pace of economic activity in the period ahead, but growth in 2007 should still be in a range of 2½ to 3% in both areas, which is clearly above potential. Further ahead, downside risks to the economic outlook have accumulated, however, not least due to the recent financial markets woes. In particular, on the back of a slowdown in the US a downshift in the global economy cannot be ruled out, despite continued brisk growth in many emerging market economies. This would inevitably have some spill-over effects on the EU and euro-area economies, their generally favourable fundamentals notwithstanding.

The economic revival in 2006-07 was greeted with significant relief. Indeed, a rather modest growth performance during the period 1996-2005 led to recurrent downward revisions of potential output growth, especially that of the euro-area ([1]), and became a source of growing concerns among economic analysts and policy makers. It is noteworthy, however, that the labour market eschewed this general tendency of a weak performance. On the contrary, since the mid-1990s employment has expanded at a sustained pace and, except for a short interruption in 2002-2003, unemployment has fallen continuously to reach a rate not seen in more than two decades (see Graph 1.1.1).

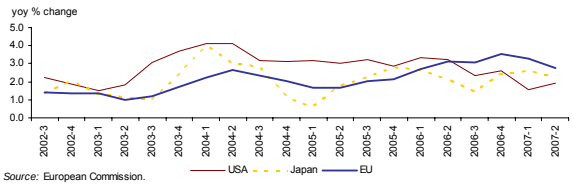
Graph 1.1.1: **Labour market developments in the EU**



Source: European Commission.

Since, by definition, output growth minus employment growth equals productivity growth, the slowdown in output growth coupled with faster employment creation implied a significant decline in labour productivity growth from the mid-1990s on. While the improved capacity of the EU and euro-area economies of creating jobs was a welcome development, the downside was that is occurred against a background of falling productivity growth. This contrasted with developments in the US, where productivity growth saw a sustained acceleration over the same period, leading to a widening productivity gap between Europe and the US.

Graph 1.1.2: **GDP growth in the EU, the US and Japan**



Source: European Commission.

([1]) See Trichet, J.-C., "Productivity in the euro area and monetary policy", Speech given at the 22nd Annual Congress of the European Economic Association, Budapest, 27 August 2007.

2. Slowing productivity growth in the EU and the euro area

The simultaneous occurrence of falling productivity growth in Europe and a sustained rise in productivity growth in the US from the mid-1990s on (see Graph 1.2.1) gave rise to increasing concerns about the health of the EU and euro-area economies. Even if in terms of GDP per capita the gap vis-à-vis the US was smaller, high productivity growth is considered to be closely associated with rising living standards, not least because it drives growth in real wages, while facilitating fiscal consolidation and assisting monetary policy in keeping inflation in check and interest rates low. Moreover, in view of the relationship between labour productivity and output growth (see Box 1.2.1), a longer-term decline in productivity growth is likely to have an adverse impact on the rate of potential output growth. This runs counter to the ambitions of the European Unions' Lisbon strategy that made raising potential growth one of the priorities of the policy agenda ([2]).

Since mid-2005, growth of labour productivity has seen a rebound in both the EU and the euro area. In the euro area, for instance, productivity growth accelerated from a year-on-year rate of 0.8% in the second quarter of 2005 to 1.8% in the first quarter of 2007. This has led commentators to conclude that the drawn-out period of slow productivity growth in the EU might have come to an end.

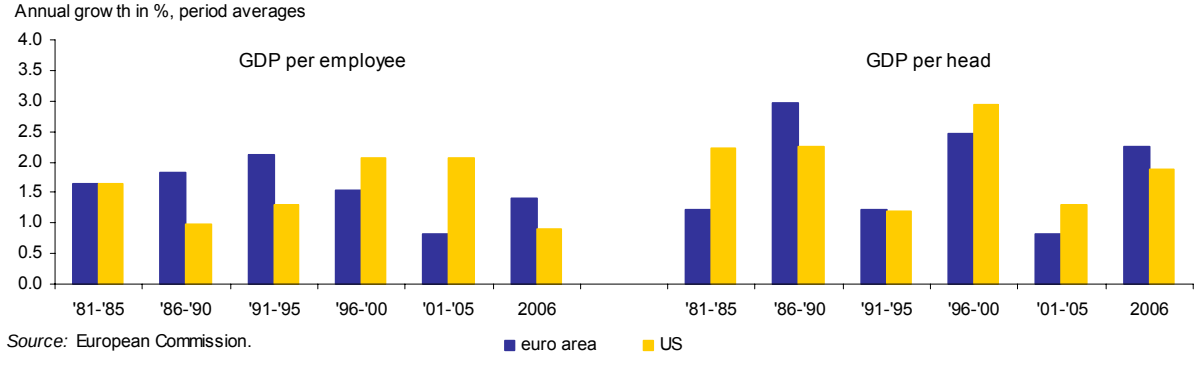
At the same time, the pick-up in productivity growth was not particularly pronounced, with the growth rate in 2006 still falling short of the average rate observed in the 1980s and 1990s. Moreover, labour productivity is known to be subject to cyclical variations. It could well be, therefore, that the recent productivity spurt reflects mainly cyclical factors rather than an improvement in the underlying trend.

The following sections aim to shed some light on this issue by assessing developments in labour productivity in the current cycle. For this purpose, quarterly national accounts data up to the first quarter of 2007 are used. With recent developments being the focus of the chapter, the emphasis lies on the timeliness of the data. This comes at the cost that a sector breakdown is only available for highly aggregated sectors.

Moreover, because of data limitations, when seeking to exploit the sectoral dimension of the data, country aggregates can only be constructed by using data from Member States for which such sectoral data is available (i.e.Germany, France, Italy, Spain, Belgium and Finland). In terms of coverage, these Member States represent about 61% of the total GDP of the EU and 83% of euro-area GDP. Since this is representative of the euro area but less so of the EU, the aggregate of the above-mentioned six Member States will be labelled "euro-area" when using sectoral data (Appendix 5 contains more details about data sources and data treatment).

([2]) See, for instance, "Strategic Objectives 2005 – 2009, Europe 2010: A Partnership for European Renewal - Prosperity, Solidarity and Security", Communication from the President of the European Commission, COM(2005) 12 final, Brussels, 26.1.2005.

Graph 1.2.1: **GDP per employee and GDP per head in the euro area and the US**



Source: European Commission.

Box 1.2.1: **Different concepts of productivity growth**

This box discusses the different concepts of productivity growth used in this chapter.

Labour productivity is defined as output divided by persons employed or hours worked (this chapter uses mostly the first concept). When referring to labour productivity in this definition, this chapter will often use "productivity" as short-hand for "labour productivity".

Denoting value added by Y and the number of persons employed by L, labour productivity equals Y/L.

Using small letters for the logarithm of a variable and differencing with respect to time, the above definition yields:

$$\Delta y = \Delta(y - l) + \Delta l$$

which shows that the rate of change of output equals the rate of change of productivity plus the rate of change of employment.

In a more formal framework, output can be expressed by use of a Cobb-Douglas production function with constant returns to scale:

$$Y = TFP \cdot L^{\beta} \cdot K^{1-\beta}$$

where, in addition to the already introduced symbols, TFP represents total factor productivity, a measure of the state of the efficiency of production and the technological know-how in the economy; K is the stock of capital; and β is the elasticity of output with respect to persons employed, assumed to be constant over time.

Dividing by L yields:

$$\frac{Y}{L} = TFP \cdot L^{\beta-1} \cdot K^{1-\beta} = TFP \cdot \left(\frac{K}{L}\right)^{1-\beta}$$

Taking again logs and differencing gives:

$$\Delta(y - l) = \Delta tfp + (1 - \beta) \cdot \Delta(k - l)$$

This equation shows that the rate of change of labour productivity can be decomposed in the rate of change of total factor productivity and the rate of change of the capital-labour ratio ("capital deepening") times a constant.

According to the results of the neo-classical growth theory, in the long run the economy should reach an equilibrium where labour productivity grows at the same rate as the capital-labour ratio (so-called "balanced growth"). Imposing this restriction ($\Delta (y - l) = \Delta (k - l)$), the above equation can be transformed into:

$$\Delta(y - l) = \frac{\Delta tfp}{\beta}$$

This equation says that, in the long term, productivity growth is determined by the rate of technical progress, which is, therefore, the ultimate source of economic growth.

Finally, it is important to note that labour productivity is defined here as output (value added) per employee. While output per hour worked might be a more adequate measure of underlying labour productivity, data for hours worked are often not available at a quarterly frequency or, when available, of generally poor quality reflecting the still imperfect harmonisation of estimates for hours worked. In terms of the focus of this chapter, previous research has shown that, qualitatively, the results do not depend very much on whether output per worker or output per hour is used (e.g. Benati, 2007).

Section 3 of this chapter takes a closer look at the recent performance of productivity growth and compares it with that in the past two decades. Since calendar periods may cover different phases of the business cycle, which may influence the results, section 4 takes averages over upswing phases of the business cycles in the past 25 years, comparing the recent recovery phase with the past recoveries. In order to shed some light on the question whether the productivity acceleration observed since mid-2005 constituted a cyclical or a structural change, section 5 uses various statistical techniques to disentangle the cyclical and trend component of productivity growth. Section 6 looks at total factor productivity in order to investigate the role this component has played in the recent evolution of labour productivity growth. Section 7 concludes.

3. The recent pick-up in labour productivity growth

After several years of sluggishness, recent developments in labour productivity in the euro area have surprised on the upside. Annual labour productivity growth measured as value-added per worker accelerated to 1.2% in 2006, compared with an average of 0.4% in the period from 2001 to 2005 (Table 1.3.1). Although this performance is not outstanding by historical standards, as the annual average growth rates of 1.7% in the 1980s and 1.4% in the 1990s demonstrate, it marks a clear change compared to the first half of this decade. In addition, in 2006 productivity accelerated despite a further strengthening of employment growth, as the dynamism of output more than offset the negative "contribution" from employment.

In the private business sector, developments in the 1980s and 1990s seemed to be similar to those in the whole economy. However, the pick-up in 2006 was somewhat more pronounced than for the whole economy, with both output and productivity growth being around 0.5 pp. higher. This conforms to the notion that, in the short term, productivity gains can be more easily achieved in the private business sector as compared to the public services sector ([3]), although, somewhat surprisingly, in the longer term there do not seem to be large differences in the developments of these two sectors.

Within the private business sector, the recent pick-up in labour productivity growth appears to be broadly shared between sub-sectors, albeit to differing degrees and with the exception of financial intermediation, where the acceleration occurred already in the first half of this decade ([4]). Specifically, annual productivity growth in manufacturing accelerated to 4.5% in 2006, up from an average of 1.8% in the previous five years. Productivity growth in the construction sector turned positive in 2006, after having been negative on average over the preceding 15 years, remaining nevertheless below the rates of the other sectors. As for the trade-related services, productivity gains quickened to a pace of 2% in 2006, up from 0.6% in the preceding half-decade and clearly improving on the performance of the previous two decades ([5]).

With productivity growth equalling output minus employment growth, it is interesting to see to what extent the former was determined by developments in the latter two variables. As shown in Table 1.3.1, the annual average rate of employment creation in the private business sector accelerated in 2001-2005 compared to the preceding decade, picking further up in 2006. This led to lower productivity growth in the first half of the decade as output growth weakened simultaneously, but in 2006 productivity growth re-accelerated owing to a strong rebound in output growth.

The pattern of development was fairly heterogeneous across sectors. In particular, in manufacturing the productivity slowdown in the first half of this decade was predominantly the mirror image of a lower rate of job shedding, whilst the marked acceleration in 2006 was chiefly a reflection of a sharp increase in output growth. In construction, productivity growth did not change significantly in 2001-2005 compared with the 1990s, owing to a higher rate of job creation being balanced by faster output growth, but rose in 2006 as a further acceleration in job creation was outpaced by even higher output growth. In the trade-related services, productivity weakened in 2001-2005, with slowing output growth being accompanied by faster employment growth, but re-accelerated in 2006 thanks to a significant pick-up in output growth combined with virtually unchanged employment growth. Finally, in financial intermediation the acceleration of productivity in 2001-2005 was due to faster output growth against stagnant employment, while in 2006 employment accelerated in step with output, leaving productivity growth unchanged.

Overall, for the euro area as a whole slowdown of productivity growth in 2001-2005 was largely concentrated in manufacturing and trade and dominated by employment-related changes in

([3]) See Dew-Becker and Gordon (2006), p. 22.

([4]) In this chapter, "financial intermediation" is defined in a narrow sense, i.e. it covers only category J of the NACE classification. The reason for adopting this restrictive definition is that the broader 'J to K' category encompasses a sub-category called 'other business services', which comprises a variety of activities that are not necessarily related to finance. In so doing, the sum of all sectors which are described in the tables do not add up to the 'whole economy'. Indeed, the whole economy also encompasses the broader financial sector (J to K) as well as agriculture (categories A to B) and other public and social services (categories L to P).

([5]) The weakness of productivity growth in services could be partly due to measurement problems, mainly related to an underestimation of price deflators linked to quality improvements.

Table 1.3.1

Labour productivity, value added and employment, selected Member States (annual % change, period averages) (1) (2)

	labour productivity				*value added*				*employment*			
	81-90	91-00	01-05	06	81-90	91-00	01-05	06	81-90	91-00	01-05	06
	year-on-year % ch.											
whole economy	1.7	1.4	0.4	1.2	2.4	2.0	1.3	2.6	0.7	0.5	0.9	1.4
private business	1.7	1.5	0.6	1.7	2.4	2.0	1.4	3.2	0.7	0.4	0.8	1.5
manufacturing	2.3	3.0	1.8	4.6	1.6	1.2	0.9	4.2	-0.7	-1.7	-0.9	-0.4
construction	1.4	-0.6	-0.8	1.1	0.9	-0.3	0.3	4.4	-0.5	0.4	1.1	3.2
trade	1.1	1.7	0.6	1.9	2.5	2.5	1.6	3.1	1.3	0.8	1.1	1.2
fin. intermediation	1.6	1.3	2.4	2.5	3.3	1.3	2.5	3.3	1.7	0.0	0.1	0.8

Source: Eurostat.

Notes: (1) Sectoral breakdown according to NACE6 classification, excluding agriculture and public administration. Financial intermediation excludes "renting and other business activities", (2) Euro area: Belgium, Germany, France, Spain, Italy and Finland.

manufacturing (lower rate of job shedding) and output-related changes in trade (lower rate of output growth). The pick-up in productivity growth in 2006 was a reflection of faster output growth in manufacturing, construction and trade, which was only partly offset by employment growth, its acceleration vis-à-vis the period 2001-2005 notwithstanding.

Looking at the euro area aggregate may conceal important differences between countries. This section therefore takes a closer look at the developments in the four largest euro-area countries, Germany, France, Italy and Spain.

As shown in Table 1.3.2, a comparison of productivity developments in 2006 with the longer-term averages across Member States indicates that productivity gains have been particularly large in Germany. Labour productivity in the German private business sector grew at an annual rate of 3.2% in 2006, placing Germany in the lead amongst the larger Member States. This is explained by rapid output growth, which outpaced employment growth by a significant margin. While the surge in the German manufacturing sector to an annual 6.7% stands out, it is remarkable that productivity growth was strong in all sectors of the German economy in 2006, including construction (+6.2%) and trade (+3.4%). Financial intermediation also saw dynamic productivity growth in 2006 (+4.7%), but this constituted a slowdown compared to the period 2001-05, where productivity was growing at an annual average of close to 6%.

France also experienced a revival of productivity growth in 2006, although to a much lesser extent than Germany. While labour productivity in the private business sector was up at 1.6% in 2006, from an average of 1.1% in the first half of the decade, this was still below the average growth rates experienced in the 1980s and 1990s. Similar to Germany, in France the acceleration of productivity growth in 2006 reflected almost fully faster output growth, with employment growth broadly unchanged. Differences across sectors were more pronounced than in Germany. Whereas productivity gains in the manufacturing sector accelerated to 4.1% in 2006, they were more muted in the trade sector and in financial intermediation. In the construction sector, labour productivity was already on a declining path during 2001-05 and deteriorated further to a rate of -1.3% in 2006.

In Italy, despite a fairly sharp swing from a strongly negative average growth rate in the period 2001-05, labour productivity growth in the private business sector remained at a subdued level in 2006. While output recovered from the very modest performance in 2001-05, its effects on productivity was largely offset by brisk employment growth. Differences across sectors were quite large. In particular, the economy-wide average was dragged down by the services sector, where growth was subdued in trade and even negative in financial intermediation.

Spain also performed poorly in terms of labour productivity growth, against a backdrop of rapid output and employment growth. After having been negative on average in the previous 15 years, labour productivity in the private business sector declined again in 2006. Job growth in Spain was very dynamic over this period. In the construction sector, for instance, employment expanded by a stunning 7.6% in 2006, following almost 6% average growth in the previous 5 years. While overall output growth remained comfortably above the euro-area average, it was insufficient to fully offset the drag on productivity from employment growth. Productivity growth was subdued in trade and was even strongly negative in the construction sector. Manufacturing

Table 1.3.2

Labour productivity, value added and employment, selected Member States (annual % change, period averages) (1)

	labour productivity				*value added*				*employment*			
	81-90	91-00	01-05	06	81-90	91-00	01-05	06	81-90	91-00	01-05	06
Germany						*year-on-year % ch.*						
whole economy	1.3	1.8	1.0	2.2	2.4	2.1	0.8	2.9	1.1	0.2	-0.2	0.7
private business	1.6	2.0	1.5	3.2	2.4	2.0	1.0	3.8	0.8	0.0	-0.5	0.6
manufacturing	1.6	3.5	2.9	6.7	1.7	0.4	1.3	5.6	0.0	-2.9	-1.6	-1.0
construction	0.5	-0.8	0.3	6.2	-0.2	-0.6	-4.5	5.9	-0.7	0.2	-4.8	-0.4
trade	1.1	1.8	1.4	3.4	2.6	2.7	1.2	3.7	1.5	0.9	-0.1	0.2
fin. intermediation	1.3	0.5	5.9	4.7	3.3	1.4	5.4	5.1	2.0	0.9	-0.5	0.3
France						*year-on-year % ch.*						
whole economy	2.2	1.4	0.9	1.3	2.5	2.0	1.5	2.1	0.3	0.6	0.6	0.8
private business	2.1	1.7	1.1	1.6	2.2	2.0	1.7	2.6	0.1	0.3	0.6	0.9
manufacturing	2.8	3.5	3.0	4.1	0.9	2.1	1.2	2.1	-1.9	-1.4	-1.7	-2.0
construction	2.3	0.8	-0.6	-1.3	1.2	-0.6	1.2	3.0	-1.1	-1.5	1.9	4.4
trade	2.6	1.9	0.6	2.4	3.4	2.5	1.8	3.1	0.8	0.6	1.2	0.7
fin. intermediation	3.4	1.9	-0.7	0.7	4.6	1.5	0.3	1.3	1.1	-0.4	1.0	0.6
Italy						*year-on-year % ch.*						
whole economy	1.6	1.4	-0.5	0.0	2.1	1.6	0.6	1.8	0.6	0.2	1.2	1.7
private business	1.6	1.4	-0.8	0.3	2.3	1.7	0.5	2.1	0.7	0.2	1.3	1.8
manufacturing	2.6	2.1	-1.0	1.7	1.6	1.0	-1.3	2.8	-1.0	-1.1	-0.3	1.1
construction	2.6	-0.5	-0.7	1.2	1.4	-0.2	2.9	1.7	-1.2	0.3	3.6	0.4
trade	0.3	2.5	0.1	0.4	1.9	2.7	1.1	2.6	1.6	0.1	1.0	2.2
fin. intermediation	-1.5	1.2	-0.2	-1.6	1.2	1.1	0.2	0.0	2.7	0.0	0.4	1.7
Spain						*year-on-year % ch.*						
whole economy	1.9	0.5	-0.1	0.2	3.0	2.2	3.1	3.6	1.1	1.8	3.2	3.3
private business	1.7	-0.2	-0.3	-0.1	2.8	2.0	3.1	3.6	1.1	2.3	3.4	3.7
manufacturing	2.7	1.5	0.2	2.6	2.2	2.2	1.2	3.1	-0.5	0.8	1.1	0.5
construction	2.1	-1.5	0.3	-2.2	3.7	1.6	6.1	5.3	1.9	3.3	5.8	7.6
trade	2.1	-0.3	-0.9	0.0	2.1	1.9	2.6	2.6	1.7	2.2	3.6	2.6
fin. intermediation	4.1	0.5	1.1	0.6	5.5	1.1	3.6	3.5	1.4	0.6	2.6	2.8

Source: Eurostat.

Notes: (1) Sectoral breakdown according to NACE6 classification, excluding agriculture and public administration. Financial intermediation excludes "renting and other business activities".

was the only sector that gave a significant positive contribution to overall productivity growth in 2006, following a very moderate performance during 2001-2005.

Overall, while the acceleration of productivity growth in 2006 was fairly general across countries and sectors, a significant part of the pick-up at the euro-area level seems to be due to developments in the private business sector in Germany. Table 1.3.2 also shows that, in general, there is a close correspondence between changes in productivity growth and changes in output growth. This is likely to be linked to the pro-cyclicality of productivity growth. It illustrates, moreover, that generally there exists no longer-term trade-off between employment growth and productivity growth. Nevertheless, the table also provides some evidence that in specific instances particularly employment-rich growth may have acted as a damper to productivity growth. The construction sector in France, Italy and Spain during this decade seems to be a case in point. However, in the latter two countries recent productivity data may also have been downward biased by the regularisation of undeclared immigrant workers.

This raises the more general question of the factors behind the widely different experiences of sectors and countries in terms of labour productivity growth during this decade. In addition to the fundamental drivers of productivity growth, i.e. capital deepening and technical and organisational progress, which will be analysed more in-depth in later chapters, "statistical" factors seem to partially account for this. In particular, due to measurement errors and differences in national accounting practices the comparison of labour productivity across countries is subject to considerable uncertainty ([6]).

More importantly, composition effects, which are due to differences in sectoral specialisation and sectoral growth between countries, may play a significant role in shaping productivity developments. While the boom in construction activity in Spain over past years is the obvious example, this effect may have been more generally relevant, especially in the services sector ([7]). Finally, the degree countries and sectors

([6]) See, for instance, OECD (2006) or Gomez-Salvador et al. (2006), p. 16.

([7]) See Dew-Becker and Gordon (2006).

resort to "outsourcing" may be an important source of divergence. Outsourcing may affect measured productivity in two ways. First, it may lead to a better division of labour and therefore improve overall efficiency. But it may also have purely "statistical" effects in that certain activities move from one sector or country to another. If the productivity of these activities differs from the average productivity of the sector or country of origin, measured productivity levels will change across sectors and countries.

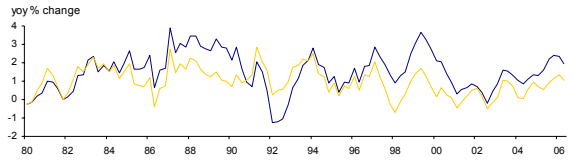
4. Cycle analysis

Labour productivity growth varies with the cycle, with productivity growth usually increasing above trend in a cyclical upswing and falling below trend during a downswing. A plausible explanation for this is that in the early phases of an economic upswing additional demand addressed to the enterprise sector is met by making incumbent employees work more efficiently (and longer hours). As the upswing matures and to the extent that the recovery is perceived as lasting, companies increase hiring. During this phase, while GDP may start to slow, employment growth accelerates, leading to slower growth of output per person employed ([8]).

The cyclicality of productivity growth is illustrated by Graph 1.4.1 which depicts the developments in output and productivity growth in the euro area over the period 1980-2007. As can be seen, the two variables move very closely together, with a contemporaneous correlation of 0.76. While it is often claimed that productivity is a variable that leads the cycle ([9]), this is not borne out by the data here. The maximum cross-correlation is reached at a lead/lag of zero, with cross-correlations of increasing leads and lags decaying quickly. Examining the turning points, the productivity variable displays a small lead at some peaks, but on average the lead is less than one quarter.

The cyclicality of productivity growth implies that the average growth rates as shown in Tables 1.3.1 and 1.3.2 may be distorted by the fact that they reflect different phases of the business cycle. One way of eliminating this distortion would be to take averages over full business cycles ([10]). This would net out the effects of the cycle and the result could therefore be interpreted as the "structural" growth rate of labour productivity over a business cycle. However, this would not allow the comparison of the current cycle with those in the past, as knowledge on the actual state of the present cycle is highly uncertain. The approach adopted in this section is, therefore, to compare cyclical upswing phases rather than full cycles, i.e. to average only over the expansion phase of current and past cycles. This approach is used to calculate average growth rates of labour productivity, value added and employment and compare the current cycle with the average of previous cycles. Appendix 1 provides more detailed information on the cycle dating procedure.

Graph 1.4.1: **Output and productivity growth in the euro area**



Source: European Commission.

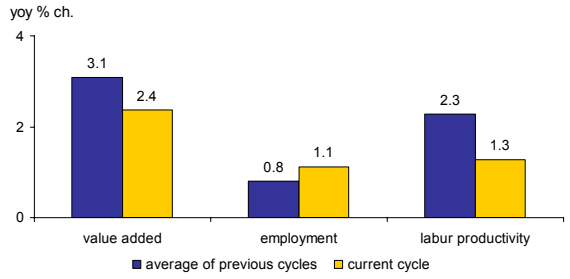
([8]) The cyclicality of productivity growth is an implication of "Okun's law" which says that the elasticity of the output gap with regard to a change in the unemployment rate is a greater than one. Okun (1970) suggested an elasticity of 3 on the basis of US data referring to the 1950s and 1960s, but later research indicated that the elasticity may have fallen over time. Cast in terms of changes in the employment rate, Okun's law implies that an increase (decrease) in the employment rate by 1% leads to an increase (decrease) in output by more than 1%, increasing (reducing) thereby the ratio between output and employment.

([9]) According to Gordon (2003), one of the stylised facts in research on business cycles is that the cyclical component of productivity growth is pro-cyclical and displays a lead when related to changes in the output gap.

([10]) See, for instance, Gordon (2003) who proposes to chose the beginning (and ending) of a cycle at points in time where the actual unemployment rate intersects the NAIRU from above.

Graph 1.4.2 shows the average growth rates of value added, employment and labour productivity in the euro area in the current upswing compared with that of previous ones. It can be seen that output growth in the current upswing lags behind that of previous cycles, while the opposite holds for employment growth. As a consequence, output per worker grew at a significantly lower rate during the latest upturn than in past upswings.

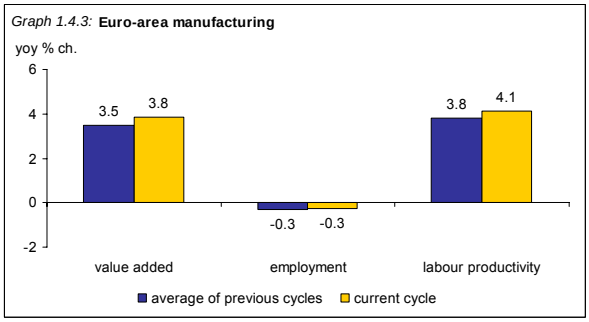
Graph 1.4.2: **Euro-area private business sector**



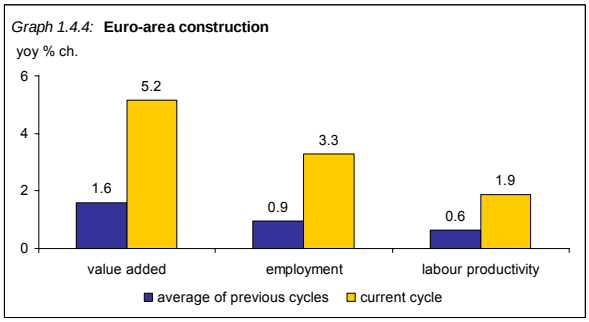
Labour productivity in the euro-area private business sector was dragged down in the current recovery by weakness in trade and financial intermediation (Graphs 1.4.3-1.4.6). Specifically, labour productivity in trade increased at an average pace of 1.6% in the current upswing, 0.8 pp. less than in previous expansions. The drop is even larger for financial intermediation, with the average growth rate having slowed down to just above 3% in the current recovery from an average of almost 5% in past recoveries. By contrast, in manufacturing and in construction the performance of labour productivity in the current upswing was more favourable than previously, with growth in the former sector averaging 4.1% in this upswing compared to 3.8% before, while in the latter sector growth accelerated noticeably to a rate of 1.9%, from 0.6% in previous cycles.

The productivity slowdown in this cyclical recovery is thus mainly attributable to developments in the services sector. In addition, composition effects seem to have played a role. In particular, the construction sector, which in terms of productivity growth was a "low-performer" in the past, expanded by much above the economy-wide growth rate during this upswing. And in financial intermediation, where despite their recent moderation productivity gains have been comparatively high, output growth was lagging behind in this upturn compared to previous upturns.

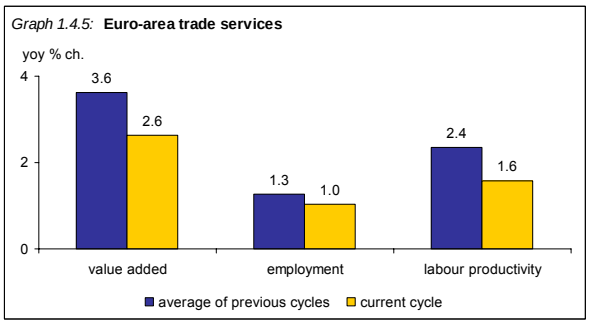
Graph 1.4.3: **Euro-area manufacturing**



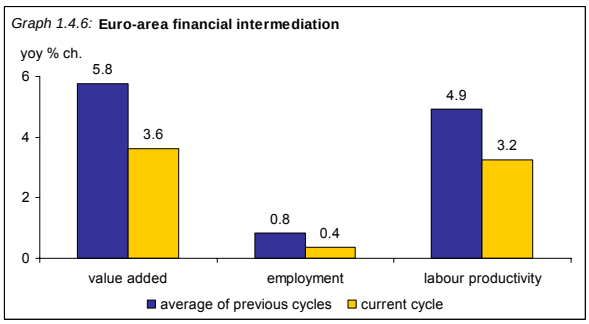
Graph 1.4.4: **Euro-area construction**



Graph 1.4.5: **Euro-area trade services**

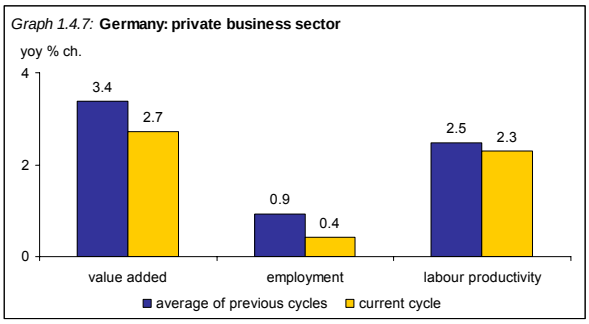


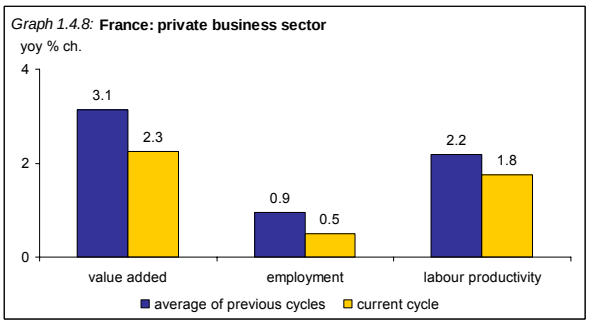
Graph 1.4.6: **Euro-area financial intermediation**

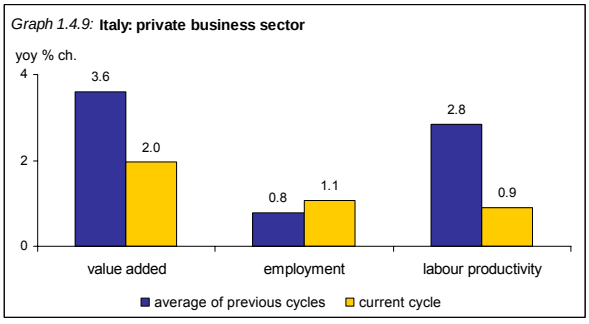


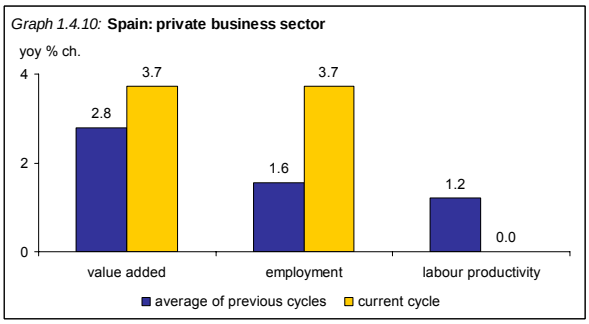
Comparing these results with those of the previous section, two main differences can be noted. Controlling for the effect of the cycle shows that the construction sector has seen a strong, output-driven acceleration of productivity growth in recent years. This did not become visible in the result of the previous section which averaged over calendar-

specific sub-periods. The opposite holds for financial intermediation, where the results of this section indicate that a slowdown in productivity growth took hold during the latest cycle compared to past cycles while the previous section showed an acceleration in this decade compared with the previous two decades.









The slowdown of productivity growth during the current recovery can be observed across all large euro-area Member States, although to varying degrees (Graphs 1.4.7-1.4.10). Italy and Spain stand out as experiencing considerably lower productivity growth during this recovery than in previous upswing episodes. In Italy, productivity grew by 0.9% in the current expansion, against 2.8% average growth in the past. In Spain, productivity remained flat during this cyclical upswing, compared to 1.2% average growth in the past. The gap is significantly smaller in the case of Germany and France. In the former country, output per worker in the current recovery broadly matched the pace of past recoveries and in the latter the gap amounted to 0.4 pp.

The developments in Italy and Spain in the current expansion appear to explain most of the underperformance of labour productivity growth at the euro-area level. This seems to be due above all to a pick-up in employment growth, which in Italy has taken place against a background of a decline in output growth, while in Spain output growth accelerated but was significantly outpaced by employment growth.

5. The trend component of labour productivity growth

The previous sections indicated that the euro area was stalled in a state of historically low productivity growth for most of the present cyclical expansion. A question that remains unanswered is whether the rebound in productivity growth since mid-2005 represents a cyclical or a structural change in productivity growth. As shown by Graph 1.4.1, the recent acceleration of labour productivity in the euro area is closely related to the strengthening of economic activity, suggesting that the up-tick in productivity growth is mainly of a cyclical nature. To shed more light on this issue this section will use statistical techniques with a view to disentangling the trend and the cyclical components of productivity growth.

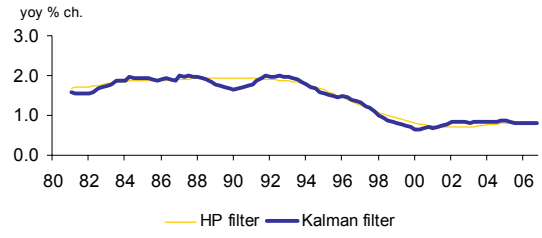
A commonly-used method of separating out the trend component from an economic time series is the Hodrick-Prescott (HP) filter. The HP-filter was used, for example, in the calculation of trend labour productivity growth for the euro area in European Commission (2006). An alternative to the HP-filter is the Kalman-filter, which estimates the trend from a time-varying parameter time-series model (see e.g. Gordon (2003) or Fritsche and Erber (2005)). Finally, statistical test procedures can be used to determine whether productivity growth is subject to structural shifts (see e.g., Jimeno et al. (2006) or Benati (2007)). Box 1.5.1 presents a more detailed discussion of these methods.

Using filters to extract trend productivity

Graph 1.5.1 shows the development of trend productivity growth in the euro-area private business sector since 1980, where the trend has been estimated with the two techniques mentioned above (HP-filter and Kalman-filter). As can be seen, the two methods yield fairly similar results except that the HP-filtered trend is somewhat smoother than the Kalman-filtered trend ([11]).

In accordance with these estimates, trend labour productivity in the euro area expanded at a year-on-year growth rate of around 2% during most years between the first half of the 1980s and the early 1990s. Thereafter, trend labour productivity growth declined rapidly, reaching a minimum at the beginning of this decade. The declining trend came to a halt between 2000 and 2002, depending on which trend curve is used. The Kalman-filter indicates a halt in 2000, with a slight pick-up during 2000-2002 and a stabilisation thereafter. The HP-filter suggests a somewhat later turning point at around 2002, with a gradual but more persistent recovery thereafter.

Graph 1.5.1: **Euro area private business sector**



The development of trend productivity in the euro-area private business sector as depicted in Graph 1.5.1 allows a slightly differentiated interpretation of the results obtained previously and presented in Table 1.3.1. In the 1980s, the average growth rate of actual labour productivity of 1.7% matches a more or less stable trend growth rate of around the same size. In the 1990s, the average growth rate of actual productivity falls to 1.5% as a consequence of a decline in the underlying trend growth, which starts towards the end of the first half of that decade. In the first half of the current decade, the actual productivity growth was dragged down (to an average of 0.5%) by a combination of a low underlying trend and unfavourable cyclical conditions. In 2006, actual productivity growth picked up to 1.7% on the back of a strong cyclical upswing, while trend productivity growth remained at around 0.6-0.8%.

These results differ from previous research (e.g. Gomez-Salvador et al. (2006), Dew-Becker and Gordon (2006)) as the latter points to the slowdown in the 1990s but fails to detect the stabilisation that occurred in the early years of this decade ([12]). This is partly related to the fact that most of this research is based on data which does not include most recent developments, partly to methodological differences.

([11]) This is partly due to the fact that, following Gordon (2003), the λ-parameter for the HP-filter (see Box 1.5.1) was set to 6400, which results in a smoother trend than would be the case with the standard parameter setting of 1600.

([12]) Results in Benati (2007), who uses data up to 2006, point to a stabilisation of productivity growth "over the last few years".

Box 1.5.1: **Disentangling trend and cycle**

In this chapter three methods to detect changes in the underlying trend of labour productivity are used: the HP filter, the Kalman filter and statistical stability tests.

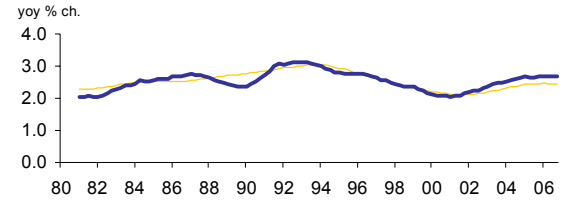
The HP filter is essentially a moving average, which smoothes a time series by removing all high-frequency movements. Due to its simplicity, the HP filter is probability the most widely used method of trend extraction. Despite its popularity it suffers from two shortcomings. First, the degree of smoothing depends on a parameter (commonly denoted as "λ"), which needs to be set beforehand. Unfortunately, there is no common understanding on the "correct" value of this smoothness parameter. Whereas most researchers use a value of 1600 for quarterly data, Gordon (2003) argues that this value leaves too much variation in the series, leading to implausible results regarding trend growth of the US economy. The second problem is the so-called end-point problem which stems from the fact that, in general, the HP filter uses a symmetric number of observations before and after a data point of the original series to compute the trend component. But due to the lack of data beyond the two end points of the series, the filter becomes asymmetric in the period close to these points, i.e. uses predominantly or exclusively values from one side. A consequence of this is that at the end-points the estimated trend becomes less reliable because it tends to pick up too much of the variation in the original series, i.e. attributes part of the cyclical component to the trend.

Among the alternative methods used to estimate the unobserved trend component, Harvey (1989) proposed to decompose an economic time series into a cyclical component, a trend component and an 'irregular' component by using the Kalman filter. Gordon (2003) used a simplified version of this approach for the purpose of estimating trend productivity in the US. It consists essentially of specifying a time-varying coefficients time series model for the evolution of productivity growth, augmented by additional explanatory variables which control for the impact of the cycle on productivity growth (essentially the output gap). The variance ratio of the disturbance terms underlying the Kalman-filter approach determines the degree of smoothness of the estimated trend component. The problem of the arbitrariness of the smoothness of the estimated trend component is therefore not eliminated with the Kalman filter. By contrast, the Kalman filter avoids the end-point problem as there is a possibility of directly controlling for the impact of cyclical developments on productivity.

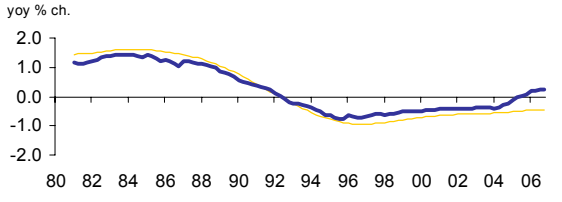
The ultimate goal of applying the HP and Kalman filter is to detect changes in the trend component of productivity growth. However, both techniques are only heuristic tools and do not provide formal statistical "proof" whether or not such developments correspond to an underlying structural change. An approach that addresses this problem is the use of statistical stability tests in the framework of univariate time series modelling. A number of such tests have been developed in recent years and they differ essentially in the way they presume *a priori* knowledge. The advantage of these tests is that they provide a rigorous statistical testing framework. Their disadvantage is that they impose very strict assumptions on the statistical properties of the time series which are often not fulfilled in practice. In this chapter two test procedures, the Nyblom-Hansen test and the Bai-Perron test, are applied. The former is a test for the overall stability of a regression equation. The latter offers the possibility of testing for several breakpoints in a regression equation and uses standard criteria to derive the "best" model. Appendix 4 gives more details on the Kalman-filter estimation and the tests for structural breaks.

Looking into the sectoral dimension, Graphs 1.5.2-1.5.5 show that trend productivity has been very heterogeneous across sectors, confirming the results of previous sections. There is some evidence that trend productitivy growth started to increase gently in manufacturing and construction, in the latter sector somewhat earlier than in the former. Such a reversal in the trend decline cannot be observed in the trade sector, even if the negative trend seems to have bottomed out. Finally, for financial intermediation strong fluctuations make the picture somewhat blurred, but the underlying tendency points to an upward trend.

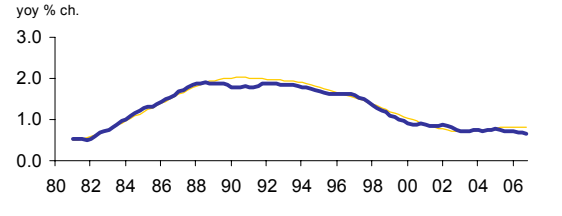
Graph 1.5.2: **Euro area manufacturing**



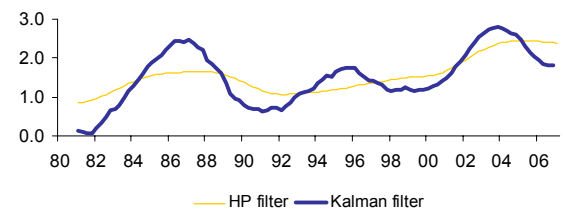
Graph 1.5.3: **Euro area construction**



Graph 1.5.4: **Euro area trade services**

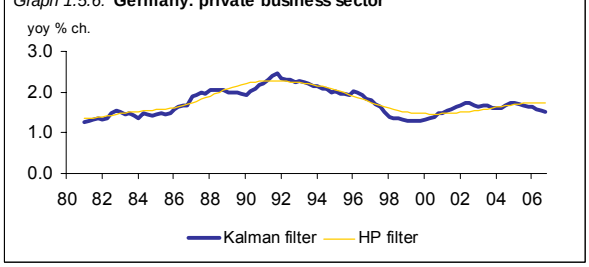


Graph 1.5.5: **Euro area financial services**

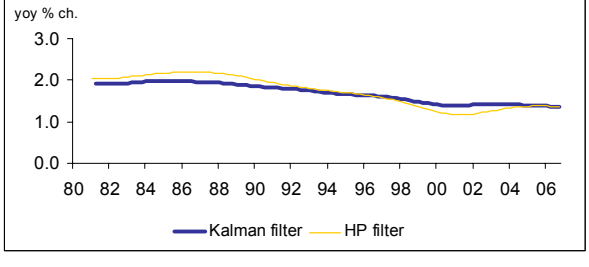


Turning to cross-country differences, the trend decline in the 1990s and the subsequent stabilisation is a common feature for all four Member States (Graphs 1.5.6-1.5.9). However, the decline in the 1990s was less pronounced for Germany and France than for Italy and Spain. In Germany, trend productivity growth, after peaking at some 2.3% in 1992, declined to about 1.5% at the end of the 1990s, before picking up slightly. In France, the decline in trend productivity growth started earlier and followed a gentle downward path until the beginning of this decade when it started to bottom out. In Italy, trend productivity growth oscillated sideways during the 1980s before dropping in the 1990s, getting negative in 2000 and tailing off thereafter.

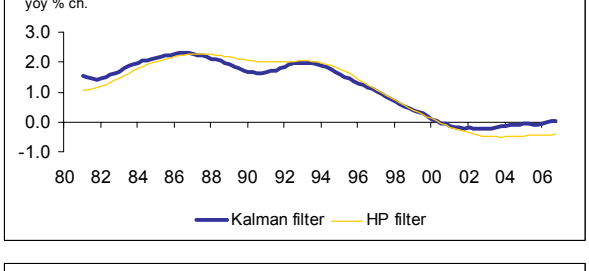
Graph 1.5.6: **Germany: private business sector**



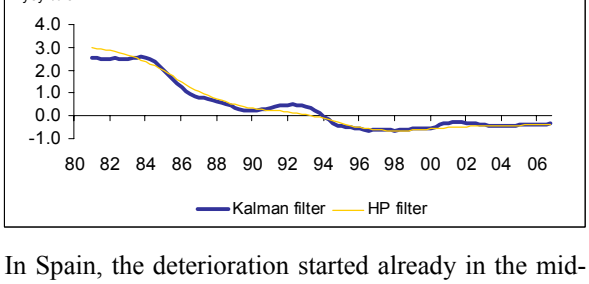
Graph 1.5.7: **France: private business sector**



Graph 1.5.8: **Italy: private business sector**



Graph 1.5.9: **Spain: private business sector**



In Spain, the deterioration started already in the mid-1980s and bottomed out in the mid-1990s at a negative rate of around 0.5%, without however seeing a distinct reversal since then. It is possible that these different trends are explained by the sectoral

composition of each economy or by differences in sectoral growth.

Trend labour productivity in the manufacturing sector differed considerably across Member States (see graphs in Appendix 2). Notably, in the 1990s a declining trend cannot be observed in the German or French manufacturing sector. Trend productivity growth in the German manufacturing sector increased steadily, starting from around 1.5% in the 1980s to above 3.5% at around 2000. In France, however, it seems that the upward trend has come to a halt, stabilising at slightly above 3% towards the end of the 1990s. In contrast, Spain and Italy experienced an unabated downward trend in labour productivity growth in manufacturing activities from the 1980s on. However, the decline in the trend seems to have come to a halt and even reversed in Spain over the most recent period. The pick-up in the manufacturing sector in Spain is noteworthy, but some stabilisation seems to have occurred also in the trade services. In the cases of both Spain and Italy, the construction sector appears to have dragged down trend growth.

The financial services sector is a very special case. The fairly positive picture at the aggregated euro-area level is predominantly explained by the strong pick-up in Germany. Developments in financial services in Spain and Italy since the end of the 1990s clearly point in the opposite direction and in France a deceleration is also visible, although to a lesser extent.

Testing for structural breaks

In order to assess the significance of the recent acceleration in labour productivity, the existence of shifts in the trend rate of labour productivity growth has been tested by way of two different types of statistical tests. The first test (Nyblom-Hansen) checks for overall stability of productivity growth. In case of a rejection, the second test (Bai-Perron) examines how many times a shift ("break point") occurred using the "Bayesian Information Criterion" to determine the "optimal" number of shifts. The tests were carried out on the series of quarter-on-quarter productivity growth in the private business sector for the euro area and the four largest euro-area Member States. The conclusions that can be drawn from these tests are the following (for further details see Appendix 4):

- Trend productivity growth over the period 1981-2006 was unstable for the euro area and the four largest Member States, with France being a borderline case.
- Based on the *a priori* assumption that three shifts in the trend of productivity growth occurred during the period 1981-2006 in the euro area, shifts are identified in the first half of the 1980s (upward shift), in the second half of the 1990s (downward shift) and at the beginning of this decade (upward shift). However, the productivity shift in the early years of this decade is statistically not robust since the assumption of a single shift (the downshift in the second half of the 1990s) yields a superior model in terms of the applied criterion for model selection.
- Regarding the results for the four largest Member States, for Germany the test procedure identifies a single shift as describing the data "optimally", with the shift occuring in the second half of the 1980s (upward shift). In other words, the statistical evidence in favour of a downward shift of productivity growth in the 1990s and a subsequent upward shift during this decade is weak. For France, there is no conclusive evidence in favour of any number of shifts (which is in line with the inconclusiveness of the stabiliy test). For Italy, two downward shifts (in the first half of the 1980s and in the second half of the 1990s) appear to best describe the data. Finally, for Spain three downward shifts (one in the mid-1980s and two in the first half of the 1990s) are chosen by the selection criterion as being "optimal".

These results suggest that, while the bottoming out of the decline in trend productivity growth at the start of this decade is broadly confirmed, evidence of a turning point beyond that date indicating a recent pick-up in trend productivity growth is weak. A caveat as to the implications of these results is, however, in order. Due to the high volatility of the underlying series (see the graphs in Appendix 4), the applied test procedures may not be able to discriminate very precisely between alternative assumptions. This is reflected by the values of the test criterion which are not very far from each other under different assumption. Moroever, as noted also by Benati (2006), the power of these tests may be very low when the underlying data generation process is

characterised by gradual change, as seems to be the case for trend productivity growth, rather than sudden shifts. For this reason, a very cautious interpretation of the results seems approproate in the sense that, while there is no strong evidence of a recent pick-up in trend productivity growth, there is also no direct evidence against it, at least for the euro area as whole.

Summing up, the fall in trend productivity growth in the euro-area is a phenomenon that is largely concentrated in (the second half of) the 1990s. The decline bottomed out at the beginning of this decade, with the Kalman-filter suggesting a slightly earlier date than the HP-filter. While there are also indications that for some sectors and countries a turn-around occurred during this decade, the strong pick-up in productivity growth since mid-2005 seems to be mainly due to favourable cyclical conditions.

6. Trend growth of total factor productivity

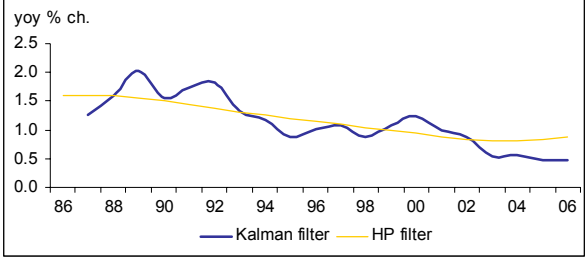
Labour productivity defined as output per employee is one among several concepts of productivity. As discussed in Box 1.2.1, labour productivity growth equals TFP growth plus capital deepening. In the long run, under certain assumptions labour productivity growth converges to TFP growth up to a constant factor. TFP growth is therefore of some interest in itself as it shows how labour productivity contributes to overall growth if capital and labour were to grow at the same rate.

TFP growth cannot be directly measured. It is usually calculated as a residual after accounting for the contribution of capital and labour input to output growth ([13]). As can be seen from Box 1.2.1, TFP growth can be calculated as the difference between output growth and capital deepening. Since both output growth and capital deepening are subject to cyclical variations, TFP growth will also vary with the cycle.

For this reason, to obtain information on the longer-term trend of TFP growth similar procedures as in the case of labour productivity can be used to extract the trend component of the series. Since the cyclicality of measured TFP growth reflects to a large extent the degree of factor utilisation that varies over the cycle (see Gomez-Salvador et al. (2006)), capacity utilisation may be a valuable piece of information in extracting trend TFP growth. As it turns out, the rate of capacity utilisation is useful in identifying the trend component of TFP growth (for further details see Annex 4). Results from such an exercise are presented below.

Graph 1.6.1 shows that trend TFP growth in the euro area drifted downwards from the second half of the 1980s up to the early years of this decade. A stabilisation at a low level is suggested thereafter, particularly when looking at the results from the HP filter, which show a marginal improvement in recent years, while the results derived from the Kalman filter are less clear in this respect. Taken together, the results may be interpreted as indicating that, similarly to the developments of labour productivity growth, the long-term decline in TFP growth has come to a halt, but evidence for a trend reversal is not robust.

Graph 1.6.1: **Trend TFP growth-Euro area**

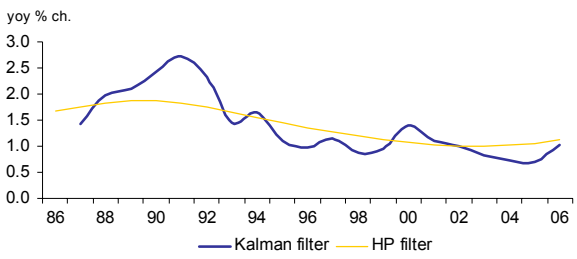


Looking at the country-specific estimates (Graphs 1.6.2-1.6.5), the only country for which some trend increase in recent years seems indicated is Germany. However, it should be noted that Germany has the most volatile TFP trend among the countries considered and the recent increase should rather be seen as a return to the normal trend growth level following several years of steeply declining growth rates after 2000. Moreover, based on the results of the Kalman filter, only the last year of the sample exhibits a rise in trend TFP growth. But inference on the last data point is statistically fragile, since the estimate is potentially subject to revisions when additional observations become available.

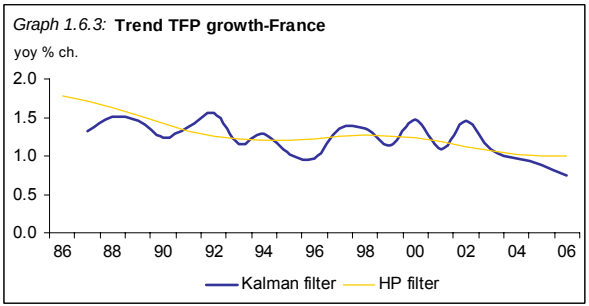
In the case of France, trend TFP growth has been heading downwards for most of the past 20 years. Although the relatively volatile Kalman-filter estimates suggest intermittent recoveries, these were more than offset by subsequent declines. While the estimates obtained with the HP filter could be interpreted as evidence for a stabilisation in TFP growth in recent years, the comparison with the results derived from the Kalman filter suggests that some caution is warranted before jumping to conclusions. In particular, given its problems at end-points, the HP filter may not have fully eliminated the cyclical component of TFP growth for the most recent data points.

([13]) Denis et al. (2006) provide an extensive overview on the official methodology of calculating TFP growth applied by the European Commission.

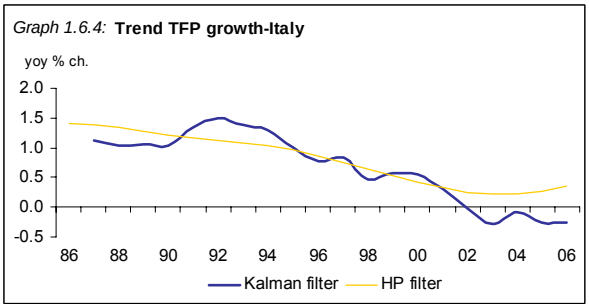
Graph 1.6.2: **Trend TFP growth-Germany**



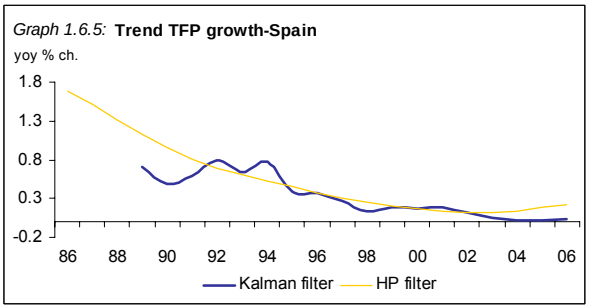
Graph 1.6.3: **Trend TFP growth-France**



Graph 1.6.4: **Trend TFP growth-Italy**



Graph 1.6.5: **Trend TFP growth-Spain**



For Italy, the development of trend TFP growth bears resemblance to that of the euro area as a whole, albeit at a lower trajectory. According to the Kalman-filter estimates, trend TFP growth was falling for most of the past 20 years, with a stabilisation at a negative rate of growth in the last three years. The results obtained with the HP filter indicate that the stabilisation could have occurred somewhat earlier, in which case trend TFP growth would have remained in positive territory. But this could again be a reflection of the HP filter's potential failure to properly disentangle the cyclical component from the trend component at end-points.

A similar conclusion holds for Spain, where the apparent recovery in trend TFP based on the HP-filter estimates could well be a statistical artefact, given that the estimates obtained with Kalman filter show almost no growth over the last years.

A common element of the above estimates seems to be that the results derived from the HP filter show a slightly more positive picture than those obtained with the Kalman filter. The most likely reason for this is that, due to the end-point problem, the HP-filter does not separate out the cyclical component from TFP growth for the most recent period, leading to an overestimation of TFP growth in the recent cyclical upswing. Taking this into account, the conclusion that can be drawn from these estimates is that there is no robust evidence of a trend reversal of TFP growth in the euro area. Among the larger euro-area Member States, the only country for which a trend increase appears possible is Germany, but according to the Kalman filter estimates the turn-around occurred only in 2006, which seems to be too short a period for drawing firm conclusions.

Concluding remarks

Summing up, the analysis of labour productivity growth using quarterly data shows that, for the euro area as a whole, trend labour productivity growth declined relatively sharply from the mid-1990s until the early years of the current decade. This applies across sectors and Member States, though the decline at euro-area level seems to have been dominated by developments in manufacturing and trade services, on the one hand, and in Germany and Italy, on the other. While the decline in trend labour productivity growth seems to have bottomed out, there is little evidence of a marked pick-up so far in the current decade.

A sectoral analysis of the data shows that the German and French manufacturing sector are exceptions to the overall pattern of a declining trend in the 1990s.

While there does not seem to exist a trade-off between employment growth and productivity growth in the longer term, there are some indications that exceptionally buoyant employment growth may have temporarily lowered productivity growth in Italy and Spain

Actual data suggests a strong pick-up in labour productivity growth since mid-2005. However, a large part of this apparent acceleration must be attributed to the cyclical upswing which the EU economy has enjoyed in this period. These results are corroborated by estimates of trend growth of total factor productivity which do not so far show much sign of a pick-up in this component of labour productivity growth.

Overall, while productivity growth appears to have stopped slowing down, it has not yet turned the corner.

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Appendix 1

Cycle dating

The quarterly series of value-added at constant prices in a specific sector is taken as the reference series to track and date the business cycle in that sector, against which the cyclical evolution of value-added, employment and labour productivity are assessed. The (asymmetric) Christiano-Fitzgerald filter, applied on the (log)level of the reference series, was used to extract the cyclical component for each reference series and to identify peaks and troughs.

The euro-area private business sector has experienced a total of five recoveries and recessions since 1980 (Table 1.A.1.1). The third quarter of 2003 marks the latest trough and the turning point in economic activity, which means that the euro area had been in recovery for fourteen quarters since. The four previous recoveries began in 1982Q4, 1987Q3, 1993Q2 and 1999Q1, respectively.

The business cycles and turning points for the four largest euro-area Member States and for the four sub-sectors of the private business sector are similar to those of the euro-area private business sector as a whole. However, the degree of synchronisation varies across time and his is especially true for the acceleration of economic activity in the first half of the 1980s and the latest upturn.

Table 1.A.1.1

Business cycle dating, private business sector

Euro area	82Q4	87Q3	93Q2	99Q1	03Q3
Germany	82Q4	87Q4	93Q3	99Q1	04Q1
France	80Q4	87Q3	93Q3	97Q1	03Q2
Italy	83Q1	87Q1	93Q2	99Q1	05Q2
Spain	80Q3	86Q4	93Q1	96Q1	04Q1
Manufacturing	82Q4	87Q3	93Q2	99Q1	05Q2
Construction	82Q2	87Q2	93Q4	98Q4	05Q1
Trade	82Q4	87Q1	93Q2	99Q2	03Q4
Financial intermediation	83Q2	87Q3	92Q2	98Q3	02Q3

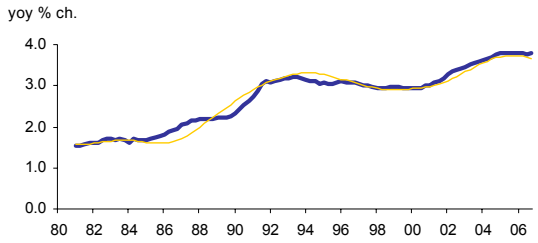
Source: Commission services.

For each expansion phase from trough to peak, the growth rate of value added, employment and labour productivity were then computed on the original level of the series. As these growth rates control for the length of each specific cycle, averaging over business cycles of different lengths one obtains an average growth rate of the variable in question. The performance of value-added, employment and labour productivity during the current expansion phases is then compared with the average performance of these variables in previous upswings.

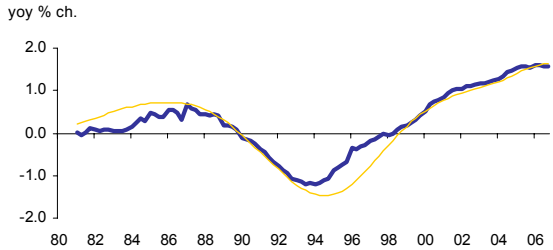
Appendix 2

Trend labour productivity growth

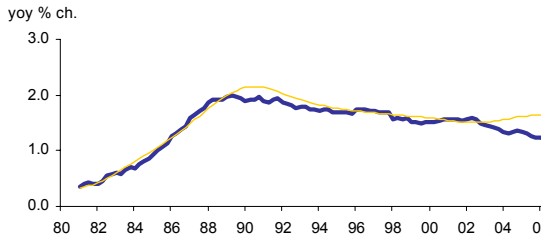
Graph 1.A.2.1: **Germany, manufacturing**



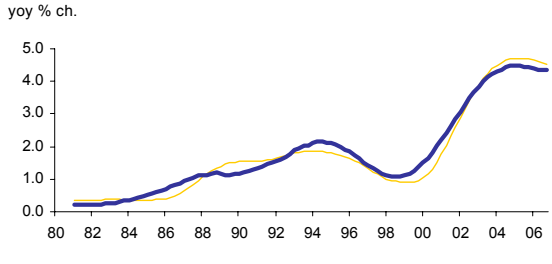
Graph 1.A.2.2: **Germany, construction**



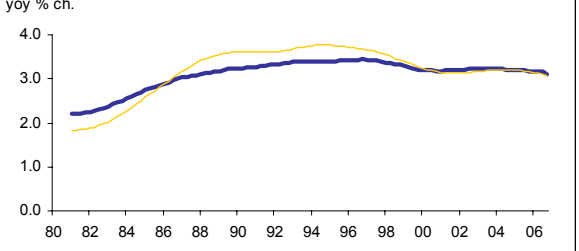
Graph 1.A.2.3: **Germany, trade services**



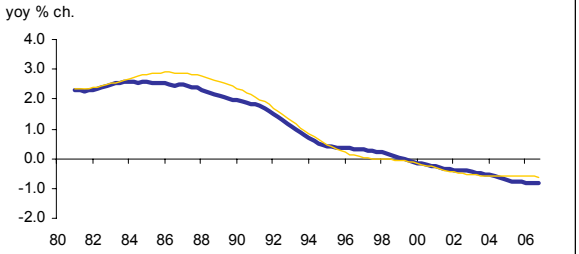
Graph 1.A.2.4: **Germany, financial services**



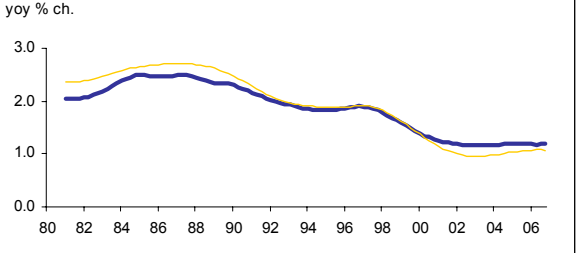
Graph 1.A.2.5: **France, manufacturing**



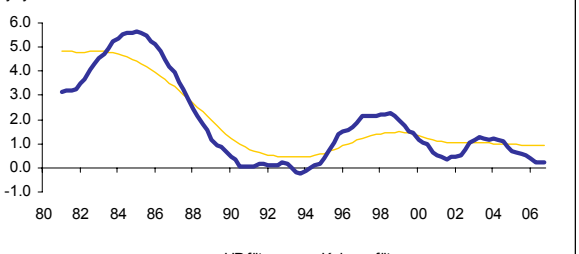
Graph 1.A.2.6: **France, construction**



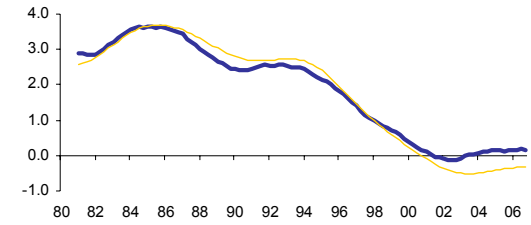
Graph 1.A.2.7: **France, trade services**



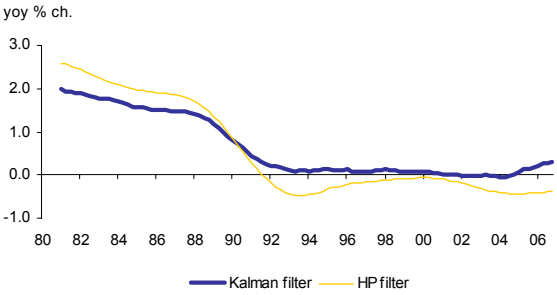
Graph 1.A.2.8: **France, financial services**



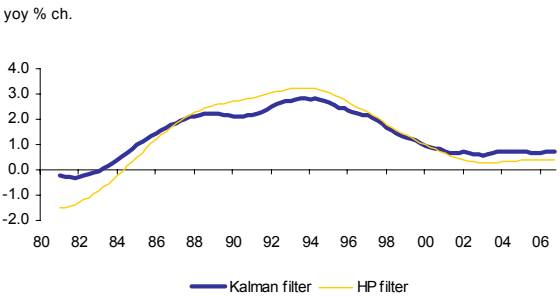
Graph 1.A.2.9: **Italy, manufacturing**



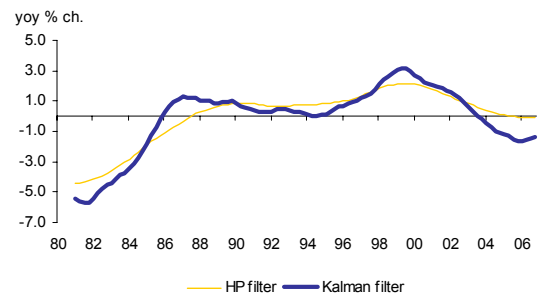
Graph 1.A.2.10: **Italy, construction**



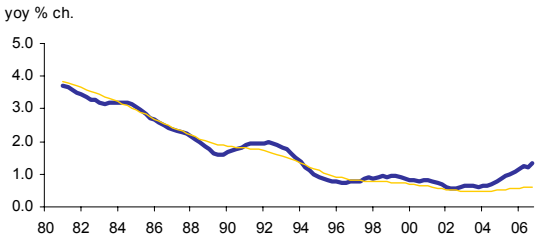
Graph 1.A.2.11: **Italy, trade services**



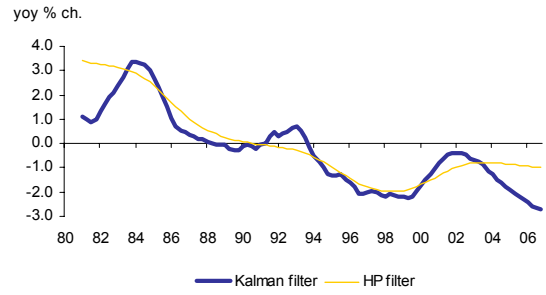
Graph 1.A.2.12: **Italy, financial services**



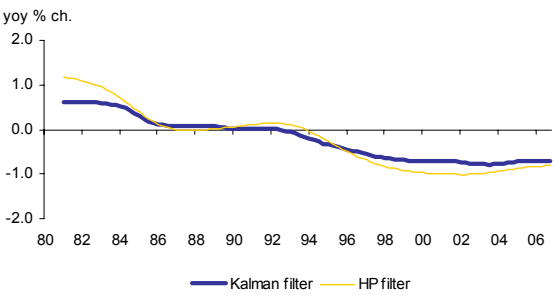
Graph 1.A.2.13: **Spain, manufacturing**



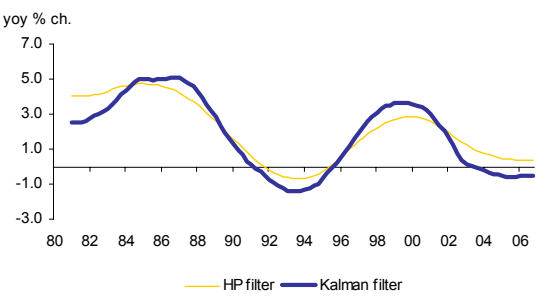
Graph 1.A.2.14: **Spain, construction**



Graph 1.A.2.15: **Spain, trade services**



Graph 1.A.2.16: **Spain, financial services**



Appendix 3

Specification of the Kalman-filter and trend labour productivity growth

(a) Labour productivity growth

The Kalman filter for the extraction of trend labour productivity growth was specified in the following way:

Measurement equation:

$$\Delta(y-l)_t = \overline{\Delta(y-l)_t} + \Sigma_i \beta_{it} . \Delta cycle_{it} + \varepsilon_t$$

$\Delta(y-l)_t$ denotes actual labour productivity, $\overline{\Delta(y-l)_t}$ denotes the unobserved trend and $cycle_{it}$ are additional (observed) variables measuring the state of the cycle (typically the output gap).

State equation:

$$\overline{\Delta(y-l)_t} = \overline{\Delta(y-l)_{t-1}} + \nu_t$$

According to the state equation, $\overline{\Delta(y-l)_t}$. follows a random walk ε_t and ν_t are independent random variables.

In the empirical analysis of this chapter the variable $cycle_{it}$ is chosen to be the output gap, more precisely the gap between actual value added and its trend extracted by a Christiano-Fitzgerald filter. Since productivity is often considered to be a leading variable, $cycle_{it}$ is entering the equation with a number of leads. The number of leads is chosen according to their statistical significance which, as a matter of fact, proves to be zero in almost all cases except for France (n=1) and Belgium (n=3). In the other cases, only the contemporaneous output gap remains at the right-hand side of the equation.

In the measurement equation, actual productivity growth is regressed on the trend component of productivity growth. The change in output gap is added to eliminate the influence of business cycle fluctuations from the trend component. As a result, $\overline{\Delta(y-l)_t}$ represents the trend of the signal. The variance ratio of the disturbance in the measurement and state equation (the so-called "signal-to-noise ratio") was constrained in way so as to produce a series which does not deviate too much from the HP-filtered series.

(b) Total factor productivity growth

The Kalman filter for the extraction of trend TFP growth was specified in a slightly different way (all variables in log-levels):

Measurement equation:

$$tfp_t = \overline{tfp_t} + \hat{tfp}_t$$

TFP growth, tfp_t, is decomposed into a trend component, $\overline{tfp}_t$ and a cyclical component, $\hat{tfp}_t$. These two components are specified in the following way:

Trend specification:

$$\overline{tfp}_t = \alpha_t + \overline{tfp}_{t-1} + \hat{u}$$

$$\alpha_t = \alpha_{t-1} + \nu_t$$

Cycle specification:

$$\hat{tfp}_t = \beta_1 \cdot \hat{tfp}_{t-1} + \beta_2 \cdot \hat{tfp}_{t-2} + \varepsilon_t$$

$$cuk_t = \gamma + \delta \cdot tfp_t + \eta_t$$

The trend is specified as a random walk process. The cyclical component is specified as a second-order auto-regressive process. cuk_t is the capacity utilisation rate which is used to identify the cyclical component of trend productivity growth (cuk_t fulfils a similar role as the output gap variable in the estimation of trend labour productivity growth).

The model can be cast into state-space form and estimated with the Kalman filter. Estimates were carried out in GAP, a programme developed by Planas and Rossi (2004).

Appendix 4

Stability tests

The main principle behind the tests implemented in this section is the following:

If $\Delta(y-l)_t$ denotes quarter-on-quarter labour productivity growth, $cycle_{it}$ the cyclical component of value added extracted by a Christiano-Fitzgerald filter, c a constant and u_t and ε_t error terms, the model is specified as:

$$\Delta(y-l)_t = \Sigma_i \beta_{it} . \Delta cycle_{it} + u_t$$

$$u_t = c + \varepsilon_t$$

As in the case of the Kalman-filter estimates, $cycle_{it}$ is chosen to be the contemporaneous output gap and leads thereof with the number of leads chosen according to their statistical significance.

Results of the Nyblom-Hansen stability test

The stability test of Nyblom-Hansen (see Nyblom, 1989; Hansen, 1992) is applied to the second equation: $u_t = c + \varepsilon_t$. The test checks the stability of c and the error variance of ε_t, separately and jointly.

The parameters are assumed to be stable under the null hypothesis, under the alternative hypothesis there is at least one-time shift in the parameters. The results are presented in the table below. With the exception of France, which is a borderline case, the hypothesis of parameter stability is rejected in all cases.

	EA	DE	FR	ES	IT
C	0.43*	0.05	0.32*	1.73§	0.53§
Var ε	0.76§	0.83§	0.11	0.20	0.74§
Joint	0.98+	0.88§	0.43	2.28§	1.63+

§,+,* …… H_0 rejected at 1%, 5%, 10%

Results of Bai-Perron test of multiple structural breaks

The test of Bai-Perron (2003) is also carried out on the second equation: $u_t = c + \varepsilon_t$.

The procedure of Bai-Perron consists in investigating all possible models under the assumption of a given number of breakpoints and a given minimum distance between the break points. The optimal model is chosen according to the Bayesian Information Criterion (BIC).

The results of the Bai-Perron tests, assuming 1, 2 and 3 breakpoints and a minimum distance between two breakpoints of three years, are presented hereafter.

Number of breaks: 1

	EA	DE	FR	ES	IT
Break	1998:1	1987:1	1998:2	1985:1	1997:2
BIC	-10.66	-9.32	-10.91	-10.05	-9.57

Number of breaks: 2

	EA	DE	FR	ES	IT
Break dates	1983:3	1987:1	1998:2	1985:1	1983:2
	1998:1	1996:4	2001:4	1994:4	1997:2
BIC	-10.65	-9.30	-10.91	-10.06	-9.63

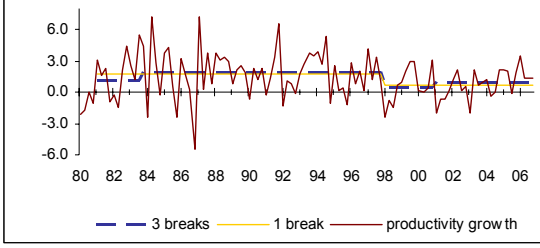
Number of breaks: 3

	EA	DE	FR	ES	IT
Break dates	1983:3	1987:1	1983:4	1985:1	1983:2
	1998:1	1997:4	1998:2	1991:1	1988:1
	2001:4	2000:4	2001:4	1994:4	1997:2
BIC	-10.62	-9.27	-10.91	-10.07	-9.61

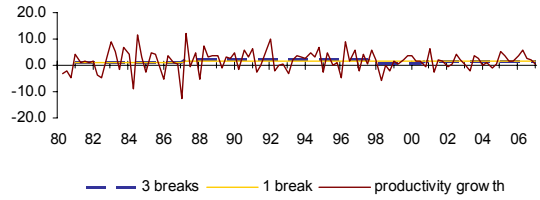
Using again the BIC to discriminate between the three assumptions on the number of breakpoints, the optimal number of breakpoints is 1 for the euro area and Germany, 2 for Italy and 3 for Spain. For France, the BIC is identical across assumptions, in line with the Nyblom-Hansen test which gives only weak evidence of a structural break.

The graphs below show on the left-hand side actual productivity growth and on the right-hand side trend productivity growth, superimposing on both sides the results of the Bai-Perron test under the assumption of 1 and 3 breakpoints. As can be seen from the graphs on the left-hand side, the quarter-on-quarter growth rate of productivity is a very volatile variable. The power of the tests to discriminate between alternative hypotheses is therefore fairly low.

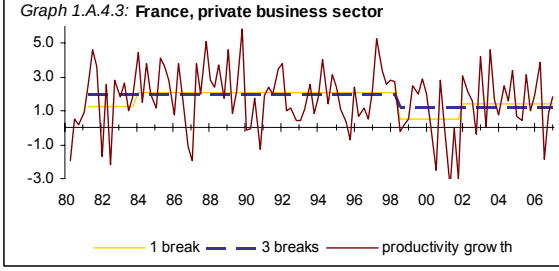
Graph 1.A.4.1: **Euro area, private business sector**



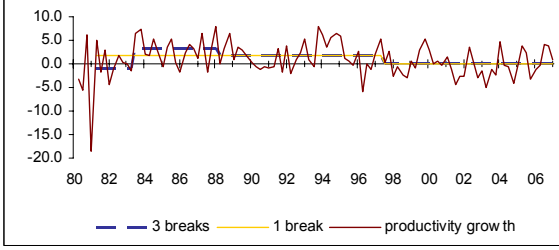
Graph 1.A.4.2: **Germany, private business sector**



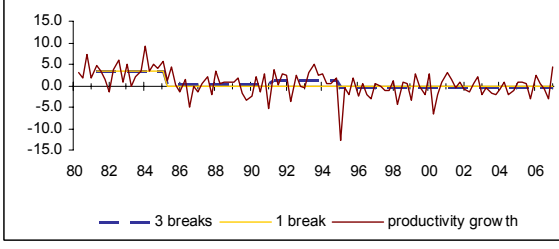
Graph 1.A.4.3: **France, private business sector**



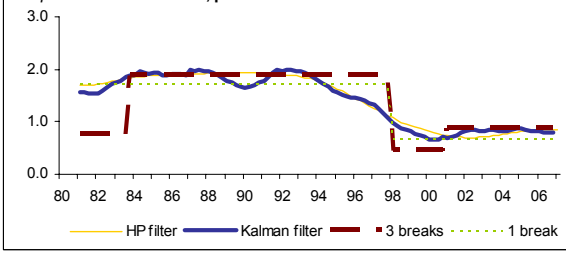
Graph 1.A.4.4: **Italy, private business sector**



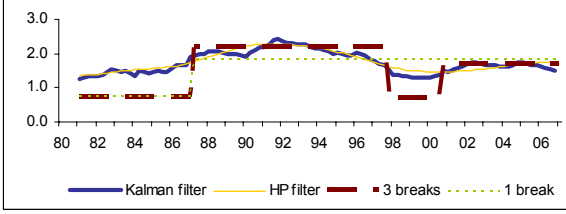
Graph 1.A.4.5: **Spain, private business sector**



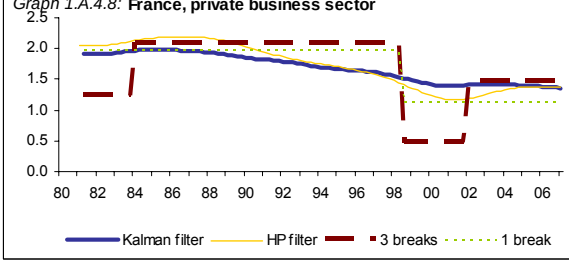
Graph 1.A.4.6: **Euro area, private business sector**



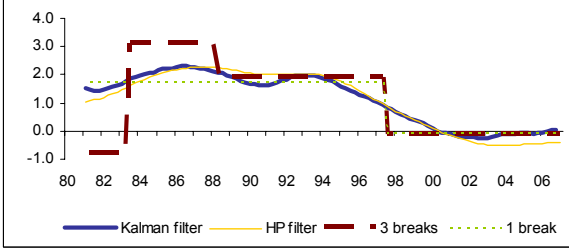
Graph 1.A.4.7: **Germany, private business sector**



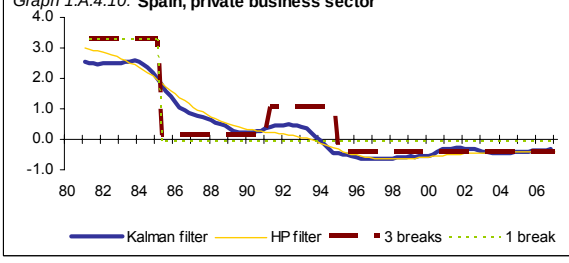
Graph 1.A.4.8: **France, private business sector**



Graph 1.A.4.9: **Italy, private business sector**



Graph 1.A.4.10: **Spain, private business sector**



Appendix 5

Data definitions and sources

- Quarterly national accounts: gross value added (in real terms, constant prices, in 1995 prices and exchange rates) and employment (number of persons employed).
- By sector, using the classification by NACE-6 branches, except for the sector 'financial intermediation', where the aggregate NACE category labelled 'J to K' was used in order to obtain the 'total' and 'private business sector'; however, for the purpose of the detailed sectoral analysis, a more restrictive definition (category J only) applied in order to better reflect the dynamics of the financial sector, thus leaving out category K that contains a variety of sub-activities, which are not necessarily financial services.
- Starting from 1981Q1 (starting date common to all 6 countries).
- Output gap data: a Christiano-Fitzgerald filter was applied to all the series using assumptions of a random walk with drift, and a window of 6 to 32 quarters.

Coverage:

- Germany: data from 1991Q1 are readily available in Newcronos (Eurostat), and series were backcast up to 1981Q1 using growth rates for West Germany.
- France: data from 1980Q1 are available, except for employment in services, where data from 1991Q1 are in Newcronos (Eurostat), and before that, annual data were used and interpolated using the share of each sub-sector in the economy.
- Italy: data from 1981Q1 are readily available in Newcronos (Eurostat).
- Spain, Finland and Belgium: data from 1980Q1 are readily available in Newcronos (Eurostat).

Methodology:

- Aggregation: data on value-added and employment have been added in levels, in order to obtain a "euro-area" aggregate (EA = sum(DE, FR, ES, IT, BE, FI)), bearing in mind that these countries represent 85% of the euro area in terms of real GDP.
- The time series for labour productivity in levels were obtained by dividing the fictitious "euro-area" value-added by the "euro-area" total employment.

Chapter 2

Assessing productivity at the industry level

Summary

This chapter exploits the detailed sectoral and industry-level information about productivity developments contained in the recently released EU KLEMS databank. An analysis of this data not only confirms the broad macro trends which have been known for some time but also adds interesting details regarding the contributions from particular sectors and industries. It is found that whilst the deterioration in the EU's productivity performance relative to the US was concentrated in the high technology part of the manufacturing sector, it was particularly entrenched in the EU's private services sector. In addition, a small group of industries are highlighted as being responsible for the post-1995 trends, namely electrical and optical equipment; wholesale and retail trade; financial services; and real estate and other business services. With regard to the nature of the reversal in productivity trends, the analysis shows that most of the EU-US differences are not to be found in investment patterns but are mainly driven by developments in TFP, the structural component of productivity.

In terms of understanding the underlying driving factors behind the TFP divergences which emerged, the analysis suggests that TFP growth is increasingly associated, especially over the post-1995 period, with innovation and technological spillovers from countries positioned "at the frontier". These results suggest that there is a growing need for a more intensive use of R&D and highly skilled human capital in frontier economies. With regard to regulatory issues, it is not possible to conclude that they are playing a significant role in explaining international TFP differentials. In particular one must be careful in drawing sweeping, macro-level, conclusions from the available evidence. The analysis suggests that industry-specific regulatory indicators are needed to better understand the effects of a more competition-friendly regulatory environment on TFP trends. In particular, research is required to assess the effects of labour, financial and product market regulations both on the innovation capacity of different industries and on their ability to introduce more advanced technologies and business practices. Regarding those specific industries where EU-US TFP differences are most concentrated, the analysis shows that a relatively wide spectrum of factors are implicated, so that there is a need to adopt a more targeted, industry-level, approach to structural reform efforts in the EU.

Finally, the analysis supports the growing view in the literature that when a country reaches, or comes close to, the technology frontier, it must re-focus its policies and institutions towards a more innovation-based economic model, with less emphasis on the imitation of available leading-edge technologies and practices. The hallmarks of an open, innovation-driven developmental model are world-class educational establishments; higher levels of excellence-driven and better targeted R&D; more market-based financing systems; and more flexible regulatory and institutional frameworks delivering a dynamic and competitive business environment. Whilst many aspects of this approach have been introduced in recent years in individual EU countries, the "mindset" shift needed to make an overall success of the process has unfortunately not yet occurred on a sufficiently large scale at the European level, despite the fact that "Lisbon" provides an effective vehicle for managing this essential transition process.

1. Introduction

Despite the recent upturn in growth across the EU, Europe's overall growth performance since the mid-1990s has been relatively disappointing. While many EU countries managed to improve their labour market positions, this unfortunately was accompanied by a slowdown on the productivity side in a significant number of Member States. This experience was in sharp contrast to many other developed economies around the world, in particular the US. For the US, the secular downward movement in productivity growth rates experienced since the 1970s was spectacularly reversed around the mid-1990s, aided by a strong performance in both the production and diffusion of information and communications technologies (ICT).

These growing divergences in the productivity performance of many developed world economies, and especially the size of the divergences presently being experienced between some of the EU's Member States, has provoked an ongoing debate in the EU regarding the implications of recent trends for future economic prospects:

- The "pessimistic view", largely supported by the Sapir report ([14])/van Ark analyses ([15]), suggests that the EU might be unable to achieve a shift in its resources to sectors with high productivity growth prospects and will continue with production in areas where it has traditionally held a global advantage, namely medium-technology manufacturing industries. This overall strategy appears increasingly threatened with the emergence of a number of strong competitors around the world in these more traditional industries, most notably China and India.

- The "more optimistic view", as enunciated by Blanchard amongst others ([16]), is that part of the explanation for Europe's poor productivity performance could be measurement problems/adjustment lags, with perhaps the basis for a future pick-up already firmly established due to the labour, capital and product market reforms which have been progressively introduced since the early 1990s. Under this view the EU may now simply be in a transition phase whereby some of the negative effects of those reforms (e.g. a temporary decrease in productivity due to labour market changes) are visible, whilst the gains to be reaped in the future are not.

Most observers, "optimists" and "pessimists" alike, would agree that restrictions concerning labour and product markets, lack of openness to trade and/or foreign direct investment, as well as barriers in terms of access to/generation of new technologies and the diffusion of existing innovations are the key determinants of EU productivity growth. International comparisons reveal sizeable disparities in investments with regard to physical capital (especially in terms of ICT capital spending), human capital and in R&D spending. The present study will examine those countries and industries where the differences are most acute and assess the extent to which these differences can be linked with overall growth divergences.

Whilst such an analysis at the macro level has been possible for some time, a detailed cross-country examination at the industry level has been more problematic due to the fact that long runs of official industry level data were only available for a relatively small number of countries, industries and variables. This situation has significantly improved with the March 2007 release of the EU KLEMS datasets. The provision in EU KLEMS of detailed industry level datasets on economic growth, productivity, employment creation, capital formation and technological change for a large range of manufacturing and service industries is particularly noteworthy. A degree of caution is warranted however since the overall quality of the datasets has yet to be thoroughly evaluated by the national statistical institutes and Eurostat. In addition, according to EU KLEMS, the EU-US productivity differences are heavily concentrated in the market services sector where the conceptual and empirical problems in accurately measuring output and price developments have been well documented.

Sections 2 and 3 present the broad stylised facts concerning growth and productivity trends at the economy-wide and industry levels for the US and the EU. Both analyses conclude that cross-country differences in labour productivity growth rates predominantly reflect differences in TFP performances, although ICT investment patterns also

([14]) See Sapir et al. (2003).
([15]) See Van Ark, Inklaar and Mc Guckian (2003).
([16]) See Blanchard (2004).

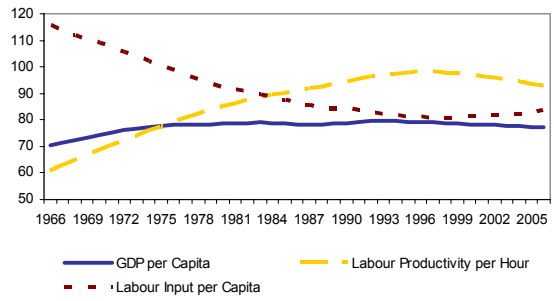
played a role in a number of specific industries, especially over the second half of the 1990s. Since TFP is normally regarded as constituting the structural component of labour productivity, Section 4 of the paper goes on to examine in more detail the possible sources of the industry level divergences in TFP performance. Using EU KLEMS and a wide range of pertinent datasets for the explanatory variables, panel regressions are exploited to assess the degree of statistical support which exists for the major hypotheses explaining TFP divergences over time ([17]) i.e. the role played by the regulatory environment (product, labour and financial markets) ([18]); by the degree of openness of economies ([19]); by demographics ([20]); and finally by the efficiency of knowledge production (R&D and education) ([21]). The summary and concluding remarks section provides an overview of the main points from the paper and draws some tentative conclusions on the implications of the analysis for the direction of economic policy in the EU over the coming years.

([17]) See Barro (1990), Barro and Sala-i-Martin (1995) and Mendoza et al. (1997).
([18]) See Soskice (1997), Nickell et al. (1997), Eichengreen and Iversen (1999), Nickell and Layard (1999), Nicoletti et al (2001), Scarpetta and Tressel (2002), Scarpetta et al. (2002), and IMF (2003).
([19]) See Sachs and Warner (1995), Alesina et al. (1997), Frankel and Romer (1999) and Ben-David and Kimhi (2000).
([20]) See EU Review (2002) and Jones (2002).
([21]) See Lucas (1988), Romer (1990), Grossman and Helpman (1991), Coe and Helpman (1995) and Aghion and Howitt (1998).

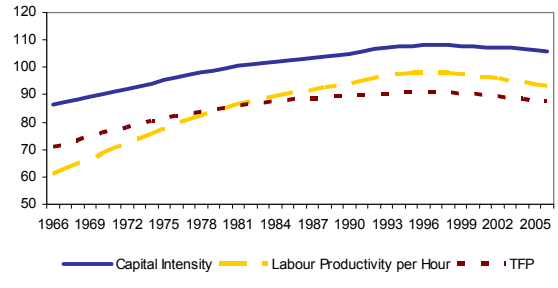
2. EU productivity trends at the economy wide level: a comparison with the US

At the moment, EU living standards (as measured by potential GDP per capita ([22])) are at roughly 77% of US levels, with about 1/3 of the gap due to labour productivity differences and with the remaining 2/3 due to differences in the utilisation of labour (i.e. differences in hours worked per worker and the employment rate). In terms of the key drivers of per capita income developments, the EU has also experienced some important changes over the course of the 1990s with, on the positive side, the previously downward movement in the EU's labour input relative to the US coming to an end and, on the negative side, the post World War II convergence to US productivity levels going into reverse (graphs 2.2.1-2.2.2). In fact, after having peaked in the mid-1990s at around 98% of US levels, EU labour productivity per hour is estimated to have backtracked to around 93% in 2006, which is close to its relative level in the late 1980s. As shown in graph 2.2.2, this deterioration is more strongly related to developments in terms of TFP rather than to changes in capital intensity.

Graph 2.2.1: **Potential GDP per capita levels accounting**

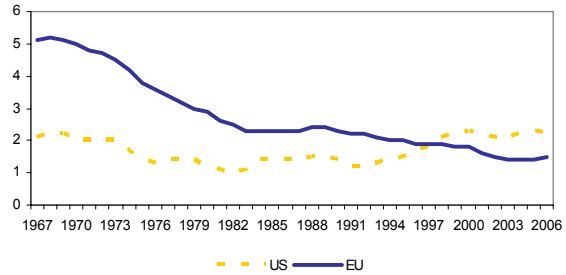


Graph 2.2.2: **Labour productivity per hour levels accounting**



The post 1995 deterioration in relative EU productivity levels reflects a sharp decline in EU productivity growth rates compared to those of the US over the period in question. This is shown clearly in Graph 2.2.3 which examines labour productivity per hour growth rates since the mid-1960s. Over most of that time, and indeed for most of the post World War II period, the EU has enjoyed productivity growth rates well in excess of those prevailing in the US. Given relatively low employment rates, the EU was able to use its superior productivity performance to broadly maintain its relative living standards.

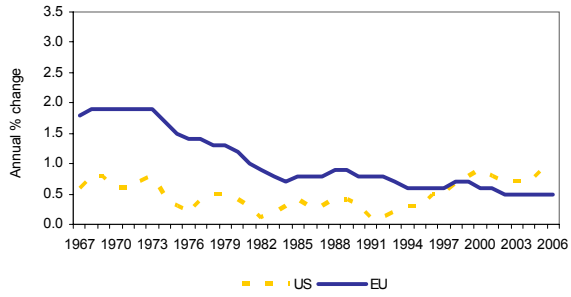
Graph 2.2.3: **Labour productivity per hour growth trends**



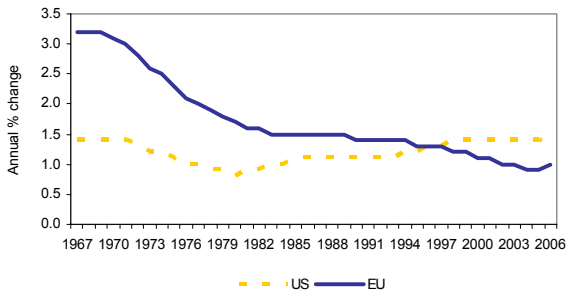
([22]) Please note that levels of potential GDP per capita are roughly 6% points higher than actual GDP per capita but over long periods of time the trends are highly correlated.

Graphs 2.2.4-2.2.5 show that the relative deterioration in the EU's labour productivity per hour growth performance since the first half of the 1990s is structural in nature, with 2/3 of the change emanating from deterioration in total factor productivity i.e. a relative decline in the overall efficiency of the EU's production processes.

Graph 2.2.4: **Capital deepening**



Graph 2.2.5: **Total factor productivity**



3. Productivity trends at the industry level: an analysis of the March 2007 EU KLEMS Datasets

Are the productivity differences between the US and Europe signalled earlier confined to the manufacturing, private services or rest of the economy sectors or linked to particularly dynamic industries within these broad sectors in the US? Due to the lack of capital stock data for some of the EU15 countries analysed in section 2, a detailed growth accounting analysis at the industry level is only possible for 10 of the "old" EU15 countries, with these ten countries grouped together to form an EU15ex5 aggregate ([23]). Fortunately, the EU15ex5 (henceforth EU) grouping includes all of the larger EU15 Member States, hence the period average growth rates for the basic industry series are almost identical for both EU aggregates.

3.1. Basic sectoral productivity trends

Before presenting the detailed growth accounting results, a few comments on the broad industry level patterns is warranted. Given the amount of industry level detail which is available in EU KLEMS, for the purposes of the present exercise, we aggregated the 60-70 industries into the three broad sectors of manufacturing, private services and rest of the economy (i.e. primary industries plus public services). Table 2.3.1 shows that the period average trends for the EU's "total industries" aggregate mirrors the downward movement in EU labour productivity which was shown for the total economy in section 2. According to EU KLEMS, EU labour productivity per hour growth rates fell from over 2% over the 1981-95 period to 1.5% (1996-2000) and then to 1% (2001-04). These trends are in marked contrast to those experienced in the US which witnessed a sharp acceleration in its productivity performance over the same time periods, with annual average growth rates doubling from 1.3% over the period 1981-95 to 2.6% for 2001-04. The apparent outperformance of the US relative to the EU has been widespread at the industry level, with both the manufacturing and private services sectors as a whole both highlighting the contrasting fortunes of both areas ([24]).

Table 2.3.1

GDP, labour input in hours and labour productivity per hour (annual average volume growth rates in %), EU15ex5 + US

	GDP			Labour input in hours			Labour productivity per hour		
	1981-1995	1996-2000	2001-2004	1981-1995	1996-2000	2001-2004	1981-1995	1996-2000	2001-2004
	Total Industries								
EU15ex5	2.0	2.6	1.4	-0.2	1.0	0.4	2.2	1.5	1.0
US	2.8	4.1	2.1	1.4	2.0	-0.4	1.3	2.1	2.6
	Manufacturing								
EU15ex5	1.5	2.0	0.3	-2.1	-0.3	-1.9	3.5	2.3	2.2
US	3.0	4.9	0.8	-0.3	0.4	-5.0	3.3	4.4	5.7
	Private Services								
EU15ex5	2.8	3.3	1.9	0.7	1.9	1.1	2.1	1.4	0.9
US	3.2	5.1	2.6	2.1	2.8	-0.4	1.2	2.2	3.0
	Rest of Economy								
EU15ex5	1.0	1.5	1.3	-0.2	0.5	0.7	1.2	1.0	0.5
US	1.8	1.7	2.0	1.5	1.6	1.4	0.3	0.0	0.6

Source: EU KLEMS, Commission Services.

In order to bring out the essential longer term patterns more clearly with regard to labour productivity per hour developments, graphs 2.3.1-2.3.4 look at trends for this specific variable for the EU and the US for the total period 1981-2004. The graphs show the contributions to the total economy change in labour productivity (i.e. the combined effect of labour productivity growth and the output shares of the respective sectors) from manufacturing, private services and "other" industries. The trends have been calculated using a Hodrick-Prescott (HP) filter which is effectively equivalent to applying a centred moving average ([25]). The set of graphs have all the same scale and are additive (i.e. manufacturing + services + rest of economy = total economy). The graphs show clearly that there is a trend EU-US productivity gap of the order of 0.8 percentage points for the most recent years, with roughly 25% of the gap emanating from manufacturing and 75% from private services, with the detailed growth accounting exercise described in 3.2 concentrating on these two broad sectors.

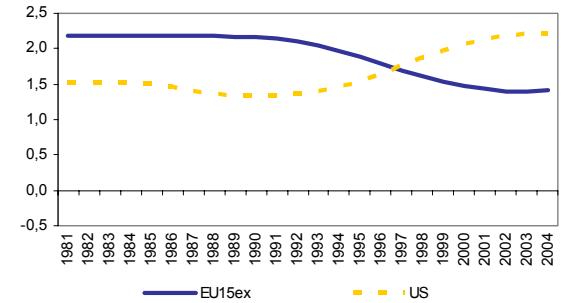
EU + US – Trend Contributions to the Total Change in Labour Productivity per Hour – Breakdown into Manufacturing, Private Services and Rest Economy.

([23]) EU15 excluding Greece, Ireland, Luxembourg, Portugal and Sweden.

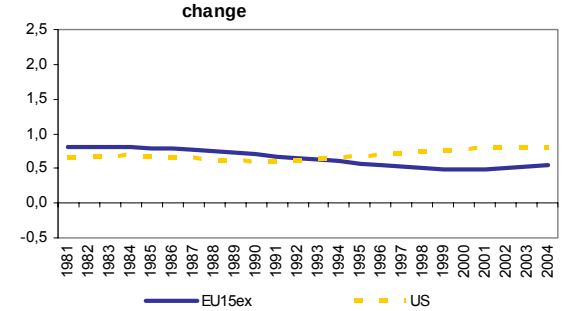
([24]) The table also appears to show that productivity trends in these sectors have little to do with the underlying labour input developments. This trade-off issue between labour market and labour productivity trends is discussed in a separate chapter of the Review.

([25]) An additional 3 years have been added at the end of the series to limit the influence of the well-known "end point bias" problem associated with the fact that the HP filter becomes asymmetric towards the end of the series.

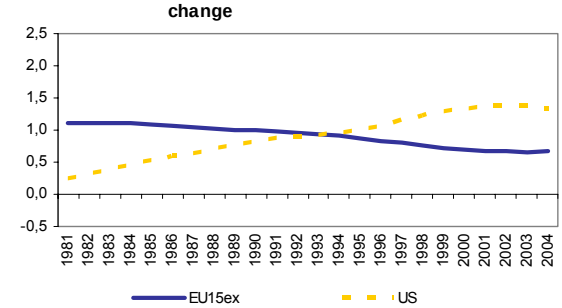
Graph 2.3.1: **Total economy, annual % change**



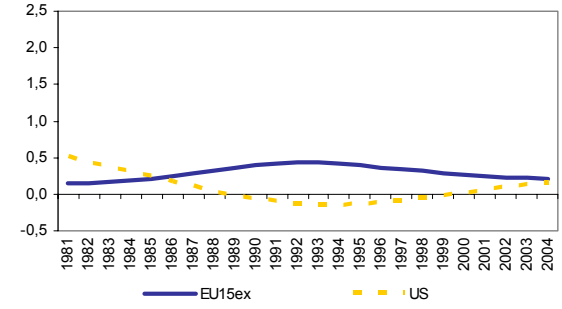
Graph 2.3.2: **Total manufacturing, annual % change**



Graph 2.3.3: **Total private services, annual % change**



Graph 2.3.4: **Rest of economy, annual % change**



3.2. Detailed growth accounting analysis of the manufacturing and private services sectors

Decomposing real GDP growth into its main determinants can be done using a wide variety of methods, one variant of which is applied by the EU KLEMS research consortium (see Box 2.3.1 for details). This variant essentially uses a production function which includes productive capital (a volume index of capital services); human capital (a skills based indicator of the average qualifications of the labour force); employment levels adjusted for hours worked; and a residual term which, amongst other things, includes an estimate of the level of efficiency associated with the use of the various factors of production.

Table 2.3.2 gives the results for the EU and the US using the EU KLEMS growth accounting approach, with value added being decomposed into labour services, capital services and TFP. The table shows that the big labour productivity gap between the EU and the US over the period since 1995 has been mainly driven by TFP developments although differences in the value added contribution of ICT capital services was a significant additional explanatory factor over the period 1996-2000. Over the most recent period, 2001-2004, it is clearly TFP which is driving the EU-US productivity differences. At the level of total industries, the TFP growth rate differential since 2000 is an alarming 1.7 percentage points, compared with a TFP gap of only 0.5 a percentage point over the earlier period 1996-2000. This gap in TFP growth rates is widespread at the sectoral level, with very large EU-US TFP growth rate differentials for both the manufacturing and private services sectors.

Box 2.3.1: **EU KLEMS Growth Accounting Methodology.**

The EU KLEMS growth accounts are based on the growth accounting methodology as laid out in the seminal contribution of Jorgenson and Griliches (1967) and put in a more general input-output framework by Jorgenson, Gollop and Fraumeni (1987) and Jorgenson, Ho and Stiroh (2005). Growth accounting allows one to assess the relative importance of labour, capital and intermediate inputs to growth, and to derive measures of total factor productivity (TFP) growth. TFP indicates the efficiency with which inputs are being used in the production process and is an important indicator of technological change**. Under the assumptions of competitive factor markets, full input utilization and constant returns to scale, the growth of output of an industry is equal to the (compensation share) weighted growth of inputs and TFP. In this way one can establish the proportion of output growth which is accounted for by the growth in intermediate inputs, capital services, labour services and TFP, respectively.

Accurate measures of labour and capital input are based on a breakdown of aggregate hours worked and of the aggregate capital stock into various components. Hours worked are cross-classified by various categories to account for differences in the productivity of various labour types, such as high- versus low-skilled labour. Similarly, capital stock measures are broken down into stocks of different asset types. Short-lived assets like computers have a much higher productivity than long-lived assets such as buildings, and this should be reflected in the capital input measures. The contribution of intermediate inputs is broken down into the contribution of energy goods, intermediate materials and services.

Measurement of capital services: The availability of investment series by asset type and by industry is one of the unique characteristics of the EU KLEMS database. They are based on series obtained from national statistical institutes, allowing for a detailed industry-by-asset analysis. Importantly, EU KLEMS makes a distinction between three ICT assets (office and computing equipment, communication equipment and software) and four non-ICT assets (transport equipment, other machinery and equipment, residential buildings and non-residential structures). ICT assets are deflated using a quality-adjusted investment deflator, except for those countries which have not yet implemented adequate quality adjustment where the harmonisation procedure suggested by Schreyer (2002) is used. The real investment series are used to derive capital stocks through the accumulation of investment into stock estimates using the Perpetual Inventory Method (PIM) and the application of geometric depreciation rates. Then capital service flows are derived by weighting the growth of stocks by the share of each asset's compensation in total capital compensation. In this way, aggregation takes into account the widely different marginal products from the heterogeneous stock of assets. The weights are related to the user cost of each asset.

The user cost approach is crucial for the analysis of the contribution of capital to output growth. This approach is based on the assumption that marginal costs reflect marginal productivity. For example, if the costs of leasing one euro of computer assets is higher than the leasing of one euro of buildings, computers have a higher marginal productivity, and this should be taken into account. There are various reasons why the costs of computers is higher than that for buildings. While computers may typically be scrapped after five or six years, buildings may provide services for several decades. In addition, the prices of new computers are rapidly declining and those of buildings are normally not. Hence the user cost of IT-machinery is typically 50 to 60 percent of the investment price, whilst that of buildings is less than 10 percent. Therefore one euro of computer capital stock should get a heavier weight in the growth of capital services than one euro of building stock. This is ensured by using the rental price of capital services as weights.

Measurement of labour services: The productivity of various types of labour input, such as low- versus high-skilled, will also differ. Standard measures of labour input, such as numbers employed or hours worked, will not account for such differences. Hence one needs measures of labour input which take the heterogeneity of the labour force into account in analysing productivity and the contribution of labour to output growth. These measures are called labour services, as they allow for differences in the amount of services delivered per unit of labour in the growth accounting approach. It is assumed that the flow of labour services for each labour type is proportional to hours worked, and workers are paid their marginal productivities. Weights are given by the average shares of each type of labour in the value of labour compensation. In this way, aggregation takes into account the changing composition of the labour force.

(Continued on the next page)

Box (continued)

share of hours worked by low-skilled workers to high-skilled workers will lead to a growth of labour services which is larger than the growth in total hours worked. This difference is referred to as the labour composition effect.

Series on hours worked by labour types are not part of the standard statistics reported by the NSIs, not even at the aggregate economy level. Also, there is no single international database on skills which can be used for this purpose. For each country covered in EU KLEMS, a choice has been made to use survey data which provide the best sources for consistent wage and employment data at the industry level. In most cases this was the labour force survey (LFS), sometimes together with an earnings survey when wages were not included in the LFS. In other cases, use has been made of establishment surveys or a social-security database, or a mixture of sources. Care has been taken to arrive at series which are consistent over time, which was important as most employment surveys are not designed to track developments over time, since breaks in methodology or coverage occur frequently.* The contents of this box are drawn directly from Timmer, M,, O'Mahony, M. and B. van Ark (2007), "EU KLEMS Growth and Productivity Accounts : An Overview", International Productivity Monitor, Number 14, Spring 2007.

** Under strict neo-classical assumptions, TFP growth measures disembodied technological change. In practice, TFP is derived as a residual and includes a host of effects such as improvements in allocative and technical efficiency, changes in returns to scale and mark-ups and technological change proper. All these effects can be broadly summarised as "improvements in efficiency", as they improve the productivity with which inputs are being used in the production process. In addition, being a residual measure, TFP growth also includes measurement errors and the effects from unmeasured output and inputs.

Graphs 2.3.5-2.3.12 examine in more detail the capital services and TFP trends over time in the manufacturing and private services sectors. This graph is constructed on the same basis as graphs 2.3.1-2.3.4 and show the HP-filtered contributions of capital services and TFP to the total change in "total industries" GDP from these two sectors (i.e. the combined effect of the growth rate of each of these different components of value added growth and their respective output shares). The graphs for the manufacturing sector (graphs 2.3.5-2.3.8) confirm that TFP trends are driving the EU-US productivity gap in this sector and that this EU-US TFP gap is rising over time. Graphs 2.3.5-2.3.8 also show that capital services trends in the manufacturing sector in both areas appear to be broadly converging over time, with this pattern a feature of both ICT and non-ICT capital deepening.

With regard to the private services sector (graphs 2.3.9-2.3.12), again the EU-US productivity gap is being driven by TFP trends rather than by capital services although it is interesting to note for this sector that there is a clear compositional shift in the US towards greater levels of ICT capital deepening. As graphs 2.3.9-2.3.12 indicate, while there is virtually no gap between both areas with regard to total capital services, there is evidence that the US's capital spending is increasingly being focussed on ICT rather than on the more traditional forms of capital expenditure. Furthermore, one should note, as shown in graph 2.3.13, that the bulk of the overall economy wide differences in ICT capital spending between the EU and the US since the mid-1990s is due to higher ICT investment spending in the private services sector. This is a feature which will be looked at in more detail in the regression analysis in section 4.

Table 2.3.2

Results of growth accounting analysis – gross value added growth and contributions (annual average volume growth rates in %), EU15ex5 + US

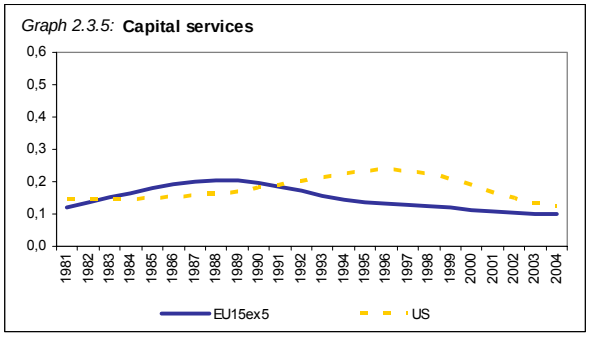
	EU15ex5			US		
	1981 -1995	1996 -2000	2001 -2004	1981 -1995	1996 -2000	2001 -2004
Total Industries						
Labour Services	0.2	0.8	0.5	0.9	1.3	-0.5
Hours	-0.1	0.7	0.3	0.7	1.1	-0.8
Composition	0.4	0.1	0.2	0.2	0.2	0.3
Capital Services	1.1	1.4	1.0	1.7	2.0	0.9
ICT	0.4	0.6	0.4	0.7	1.4	0.6
Non-ICT	0.8	0.8	0.6	1.0	0.6	0.3
TFP	0.7	0.3	-0.1	0.3	0.8	1.7
Total Industries	2.0	2.6	1.4	2.8	4.1	2.1
Manufacturing						
Labour Services	-1.2	0.1	-0.9	-0.2	0.3	-3.4
Hours	-1.5	-0.2	-1.3	-0.6	-0.1	-3.9
Composition	0.3	0.2	0.5	0.3	0.5	0.5
Capital Services	0.8	0.9	0.4	1.0	1.8	0.2
ICT	0.3	0.4	0.2	0.5	1.1	0.3
Non-ICT	0.6	0.5	0.2	0.4	0.7	-0.1
TFP	1.9	1.1	0.7	2.2	2.8	4.0
Total Manufacturing	1.5	2.0	0.3	3.0	4.9	0.8
Private Services						
Labour Services	0.7	1.2	0.7	1.4	2.1	-0.1
Hours	0.5	1.1	0.6	1.2	1.7	-0.3
Composition	0.1	0.1	0.1	0.2	0.4	0.2
Capital Services	1.4	1.9	1.4	2.4	2.5	1.2
ICT	0.5	0.9	0.5	0.9	1.9	0.9
Non-ICT	1.0	1.1	0.9	1.5	0.6	0.3
TFP	0.7	0.2	-0.2	-0.5	0.5	1.6
Total Private Services	2.8	3.3	1.9	3.2	5.1	2.6
Rest of Economy						
Labour Services	0.5	0.8	0.9	1.5	1.3	1.4
Hours	0.3	0.6	0.8	1.2	1.3	1.2
Composition	0.2	0.2	0.1	0.3	0.0	0.2
Capital Services	0.7	0.6	0.5	0.7	1.1	0.8
ICT	0.2	0.3	0.2	0.3	0.7	0.3
Non-ICT	0.5	0.3	0.3	0.4	0.5	0.5
TFP	-0.2	0.1	-0.2	-0.4	-0.7	-0.2
Total Rest of Economy	1.0	1.5	1.3	1.8	1.7	2.0

Source: EU KLEMS, Commission Services.

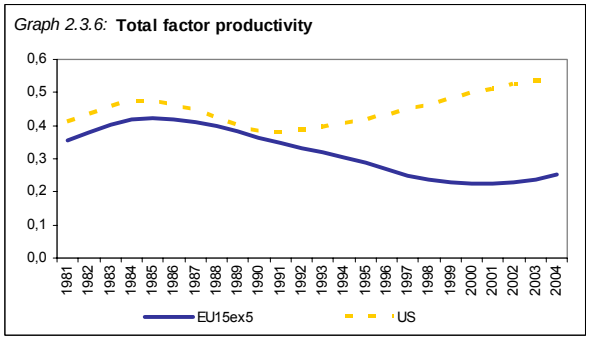
EU + US – Growth Accounting Analysis – Graphs of Trend Contribution to the Total Change in GDP from Capital Services (ICT/Non-ICT) and TFP:

Manufacturing sector (annual % change)

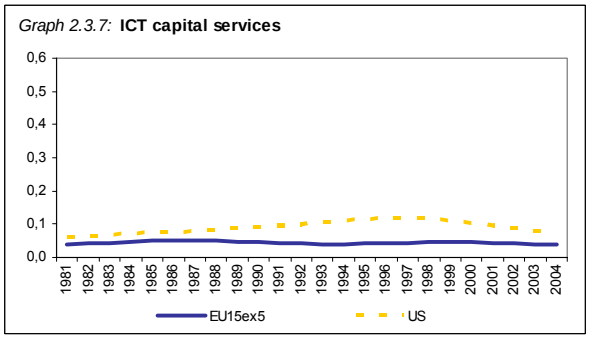
Graph 2.3.5: **Capital services**



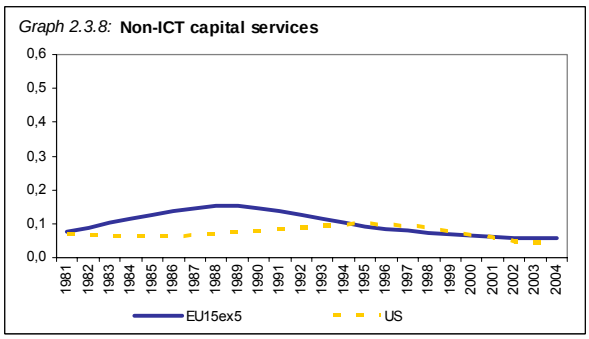
Graph 2.3.6: **Total factor productivity**



Graph 2.3.7: **ICT capital services**

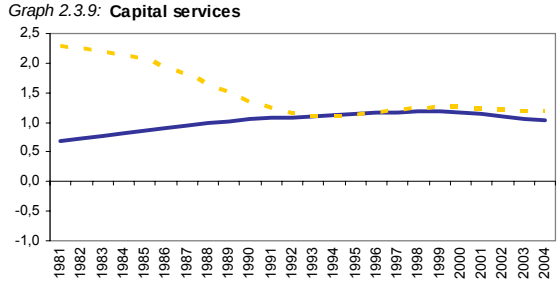


Graph 2.3.8: **Non-ICT capital services**

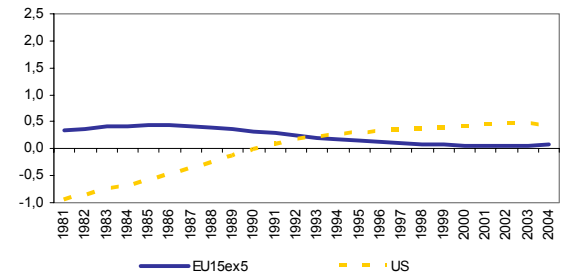


Private services sector (annual % change)

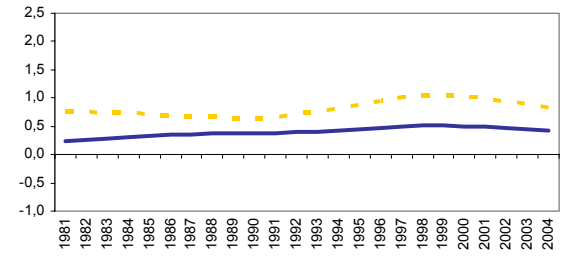
Graph 2.3.9: **Capital services**



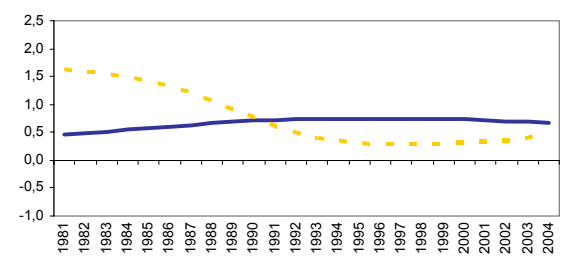
Graph 2.3.10: **Total factor productivity**



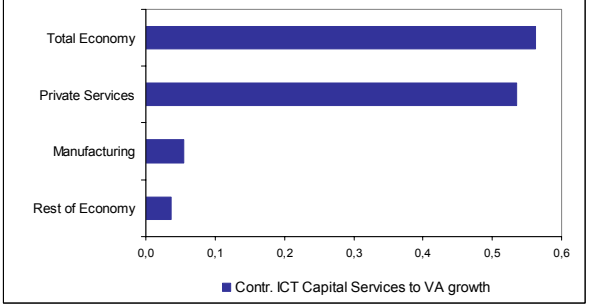
Graph 2.3.11: **ICT capital services**



Graph 2.3.12: **Non-ICT capital services**



Graph 2.3.13: **Sectoral contributions from ICT capital services to the total economy change in value added growth US minus EU (1996-2004)**



3.3. Industry level TFP trends

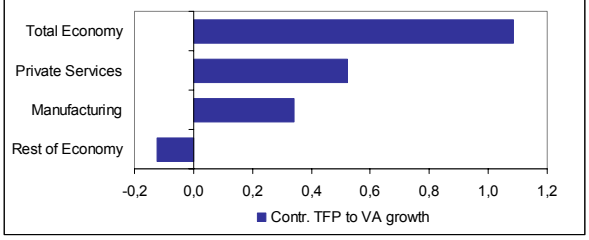
Due to the availability of capital stock data for a large number of individual industries in EU KLEMS, it is possible to do a more detailed productivity breakdown of the manufacturing, private services and "rest of economy" sectors (described in 3.2) by examining those industries in the databank (28 in total – 14 manufacturing, 7 private services and 7 "other industries") where capital stock data exists and which are therefore amenable to growth accounting analysis. Graphs 2.3.14-2.3.15 focus on showing the differences in contributions to "total industries" TFP growth for these 28 industries in order to isolate the small number of industries which are the key drivers of the overall EU-US TFP growth gap. The relative performance of both areas is established by taking the US TFP contributions and subtracting the equivalent figures for the EU for the various industries and sectors. The graphs show the sectoral (i.e manufacturing, private services and "rest of economy") TFP differences as well as those for the 28 individual industries, with each of the latter in turn attributed to their respective sectors (i.e. M = manufacturing; P.S. = private services and O = "other industries").

With regard to overall EU-US differences in TFP growth rates, graph 2.3.14 confirms the points made earlier that the large "total industries" EU-US TFP gap over the period 1996-2004 reflects similar gaps in favour of the US in both the manufacturing and private services sectors. Graph 2.3.15 then goes on to decompose the "total industries" TFP gap over this period into the respective contributions from the 28 industries. The graph shows the highly industry

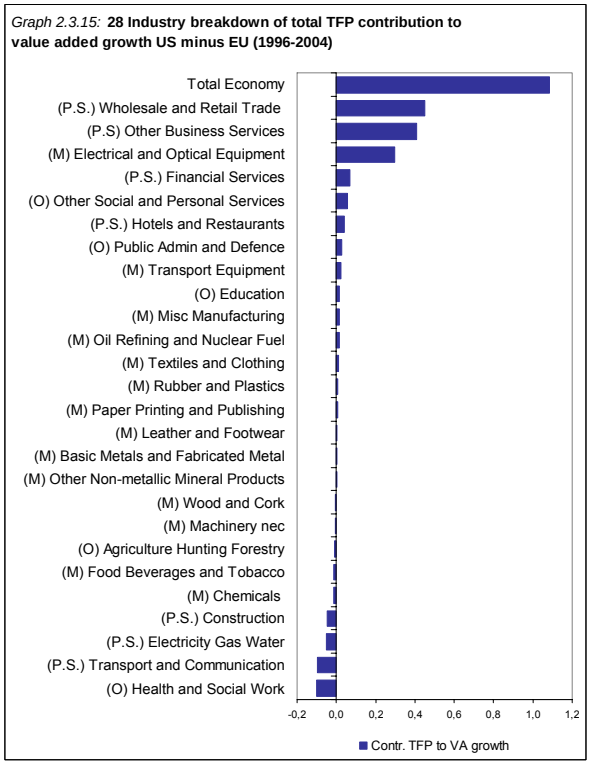
specific nature of the TFP differences, with only a small handful of industries explaining the diverging EU-US trends, namely wholesale and retail trade; real estate and other business services; electrical and optical equipment (which includes semiconductors, the main ICT-producing industry); and to a lesser extent financial services. On a more positive note, graph 2.3.15 also shows some industries where the EU has done better, with a number of the so-called "network" industries doing particularly well.

Given the highly industry specific pattern of EU and US developments, it is evident that the regression analysis in the next section will need to look at this small group of industries in more detail in order to try to decipher the set of factors which have contributed to the superior performance of the US and the EU in such a diverse grouping. While the TFP patterns in "electrical and optical equipment" (the only one of the industries located in the manufacturing sector) are relatively easy to explain given that this industry has benefited enormously from the TFP enhancing effect of "Moore's Law" ([26]), the TFP determinants of the remaining industries would appear to be a more difficult challenge for the regression analysis to explain. One particularly interesting hypothesis to be tested is the extent to which ICT capital deepening trends in some of the US market services industries played a role in the divergences which have emerged. More specifically, is there any evidence to support the view that TFP spillover effects may be starting to manifest themselves due to the growing pervasiveness of, general purpose, ICT technologies?

Graph 2.3.14: **Sectoral TFP contributions to total economy change in value added growth US minus EU (1996-2004)**



Graph 2.3.15: **28 Industry breakdown of total TFP contribution to value added growth US minus EU (1996-2004)**



([26]) Moore's Law is the empirical observation made in 1965 that the number of transistors on an integrated circuit doubles every 24 months.

4. Understanding the determinants of TFP growth

The previous sections have focused on a description of macro trends and sectoral/industry level patterns in productivity growth. The analysis contained in this section aims at isolating those factors which are critical in explaining differences in the evolution of total factor productivity (TFP), which, as shown earlier, accounts for the most important share of the gap in productivity growth between the EU and the US over the last decade. In addition, as we have seen in section 3, EU-US TFP growth differences over this period can be traced to a small number of industries in the manufacturing and private services sectors. As a result of this highly concentrated TFP pattern, there will be a consistent effort in the present section to focus the analysis on deriving the specific determinants for this small group of industries. This approach should help in identifying those policies which could potentially have the strongest impact in those areas of the economy where the TFP gap is largest.

4.1. Conceptual framework

A better understanding of the key determinants of TFP growth has been high on the research agenda of international organisations and the academic community over the past decade ([27]). For a long period of time growth theory was not endowed with an appropriate paradigm to explain the determinants of TFP growth. For example, in the neoclassical growth framework, TFP corresponds to a residual (the "Solow residual") and consequently these models are largely silent on the role which could be played by specific policies in affecting the growth rate. In addition, the early wave of endogenous growth models (the so-called "AK models") put the emphasis on capital accumulation as being the key driver of growth, with the implication being that growth-friendly policies should be focussed on promoting savings and investment. The limitations of such models have become increasingly evident, with their predictions failing to provide an adequate interpretation of the developments in TFP growth which have taken place over recent decades, especially in the post-1995 period. For example, investment rates, as shown in levels of capital intensity, were higher in Europe over this latter period and yet the US managed to substantially leapfrog the EU in terms of TFP growth rates.

Due to the limitations of existing paradigms, there is a growing consensus in the literature that recent growth theories, based on "Schumpeterian" creative destruction mechanisms, seem better equipped to interpret recent developments (see, for example, Aghion and Howitt (2005)) ([28]). This theory focuses on innovation as the key driver of growth in economies at, or close to, the "technology frontier" ([29]). Innovators, by introducing superior product varieties and technologies, have the effect of both displacing existing firms and of inducing the adoption of new products and techniques at the wider industry level. At the aggregate level, the innovation rate depends on the resources devoted to the innovation effort (i.e. R&D and human capital) and on the stock of existing knowledge (knowledge spillovers). The growth rate of the economy will depend not only on the rate of innovation but also on the rate at which "state-of-the-art" technologies are adopted/diffused throughout the wider economy. Countries that are close to the technology frontier will mainly grow thanks to the introduction of new technologies, whilst the "follower" grouping of countries will derive the largest share of their TFP growth from the adoption of better, but already existing, technologies which are available "at the frontier".

In this "Schumpeterian" world, institutions and policies play a key role in determining the coherence of the relative position of countries in the global innovation race. These framework conditions directly impact on the relative ability of countries to innovate at the frontier or to adopt existing, leading-edge, technologies. While follower countries would gain from institutions and policies favouring the cost efficient adoption of existing technologies, countries operating at the frontier would, on the other hand, profit from policies that promote excellence in higher education and R&D; financial markets that reward risky projects; and regulations that do not put an

([27]) This theoretical framework has also been used by DG EMPL in "Employment in Europe (2006)" to examine how skilled human capital can contribute to boosting growth in Europe.

([28]) See also Nelson and Phelps (1966), Abramowitz (1986) and Benhanbib and Spiegel (1994).

([29]) Hence, the focus is on TFP growth as the engine of growth.

excessively heavy burden on either incumbent firms nor on potential entrants.

4.2. Existing empirical work

A number of papers in the literature have already analysed the determinants of TFP in a Schumpeterian framework. Most of the existing analyses use panel data information, pooling together data on TFP levels and growth rates over several years and countries. Some papers also use information at the sectoral/industry levels, with the datasets usually obtained from the OECD's STAN database ([30]). The available empirical specifications normally reflect a reduced form of the basic innovation-imitation model, with most of them regressing TFP growth on two essential variables:

- firstly, a measure of the technology gap (i.e., the distance between the TFP of the country analysed and that of the country with the highest level of efficiency);
- secondly, an estimate of the growth rate of TFP at the frontier (i.e. the TFP growth rate of the most efficient country).

The first variable captures the extent to which TFP growth in a specific country can be explained by the adoption of more efficient existing technologies. The assumption here is simply that the larger the technology gap, the higher the potential gains from adopting more efficient, internationally available, technologies and consequently the faster the rate of TFP growth. The second variable aims at capturing the link between TFP growth in the "catching-up" country with the extent of innovation and knowledge spillovers which are occurring in the technologically most advanced country. In addition to these two basic explanatory variables, most papers also control for a series of policy and institutional factors that may affect the rate of TFP growth independently or may interact with the "technology gap" and "technology spillovers" variables to have an impact on TFP.

The choice of explanatory factors which we use in our analysis of the factors driving technological change and efficiency gains is strongly driven by the work of Aghion and Howitt (2005) as well as the Sapir report (Sapir, et al. 2003). Both of these studies suggest that the failure of the EU's economic system to deliver a satisfactory growth performance from the mid-1990s onwards was due to outdated economic institutions (which were supportive of growth in the past but have now become an obstacle to growth) and the failure of the EU to transform its industrial structure to achieve an innovation-based economy. High growth in the post-WWII era was driven by high levels of industrial production, economies of scale and imitation of US technological advances. As the EU approached the technological frontier, growth became increasingly dependent on innovation.

Both studies suggest that economies based on innovation are the key to higher employment and growth. The necessary new organisational forms, less vertically-integrated firms, greater mobility and flexibility in the labour market, larger reliance on market finance, and the high demand for both R&D and third level education – all necessary conditions to shift from imitative to innovative economies – have not yet occurred on a sufficiently large scale in Europe. The studies stress that innovation stems from entrepreneurial activities but that these activities can only develop if Europe focusses on reforming their education systems; promoting higher levels of better targeted R&D; ensuring better regulation to facilitate entry and exit of firms (instead of focussing on competition between existing players); providing more adequate infrastructure to facilitate the free movement of people, goods and ideas; stimulating innovation via financial and tax incentives; and promoting more labour market flexibility, notably through a lower tax burden on workers.

The growth-policy recommendations included in the above studies also find support in the empirical literature where innovation and imitation (i.e. adoption of available technologies) are assessed as to their respective roles in determining the overall technological gains of an economy. Within this overarching endogenous growth framework, the importance of the high/low skill composition of a country's human capital and the economy's distance from the technological frontier are both assessed. For example, Vandenbussche, Aghion and Méghir (2005) show that if one holds the level of human capital constant, its growth enhancing effects depend both on

([30]) See, for example, Nicoletti and Scarpetta (2003) and (2005); Conway et al. (2006).

its composition and on distance to the technology frontier. More specifically, Vandenbussche et al. contend that the TFP growth-enhancing impact of skilled labour increases with a country's proximity to the frontier under the reasonable assumption that innovation is a relatively more skill intensive activity than imitation. As a result, in advanced economies, the authors suggest that unskilled labour contributes relatively little to technological improvements since the potential for catching-up/imitation is limited.

In keeping with this theme, Acemoglu, Aghion and Zilibotti (2002) emphasize the distinction between innovation and imitation as two alternative sources of productivity growth and of the importance of growth-maximising institutions or policies evolving as a country or industry catches up with the technology frontier. This line of reasoning is supported by Aghion, Bloom, Blundell, Griffith and Howitt (2003) who show that when most firms in an industry are close to the national technological frontier, product market competition is positive for innovation. This is also suggested in the paper by Aghion, Blundell, Griffith, Howitt and Prantl (2006), where evidence is presented that the closer industries in an economy are to the world technology frontier, the more growth-enhancing is the threat of entry. Griffith, Redding and Van Reenen (2004) showed that R&D plays a role in the convergence of TFP levels within industries across OECD countries and identified a role for human capital in stimulating innovation and absorptive capacity. Finally, Nicoletti and Scarpetta (2003) also show that lowering barriers to entry has a positive effect in terms of stimulating TFP growth.

One interesting feature of the Nicoletti et al. paper is that the TFP findings are mostly limited to manufacturing industries and yet the evidence in section 3 of the present paper suggests that the bulk of the unexplained differences in TFP growth rates across countries is in market services. Given the greater amount of data on market services provided in EU KLEMS, one of the key questions to be addressed in the regression analysis is the extent to which TFP growth rate effects from regulation is also a feature of market services. As stressed in Conway and Nicoletti (2006), given their relatively low import penetration levels, it is in the services sector where economic regulation is most concentrated. At a wider level, given the size of the services sector as a whole and its potential for strong TFP growth, as shown by the post-1995 experience of the US, it is essential that policy makers have a better understanding of the role of service sector regulation in explaining cross-country TFP patterns.

4.3. Empirical strategy

The aim of the present analysis is to take a step forward compared with existing work in this area by capitalising on the recent release of the EU KLEMS datasets and specifically on the increased availability of TFP data series and of substantially enhanced industry level detail. There is also an attempt in the analysis to control for a large number of policy and institutional variables. The analysis concerns 9 EU countries plus the US over the 1980-2004 period and covers a total of 28 industries ([31]). The empirical approach is similar to that in Nicoletti and Scarpetta (2003). In the baseline specification, TFP growth rates are regressed over a measure of innovation/technology spillovers (i.e. the TFP growth rate of the leader country) and of a technology gap term (i.e. the lagged logarithm of the difference between TFP in a specific country and TFP at the frontier, with the frontier being determined by the country exhibiting the highest TFP level in that particular industry, in that particular year). Country, sector and year fixed effects control for factors that independently may affect TFP growth rates.

The TFP growth rates used in the analysis have been computed using the established "ex-post" capital services approach on the basis of the EUKLEMS data series on value added and factor inputs. With regard to the measurement of the technology gap variable, care is undoubtedly required in measuring TFP levels, due to the need to have industry level data which is comparable across countries. In this respect, we make use of the PPP-adjusted TFP levels dataset provided for the 10 countries in Inklaar et al. (2007) ([32]).

([31]) The 9 EU countries are Denmark, Germany, Spain, France, Italy, the Netherlands, Austria, Finland and the UK. The 28 industries are those shown in graph 2.3.15.

([32]) The TFP levels data in Inklaar et al. (2007) refer to the year 1997. TFP levels for other years are derived from TFP growth rates computed ex-ante. R. Inklaar is gratefully acknowledged for providing the TFP levels data produced in Inklaar et al. (2007).

In addition to the two main explanatory variables, the baseline specification is subsequently augmented to control for the impact of framework conditions. A long list of country-level variables are added which capture, amongst other things, the overall macroeconomic conditions in economies; the presence of those economy-wide infrastructures which are most closely associated with the development of new technologies; the importance of ICT use to TFP patterns; variables to allow for the age structure of the population; and finally a series of indicators for testing the impact of a wide variety of barriers to entry and competition, including a range of product market regulations ([33]). Against our prior expectations, such economy-wide variables produced results which were generally insignificant in terms of their TFP effects. In addition, there is little evidence from the regressions that ICT use has had a large role to play in determining cross-country TFP trends. The overall contribution of ICT would appear therefore to be adequately reflected in the growth accounting results presented earlier in section 3, with the regression analysis finding little support for additional TFP-enhancing spillover effects from an intensive use of ICT capital at the macro level. Industry-specific indicators of human capital ([34]) and R&D spending ([35]) performed better, especially in the absence of country or industry fixed effects. Furthermore, indicators of product market regulation in the services sector ([36]) and economy-wide regulation in labour and financial markets ([37]) also exhibited a relatively high degree of significance.

Given this initial set of regression results, the impact of the human capital, R&D and regulatory indicators was more systematically analysed in the subsequent regression work, with the objective of disentangling the separate effects produced on TFP growth via the adoption of new technologies and from the effects of technological externalities. Compared with previous work in this area, there is an attempt to check the robustness of the results with respect to the sectoral dimension, with separate regressions being performed for different sectoral aggregates. As will be made clear later on, the same explanatory variables that produce significant results for a given sectoral aggregate may not do so for the different constituent industries. There will also be an attempt to isolate the determinants of TFP growth in those specific industries in which the US and the EU have shown superior performances in the post-1995 period.

4.4. Regression results

Table 2.4.1 presents the results for the baseline specification ([38]). When applied to the whole sample (column (1)), the results support the expectation that TFP growth is higher in a country when:

- firstly, there is stronger TFP growth in the frontier economy (which reflects the impact of innovation and technology spillovers);
- secondly, when the technology gap is larger, with the gap measured by the difference in TFP levels for the country in question relative to the global

([33]) The data sources are as follows: ECFIN's AMECO database for macroeconomic conditions (output gap, relative contribution of consumption to GDP growth, relative contribution of investment to GDP growth); World Bank Development Indicators for infrastructure (number of internet users, computer diffusion, share of population with tertiary degree, public spending on education, public spending on R&D, number of patent applications) and for the age structure of the population; OECD for economy-wide indicators of product market regulation and barriers to competition (public ownership of firms, public involvement in business operations, regulatory and administrative opacity, administrative burden on start ups, barriers to competition, explicit barriers to foreign trade and investment, other barriers to foreign trade and investment).

([34]) The share of high-skilled labour compensation in total labour compensation, source EUKLEMS.

([35]) The share of R&D expenditure in gross output, source OECD STAN database.

([36]) Source: OECD, "Regimpact" indicator" (Conway and Nicoletti (2006). The indicator measures the "knock-on" impact of regulation in services on all the remaining sectors.

([37]) Source: Fraser Institute. The indicator for labour market regulation includes the following information: i) impact of minimum wages; ii) hiring and firing practices; iii) share of contracts determined by centralised bargaining, iv) unemployment benefit characteristics; v) use of conscripts to obtain military personnel. The indicator for financial market regulation includes information on i) the ownership structure of banks; ii) competition among banks; iii) access to credit; iv) occurrence of negative interest rates; v) presence of interest rate controls.

([38]) Since the explanatory variables are likely to be exogenous, OLS estimation methods are used. Standard errors are robust with respect to heteroschedasticity and the possible autocorrelation of the residuals within countries.

Table 2.4.1
Basic specification

	All industries and years	Ex-ante TFP calculation (ECFIN)	Only manufacturing sector	Only private services sector	Only ICT-related sectors	Only years after 1995
	1	2	3	4	5	7
TFP growth at the frontier	0.159**	0.113**	0.164**	0.135**	0.138***	0.158*
	(2.98)	(2.61)	(2.38)	(3.39)	(4.70)	(2.08)
Technological gap	-0.046***	-0.038***	-0.060***	-0.029***	-0.027***	-0.046
	(4.48)	(5.12)	(3.81)	(4.14)	(4.85)	(1.20)
N. obs.	6619	6059	3058	2133	2371	2796
R^2	0.13	0.12	0.16	0.10	0.50	0.12

Notes:
Estimation method: panel OLS regressions; fixed effects included for countries, sectors, and years; standard errors robust with respect to heteroschedasticity and possible correlation within countries. Absolute value of t tests reported in parenthesis.
***, **, * denote, respectively, statistical significance at 1, 5, and 10 per cent level.
TFP growth at the frontier: TFP growth of the country with the highest TFP level in sector *s*, year *t* (leader country).
Technological gap: lagged log(TFP level –TFP level of the leader country).

leader (which reflects the impact of adopting existing superior technologies).

In comparison with the results quoted in the literature, whilst in most existing analyses there is supporting evidence of a significantly negative relationship between TFP growth and the gap in technology, the impact of TFP growth at the frontier is not however always significant (e.g., Nicoletti and Scarpetta (2003)). Given that our results are strongly significant for "frontier" growth effects, as a robustness check, column (2) in Table 2.4.1 also reports the same specification as in column (1) but using "ex-ante" calculated TFP growth rates ([39]). It is comforting to note that the results are broadly similar in terms of the coefficient estimate and its significance level.

Table 2.4.1 also reports results for the basic specification based on different sectoral breakdowns and time periods. Column (3) reports the results when the sample is restricted to the manufacturing sector, whilst columns (4) and (5) do the same for, respectively, private services and ICT-related sectors (the latter comprises both ICT producing manufacturing sectors and all sectors of the economy that use ICT goods intensively). A number of interesting conclusions can be drawn from this set of results:

- Firstly, for the whole sample period, all of the sectors are characterised by TFP growth which is driven both by growth at the frontier and by the extent of the technological gap.
- Secondly, innovation or knowledge spillovers have a broadly similar effect on the TFP growth performance of the manufacturing, private services and ICT-related sectors.
- Thirdly, regarding the technology gap term, TFP growth in the manufacturing sector is relatively more driven by the adoption of superior existing technologies, compared with the private services and ICT related sectors.
- Finally, the last column of Table 2.4.1 reports the same regression as in column (1) but restricts the sample to the years after 1995. It turns out that in the decade from 1995-2004, TFP growth was mostly driven by growth at the frontier, with a non-significant impact from the technology gap variable. This finding is consistent with the view that across Europe, growth is increasingly being driven by innovation activity and less by the adoption of existing up-to date technologies. Given these emerging patterns, these results could be interpreted somewhat negatively given that they appear to indicate that the extent of catching up across countries is weakening over time.

With the striking impact of ICT, there has been considerable interest in analysing the effects of investments in knowledge and human capital formation on the overall TFP performance of

([39]) The essential difference between both methods is that the ex-ante method is based on an exogenous value for the rate of return whereas the ex-post approach estimates the internal rate of return as a residual given the value of capital compensation from the national accounts and estimates for depreciation and capital gains.

Table 2.4.2

The role of human capital and R&D

	All Industries				Only manufacturing sector	Only private services sector	Only ICT-related sectors
	1	2	3	4	5	6	7
TFP growth at the frontier	0.177*	0.176*	0.187*	0.174**	0.173**	0.438***	0.141**
	(2.02)	(2.02)	(2.19)	(2.66)	(2.40)	(3.90)	(3.16)
Technological gap	0.083**	-0.082**	-0.079**	-0.080***	-0.105**	-0.036	-0.013
	(3.16)	(3.14)	(3.06)	(3.21)	(2.80)	(1.32)	(1.41)
Human capital	-0.009	0.005	0.001	-0.006	-0.017	0.004	-0.007
	(1.40)	(1.23)	(0.17)	(0.55)	(0.69)	(0.86)	(1.01)
R&D	0.001	0.005	0.005***	-0.000	0.008	0.023	0.000
	(0.33)	(1.33)	(4.96)	(0.02)	(0.56)	(0.86)	(0.02)
Interaction TFP growth at the frontier with human capital				0.169	0.216	0.198***	0.128
				(1.32)	(1.40)	(5.39)	(1.32)
Interaction TFP growth at the frontier with R&D				0.019	0.013	0.459	0.064
				(0.54)	(0.36)	(1.71)	(1.38)
Interaction technological gap with human capital				0.018	0.015	0.002	0.014
				(0.89)	(0.41)	(0.35)	(0.99)
Interaction technological gap with R&D				0.004	0.019	-0.033	-0.005
				(0.21)	(0.64)	(0.64)	(0.46)
Country fixed effects	Yes	No	Yes	Yes	Yes	Yes	Yes
Sector fixed effects	Yes	Yes	No	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. obs.	2385	2385	2385	2385	1535	674	892
R^2	0.19	0.18	0.19	0.20	0.23	0.20	0.31

Notes:

Estimation method: panel OLS regressions; standard errors robust with respect to heteroschedasticity and possible correlation within countries. Absolute value of t tests reported in parenthesis. ***, **, * denote, respectively, statistical significance at 1, 5, and 10 percent level.

TFP growth at the frontier: TFP growth of the country with the highest TFP level in sector *s* , year *t* (leader country). *Source:* EUKLEMS.

Technological gap: lagged log (TFP level –log(TFP level of the leader country).
Source: EUKLEMS.

Human capital: share of high skill labour compensation in total labour compensation. Standardised variable. *Source:* EUKLEMS*.

R&D: R&D expenditure/gross output. Standardized variable. *Source:* OECD STAN.

countries. With Europe lagging behind not only in terms of ICT penetration rates but also with regard to other indicators of knowledge production (such as R&D investments and the share of high tech industries), the creation of knowledge capital has emerged as a central policy concern, with the Lisbon process being a concrete example of an ongoing policy programme aimed at boosting the pace of innovation. Against this background, Table 2.4.2 reports the results for the basic specification augmented to take into account the role of human capital and R&D in affecting TFP growth ([40]).

The main message to be retained from the table is that both human capital and R&D do have a positive effect on TFP growth, with R&D having a direct impact on the latter ([41]). With respect to human capital, the effect is indirect, emanating from a stronger positive impact of TFP growth at the frontier. The latter influence, however, is highly sector-specific, with human capital appearing to be most effective in determining the TFP performance of the private services sector ([42]). While the evidence is far from overwhelming, consistent with the current view in the literature on the role of human capital and R&D, the

([40]) To facilitate the interpretation of the results, the human capital and R&D variables have been standardised in such a way as to have a zero mean and a unit standard deviation. When, for example, the human capital variable is interacted with variable *x*, the coefficient indicates the change in the coefficient of variable *x* which is associated with a one-standard-deviation increase in the human capital variable (while the coefficient of variable x indicates its impact in keeping human capital at its mean value).

([41]) Column (1) shows that the direct impact of R&D is not significant. A significant impact is recovered only by eliminating sector fixed effects (as shown in columns (2) and (3)).

([42]) This effect is captured by the significant coefficient on the human capital variable when interacted with the variable for TFP growth at the frontier in column (6).

most likely interpretation of these results is that these variables can help to accelerate TFP growth ([43]).

These frontier effects are suggestive of the view that for countries at or close to the technology frontier, policies aimed at improving the overall framework conditions for maximising the TFP benefits of human capital and R&D would be directly beneficial in facilitating the transition of their growth models to one based more on their own internal innovation capacity.

* This measure of human capital has been used for a number of reasons. Firstly, more traditional measures of human capital, like educational attainment levels from sources such as Barro and Lee, were tested but produced only small and insignificant effects. Secondly, as with the rest of the regression work, the paper wished to stick as closely as possible to the Nicoletti and Scarpetta empirical specification. Finally, this measure of human capital allows one to capture both compositional and quality shifts in the labour force, with not only cross-country differences in skill levels being taken into account but also differences in the remuneration of such workers as reflected in differences in the compensation shares of high skilled workers in total, economy-wide, labour compensation.

Recent studies (e.g., OECD (2003), IMF (2003)) report that levels of regulation are potentially crucial driving forces for efficiency gains. To assess the importance of this specific determinant, Table 2.4.3 presents the results for the impact of several regulation indicators in the product, labour and financial markets on TFP performance ([44]). The results suggest that, across "all industries", the different regulatory indicators do not play a very important direct role in determining TFP growth, with non-significant results for most of the alternative specifications tested. In addition, there are some non-obvious results when the analysis is restricted solely to the manufacturing, private services or ICT-related sectors, with tighter product market and financial market regulations predicted to be positive for TFP growth in some specific sectors.

Table 2.4.3
The role of regulations

	All Industries		Only manufacturing sector	Only private services sector	Only ICT-related sectors
	1	3	4	5	6
TFP growth at the frontier	0.171***	0.175***	0.398***	0.138***	0.153***
	(3.39)	(5.82)	(4.02)	(3.97)	(7.07)
Technological gap	-0.049***	-0.047***	-0.042*	-0.026***	-0.030***
	(5.09)	(5.20)	(2.26)	(5.13)	(6.95)
Product market regulation	-0.002	-0.000	0.126***	-0.008	0.008**
	(0.96)	(0.01)	(3.41)	(1.65)	(2.81)
Labour market regulation	0.008	-0.004	-0.009	0.002	0.006
	(1.45)	(0.79)	(1.46)	(0.36)	(0.95)
Financial market regulation	0.005	-0.007	-0.004	0.009	0.009*
	(1.31)	(1.43)	(0.36)	(1.73)	(2.01)
Interaction TFP growth at the frontier with product market regulation		0.016	0.416**	-0.005	-0.040
		(0.41)	(2.73)	(0.23)	(0.98)
Interaction TFP growth at the frontier with labour market regulation		0.090**	0.080**	0.069*	0.014
		(2.43)	(2.12)	(1.85)	(0.35)
Interaction TFP growth at the frontier with financial market regulation		-0.078	-0.127**	-0.063**	-0.081**
		(1.62)	(2.80)	(2.55)	(2.57)
Interaction technological gap with product market regulation		-0.007	0.064	-0.013*	0.002
		(0.90)	(1.17)	(2.07)	(0.38)
Interaction technological gap with labour market regulation		-0.004	-0.007	-0.005	0.001
		(0.48)	(0.47)	(0.81)	(0.16)
Interaction technological gap with financial market regulation		-0.003	-0.014	0.016**	0.007*
		(0.34)	(0.97)	(2.34)	(1.89)
N. obs.	6340	6340	2929	2043	2271
R^2	0.13	0.14	0.18	0.11	0.22

Notes:

Estimation method: panel OLS regressions; fixed effects included for countries, sectors, and years; standard errors robust with respect to heteroschedasticity and possible correlation within countries. Absolute value of t tests reported in parenthesis.
***, **, * denote, respectively, statistical significance at 1, 5, and 10 percent level.

TFP growth at the frontier: TFP growth of the country with the highest TFP level in sector *s* , year *t* (leader country). *Source:* EUKLEMS.

Technological gap: lagged log(TFP level)–log(TFP level of the leader country). *Source:* EUKLEMS.

Product market regulation: indicator of the "knock on" sectoral impact of regulations in non-manufacturing sectors. Standardised variable. Source: OECD "Regimpact" indicator

Labour market regulation: indicator of anti-competitive regulations in the labour market. Standardised variable.
Source: Fraser institute freedom indicators (taken with negative sign).

Financial market regulation: indicator of anti-competitive regulations in the labour market. Standardised variable.

Source: Fraser institute freedom indicators (taken with negative sign).

([43]) While these results are supportive of the view that human capital and R&D are important for TFP growth, due to differences with respect to sample periods, specification issues, the definition of the human capital variable and the overall estimation methodology, the results are not directly comparable with other published papers in this area such as, for example, the paper by Griffith et al (2004). The results shown in Table 2.4.2 suggest that both human capital and R&D are playing a role but mostly as an interaction effect in non-manufacturing sectors or, in the case of R&D, mostly across sectors (shown by the fact that it is directly significant when sector fixed effects are removed). Human capital has a positive direct effect when country fixed effects are excluded (although this effect is not statistically significant which is suggestive of the view that human capital helps mostly in understanding differences across countries).

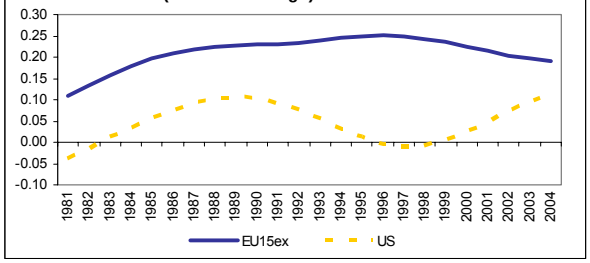
([44]) To facilitate the interpretation of the results, the indicators are standardised. The indicators increase with the intensity of the regulatory burden.

With regard to the indirect interaction effects of the different forms of regulation, tighter financial market regulation appears to have consistently negative effects for TFP growth taking place at the frontier, both when all the sectors are pooled together and when only individual sectors are considered in the regressions (i.e. manufacturing, private services and ICT related sectors). Conversely, the results for product market regulations do not appear to be as robust since many of the coefficient estimates are insignificant and shift from positive to negative depending on the sector considered. As far as labour market regulations are concerned, they appear to increase TFP growth at the frontier, irrespective of the sectoral breakdown used in the sample. Since the theoretical literature does not provide a clear-cut answer regarding the link between labour market regulation, innovation, and TFP, a note of caution is required in interpreting the positive relationship between stricter labour market regulation and TFP growth. In particular, the limited time-variation of the sample used in the regressions makes it difficult to disentangle the short term transitional effects of labour market reforms, introduced by many EU countries since the early 1990s, from the long run impact of those reforms on TFP growth rates ([45]).

In overall terms, given the lack of any evidence of a direct impact from the regulatory indicators at the level of "total industries" and the robustness issues/counter-intuitive results for the indirect interaction effects, it is clear that more research is needed to get a better understanding of the role of the regulatory environment in explaining cross-country TFP growth differentials.

Part of the problems experienced with the regulatory regressions may be linked to the need to use a lower level of disaggregation than the broad sectoral aggregates which were used for the analysis in Table 2.4.3 This is attempted in Table 2.4.4 which presents results for sectors defined at a finer level of industry disaggregation. The aim is to identify the key TFP growth determinants in those broad industry groupings that explain the bulk of the EU-US TFP differences over the past decade ([46]). As shown earlier in Graph 2.3.15, the EU-US TFP gap is concentrated in the ICT producing manufacturing industry (i.e. electrical and optical equipment which includes semi-conductors) and a number of private services industries. In addition to showing where the EU is underperforming, graph 2.3.15 also shows that there is a small group of industries where the EU has outperformed the US over the past decade i.e. the "network" industries (see graph 2.4.1).

Graph 2.4.1: **EU+US – trend contributions from TFP in the *Network Industries* to the Value Added Growth Rate of the EU and US economies over the period 1981-2004 (annual % change)**



([45]) On the one hand, stricter labour market regulation, notably employment protection legislation, by limiting the room for re-adjusting the labour force in case of redundancies, may hinder the incentives of firms to engage in risky innovation projects, thus reducing TFP growth at the frontier. On the other hand, stronger protection of employment may increase training and investment in skills, which are generally complementary to innovation and TFP growth (see, e.g, Bassanini and Ernst (2002) for a discussion of the alternative channels highlighted in the theoretical literature). In addition, studies such as Acemoglu and Shimer (2000) argue that a minimum degree of employment protection / unemployment insurance is necessary to stimulate human capital formation and TFP growth.

([46]) Results which simultaneously consider the role of human capital, R&D and regulations are not reported and most results are qualitatively unchanged. These variables display a fairly high degree of correlation and the simultaneous use of these control variables may lead to multicollinearity problems. For this reason, specifications only include groups of controls separately.

Table 2.4.4
Industry-specific models

	ICT producing manufacturing		Retail and affiliated industries		Utilities	
	Only ICT producing manufacturing	Only remaining industries	Only retail and affiliated industries	Only remaining industries	Only utilities	Only remaining industries
	1	2	3	4	5	6
TFP growth at the frontier	0.007	0.168**	0.152**	0.194**	0.086	0.190***
	(0.05)	(2.34)	(2.61)	(2.37)	(0.47)	(4.08)
Technological gap	0.010	-0.082**	-0.034***	-0.0544***	-0.022	-0.048***
	(0.67)	(3.28)	(4.26)	(4.03)	(0.84)	(4.92)
Interaction TFP growth at the frontier with R&D	0.130***	0.016				
	(3.50)	(0.38)				
Relative contribution of private consumption to GDP growth			0.004***	0.001		
			(5.08)	(1.80)		
Product market regulation					-0.010*	0.004
					(2.00)	(0.063)
Interaction TFP growth at the frontier with product market regulation					0.032	0.043
					(0.33)	(1.32)
Interaction technological gap with product market regulation					-0.115	0.005
					(1.06)	(0.90)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sector fixed effects	No	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes
N. obs.	141	2497	836	5030	684	5656
R^2	0.56	0.18	0.17	0.14	0.22	0.13

Notes:

Estimation method: panel OLS regressions; fixed effects included for countries, sectors, and years; standard errors robust with respect to heteroschedasticity and possible correlation within countries. Absolute value of t tests reported in parenthesis.
***, **, * denote, respectively, statistical significance at 1, 5, and 10 percent level.

TFP growth at the frontier: TFP growth of the country with the highest TFP level in sector s, year t (leader country). *Source:* EUKLEMS.

Technological gap: lagged log (TFP level)–log(TFP level of the leader country). *Source:* EUKLEMS.

R&D: R&D expenditure/gross output. Standardized variable. *Source:* OECD STAN.

Human capital: share of high skill labour compensation in total labour compensation. Standardised variable. *Source:* EUKLEMS.

Relative contribution of private consumption to GDP growth: GDP growth due to private consumption/GDP growth. *Source:* AMECO.

Product market regulation: indicator of the "knock on" sectoral impact of regulations in non-manufacturing sectors. Standardised variable. *Source:* OECD "Regimpact" indicator.

Financial market regulation: indicator of anti-competitive regulations in the labour market. Standardised variable. *Source:* Fraser institute freedom indicators (taken with negative sign).

ICT-producing manufactures: electrical and optical equipment (30t33).

Retail and affiliated industries: Retail and sale of fuel and sale maintenance of and repair of motor vehicles and motor cycles (50) + wholesale trade and commission trade except motor vehicles and motor cycles (51) + repair of household goods and retail trade except of motor vehicles and motor cycles (52)+ hotels and restaurants (H).

Utilities: energy (E) + transport and storage (60t63) + post and telecommunications (64).

For a selection of these industry groupings, the most significant variable has been chosen in table 2.4.4 which, when added to the baseline specification, best explains the TFP growth of the grouping in question. Column (1) shows that for the ICT producing industry (i.e. electrical and optical equipment) the basic variables behave somewhat differently to prior expectations. The frontier and technology gap variables are non-significant, with the latter indicating that TFP growth rather than converging is diverging across countries in this particular industry. This result is consistent with the existing evidence which suggests that labour productivity in the "high tech" sectors is not converging across countries, in contrast with what is observed for most other sectors (see, for example, Scarpetta and Tressel (2002)). Interestingly, the results change drastically when the same specification is tested on "total industries" excluding the ICT-producing manufacturing industry itself (column (2)).

Regarding retail and wholesale trade services (column (3)), the results indicate a significant role for cyclical factors in providing a direct explanation for observed differences in TFP growth between the US and the EU's Member States (as suggested by the strongly significant positive coefficient for the relative contribution of private consumption to GDP

growth) ([47]). Due to its construction as a residual term, TFP growth also captures productivity improvements associated with the better exploitation of scale economies, which are likely to be a relevant factor in explaining productivity dynamics in this group of service industries. It is worth noting that a similar positive impact of cyclical factors is not observed in the remaining sectors (column (4)).

Finally, regarding the "network" industries, product market regulations are shown to have a significant negative impact on this grouping of industries but not on the rest of the economy (for which the coefficient has instead an unexpected positive sign - see column (6)). This regulatory impact appears to reflect the "knock-on" effects of regulations in this specific industry grouping on all other sectors of the economy. Its influence is likely to be particularly high, given the amount of regulations which have tended, in the past at least, to be imposed on a number of individual network industries, including electricity, gas and water, as well as transport and communications. The direct impact exercised should however be interpreted mostly in terms of the better exploitation of scale economies and reduced "X inefficiencies" rather than to any dynamic TFP gains.

- Firstly, whilst there is a generalised tendency toward catching up across countries in terms of TFP growth, such a tendency seems to be weakening over time, especially in the post-1995 period. Moreover, for the ICT-producing manufacturing sector this process of catching-up is particularly weak.

- Secondly, TFP growth appears increasingly associated with innovation and technological spillovers from countries positioned "at the frontier".

- Thirdly, TFP growth is likely to benefit more from innovation at the frontier if there is more intensive use of R&D (direct effect) and human capital (indirect effect).

- Fourthly, regarding the impact of product, labour and financial market regulations, at the level of "total industries" and broad sectors, little robust evidence was found to suggest that the regulatory framework can offer a credible explanation for differences in cross-country TFP growth rates. Failure to discover such a link, however, may reflect the fact that the TFP effects are highly sector specific and consequently may be valid for some sectors but not for others. This offers one possible explanation for the weak results obtained when pooling a large number of very heterogeneous sectors in the same sample.

- Finally, the TFP growth performance of the EU compared with the US in a range of individual industries can be linked to a relatively wide spectrum of factors, underlining the importance of a targeted, industry level, approach to reform efforts. For example, differences in the ICT-producing manufacturing industry could, inter-alia, be attributed to the weaker role of R&D intensity in EU countries in this particular industry. In the retail and wholesale trade industry, the role being played by cyclical factors would need to be examined as a possible explanation for the EU's relatively poor performance. Finally, regarding the comparatively satisfactory TFP performance of the EU in the network industries, this could be related to the deregulation drive which has been a feature of the sector over the last two decades, with the more pro-competitive environment created yielding significant benefits in terms of overall TFP trends. However, these latter benefits are likely to be skewed more towards one-off static efficiency gains, rather than permanent dynamic effects.

([47]) A role for cyclical factors is suggested also by the positive and significant coefficient of the output gap as an alternative explanatory variable.

Concluding remarks

This chapter exploits the detailed sectoral and industry-level information about productivity developments contained in the recently released EU KLEMS databank. An analysis of this data not only confirms the broad macro trends which have been known for some time but also adds interesting details regarding the contributions from particular sectors and industries. It is found that whilst the deterioration in the EU's productivity performance relative to the US [when? adjust use of tenses below accordingly] was a feature of [do you mean ‘was concentrated in’?] the high technology part of the manufacturing sector, it was particularly entrenched in the EU's private services sector. In addition, a small group of industries are highlighted as being responsible for the post-1995 trends, namely electrical and optical equipment; wholesale and retail trade; financial services; and real estate and other business services. With regard to the nature of the reversal in productivity trends, the analysis shows that most of the EU-US differences are not to be found in investment patterns but were [tense?] mainly driven by developments in TFP, the structural component of productivity.

In terms of understanding the underlying driving factors behind the TFP divergences which emerged, the analysis suggests that TFP growth is increasingly associated, especially over the post-1995 period, with innovation and technological spillovers from countries positioned "at the frontier". These results suggest that there is a growing need for a more intensive use of R&D and highly skilled human capital in frontier economies. With regard to regulatory issues, it is not possible to conclude that they are playing a significant role in explaining international TFP differentials. In particular one must be careful in drawing sweeping, macro-level, conclusions from the available evidence. The analysis suggests that industry-specific regulatory indicators are needed to better understand the effects of a more competition-friendly regulatory environment on TFP trends. In particular, research is required to assess the effects of labour, financial and product market regulations both on the innovation capacity of different industries and on their ability to introduce more advanced technologies and business practices. Regarding those specific industries where EU-US TFP differences are most concentrated, the analysis shows that a relatively wide spectrum of factors are implicated, so that there is a need to adopt a more targeted, industry-level, approach to structural reform efforts in the EU.

Finally, the analysis supports the growing view in the literature that when a country reaches, or comes close to, the technology frontier, it must re-focus its policies and institutions towards a more innovation-based economic model, with less emphasis on the imitation of available leading-edge technologies and practices. The hallmarks of an open, innovation-driven developmental model are world-class educational establishments; higher levels of excellence-driven and better targeted R&D; more market-based financing systems; and more flexible regulatory and institutional frameworks delivering a dynamic and competitive business environment. Whilst many aspects of this approach have been introduced in recent years in individual EU countries, the "mindset" shift needed to make an overall success of the process has unfortunately not yet occurred on a sufficiently large scale at the European level, despite the fact that "Lisbon" provides an effective vehicle for managing this essential transition process.

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Chapter 3

Is there a trade-off between productivity and employment?

Summary

The labour market performance of the last years has been a positive surprise. Since the launch of the Lisbon agenda in 2000, about 10 million jobs have been created. In the first quarter of 2007, employment and participation rates reached 64.4 and 69.9%, up respectively by 2.3 and 1.4 percentage points compared to 2000. However, many European countries have seen labour productivity decline over the same period. Thus, after the jobless growth of the 1980s and early 90s, recent years have witnessed "growthless" job creation.

One might assume that the recent jobs 'miracle' itself has caused the productivity slowdown. A short-term trade-off between more jobs and productivity may indeed emerge, if, for any given stock of employment, faster employment entails a lower capital per worker and if more workers with relatively low skills and experience are employed. But this can be offset by the impact of the development and diffusion of new technologies and best work practices, which is what determines labour productivity in the long run. If labour and product markets function well and technological progress advances, high employment growth is compatible with high productivity growth.

Post-war economic history also shows that there is not always a trade-off between employment growth and productivity growth. Since the mid-1990s the US has performed well on both counts, but did not in the 1970s and 1980s, which shows that the relationship between employment growth and productivity growth is not stable over time.

Where a trade-off tends to emerge is in periods where inappropriate labour market institutions slow down the adjustment process. In the 1970s and 1980s, the European Union combined relatively fast productivity growth with sluggish employment growth – as opposed to the United States which experienced fast job growth amid a productivity slowdown. The sharp rises in oil prices and the associated surge in real wage cost in many EU countries triggered a substitution of capital for labour, which meant that fast labour productivity growth came with massive labour shedding. However, while it is algebraically correct to interpret this phenomenon as a productivity-employment trade-off, it is also misleading. It was in fact the behaviour of labour market institutions motivated only by distributional concerns which contributed to the protracted adjustment of real wages to the supply shocks and thus induced a massive rise in both unemployment and productivity.

In the second half of the 1990s, in order to mobilise those least attached to the labour market, several countries introduced reforms that increased labour market flexibility, for example by liberalising temporary contracts for new entrants, while largely maintaining the protection for incumbent workers on permanent contracts. A decline in labour productivity growth was observed in many instances, but econometric estimates show that the trade-off has diminished, demonstrating that policy-makers have succeeded in minimising the negative effects on labour productivity of these activation policies.

Even so, the EU's adjustment capacity may still be hampered by labour market institutions allowing only partial flexibility. Tight employment protection regulation for permanent workers and (high) minimum wages act as a deterrent to labour mobility.

Labour market reforms, including the introduction of flexible employment contracts and working-hours arrangements alongside more employment-friendly wage-bargaining practices, can also cause labour productivity to slow down as the capital per worker falls and/or less attached groups enter the labour market. However, this chapter suggests that this effect is fairly small, and that the recent intense job creation and productivity slowdown in fact have specific causes.

Estimates of the trade-off suggest a 0.1-0.4% productivity loss for a 1% employment gain. This chapter uses information from the LABREF database of labour market reforms, which have markedly intensified in the last decade, to conduct a "policy experiment" on the effects of reforms for marginally attached groups on employment and productivity. Econometric estimates show that policies that affect the job prospects of "marginal" workers such as women, older workers or the low-skilled (for example, fiscal incentives for temporary and part-time work, targeted tax cuts for low-skilled/low-income workers, employment subsidies, direct job creation schemes and in-work benefits) may have raised employment by slightly over 1% over the 2001-06 period in countries where they were implemented, while reducing productivity by 0.25 to 0.5%.

1. Introduction

Growth in employment and labour productivity are both conducive to higher per capita output. So it is not surprising that policies, including those that are covered by the Lisbon Agenda adopted in March 2000, have been designed to boost both employment and labour productivity ([48]). A crucial issue is to what extent the twin objective of faster employment and productivity growth can be achieved simultaneously. Measures to increase labour supply, promote investment in human capital, improve the adaptability of the workforce, encourage regulatory reform and stimulate entrepreneurship and innovation, as proposed in the Lisbon Strategy, all aim at achieving higher growth via more and more productive jobs. However, this goal would be difficult to achieve if there was a strong and inescapable negative relationship between employment and productivity growth – i.e. if faster productivity growth would always come with less job growth or vice versa. This trade-off may hinder the efforts of policy makers to release the potential of the European economy.

Against this backdrop this chapter examines the relevance of an employment-productivity trade-off in more detail. The main findings are that:

- The analysis of the stylised facts in Section 2 suggests that the relationship between employment and productivity growth has been influenced by substantial improvements in the performance of the European labour markets. Evidence of these changes comes form the improvements in the structural unemployment rate and in the employment and participation rates, especially of those groups with relative low labour market attachments such as older workers and female population. These improvements may explain the reduction in productivity growth observed since the second half of the 1990s. Even so, it should be considered that these positive changes contributed to bring the average output growth to a value (about 2.5%) higher than the average of the previous two decades. However, the decline in labour productivity cannot be explained without accounting for the decline in the total factor productivity growth. Moreover, the US experience suggests that there is no necessary an inescapable strongly binding trade-off. Indeed, in the same period this country experienced sizeable increases in productivity growth while employment growth declined only very little.

- Standard neoclassical growth theory suggests that there is no trade-off between employment and productivity growth in the long-run. However, in the short- to medium-term employment and productivity are negatively related because of the substitution between capital and labour which is affected by the relative factor prices. This framework could explain the pick up in productivity growth experienced by many countries after the wage push of the early 1970s. When TFP growth started to decline in the 1980s, the fall in labour productivity started from the high level implied by the labour shedding which follow the wage shock. Similarly policies that increase the level of employment permanently may temporarily be accompanied by a decline in labour productivity growth, which however, is ultimately influenced by measures that stimulate total factor productivity (i.e. the efficiency in which factors of production are combined thanks to organisational changes and technical progress). The empirical analysis in Section 3 suggests that the medium-term trade-off between labour productivity and employment growth is not stable over time. Yet, trade-off appears less binding in the more recent period, which may indicate that policy makers have been successful in limiting the temporary negative effects on labour productivity growth of an increase in employment, partly due to the implementation of structural reforms.

- Section 4 explores the effects of reforms on the employment and productivity trade-off. It turns out that the observed reduction in the NAIRU cannot be explained without accounting for a shock to the wage mark-up which, according to the basic theoretical framework, could imply the appearance of a negative relationship between employment and productivity. The QUEST simulation suggests that a medium-run elasticity of productivity growth with respect to

([48]) The Lisbon strategy sets explicit targets for 'more jobs': an employment rate of as close as possible to 70 per cent and a female employment rate of over 60 per cent by 2010. The Stockholm summit a year later added a further target of an employment rate of 50 per cent for older working-age people. The Lisbon Strategy implicitly also established a target for labour productivity growth given that it put forward an objective of 3 per cent GDP growth.

employment growth of about -0.2. This result is of a similar order of the cross-country rolling growth regression estimates of section 2. Finally, information on the chronology of reforms available from the LABREF database is used to evaluate whether reforms advocated to promote the employment rates of marginally attached people could account for the increase in the employment rate and, consequently, for the expected decline in productivity growth. The comparison between the change in employment rate and productivity growth before and after reforms suggests that, compared to the average, countries which did reforms experienced a positive increase in the employment rate and a decline in productivity.

2. The stylised facts

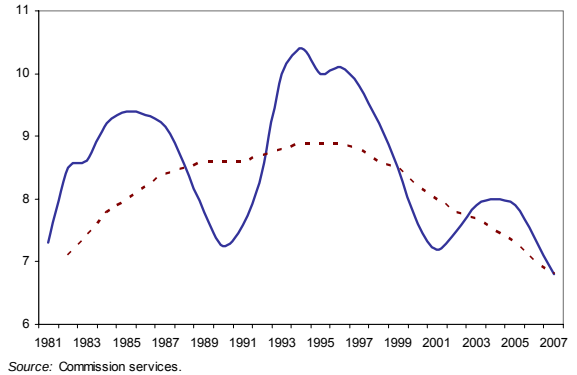
Labour market performance and economic outcomes differ substantially over time and across countries. During the 1960s and throughout much of the 1970s and early 1980s, European countries experienced relatively fast increases in productivity and modest employment growth. Conversely, during the same period, the United States posted strong employment growth amid a persistent productivity slowdown. The mid-1990s saw a partial reversal of these tendencies. During the decade 1996-2006 the European Union experienced a significant pick up in employment growth, which was partly offset by a slowdown in labour productivity. By contrast, the US (as well as other non-EU English-speaking countries) combined a pick-up in labour productivity growth with stable and robust employment growth, resulting in GDP growth being a full percentage point higher than in the EU over this period.

In terms of GDP, population, GDP per capita, employment and productivity, Table 3.2.1 provides an overview for the various EU aggregates, for a number of individual Member States, and for the US over the period 1996-2007. Regarding GDP growth rates, Table 3.2.1 indicates that, with the exception of the new Member States, all areas witnessed a deceleration in trend growth over the 2001-07 period, with cyclical factors clearly playing a large role. In terms of population, the table shows that the US continued to enjoy substantially better demographic patterns compared with the EU. Within the EU, the most striking feature of the data is the difference between the "old" and "new" Member States, with the latter experiencing persistent population declines over the last 10 years compared with growth rates of 0.25 to 0.5 of a percentage point annually for the EU15 countries. In terms of employment growth, compared to the first sub-period 1996-2000 more nuanced are the differences between different groups of countries in the second sub-period.

Regarding productivity and per capita income developments, the Euro area, driven especially by the poor performance of some of the larger Euro area Member States, has continued to under-perform over the period as a whole, while the "rest of EU15" grouping scored better growth rates, yet modest compared to the second half of the 1990s. The EU25 GDP per capita grew by as much as in the US over the period 1996-2005, owing to the strong convergence of the new Member States. Indeed, the difference becomes larger (about 0.5 percentage point) when the comparison is with the EU15. In contrast, productivity growth declined in the second sub period in Europe while it hovered around the average of the second half of the 1990s in the US. Hence the increase in employment in Europe contributed to reduce the gap between the EU and the US GDP per capita growth.

The performance of the European labour markets improved significantly during the second half of the 1990s. Table 3.2.2 provides a summary of the main key labour market indicators, while Graph 3.2.1 contrasts the evolution of the unemployment rate with DG ECFIN estimates of the its structural component (NAIRU). After having achieved a peak of 10.4% in 1994, the unemployment rate started gradually to decline hovering below 7% in 2007. What is remarkable is that this decline occurred while both the employment and the participation rates kept rising. From 1995 to 2006 the overall employment and participation rates raised respectively by about 6 and 4.5 percentage points, from 60 to 66% and from 67.2 to 71.6%. Notable was the increase in the female and the older workers employment and participation rates, the most dynamics components with increases since 1995 higher than 7.5 percentage points.

Graph 3.2.1: **Unemployment rate and the NAIRU in the EU15: 1981-2007**



Source: Commission services.

To some extent these improvements reflect long-term changes in the socio-economic behaviour (e.g. a different aptitude toward female employment and participation) as well as changes in the demographic structure of the working age population ([49]). However,

([49]) The ageing of the population boost the employment and participation rates as the weight of classes with higher rates increases. Between 1995 and 2007 the share over the 15-64 population of those in the 15-34 age class declined from 43% to 38%. During the same period, the share of those aged 35-49

Table 3.2.1

Actual GDP, Population and GDP per capita 1996-2007 period average % changes for the US and EU aggregates

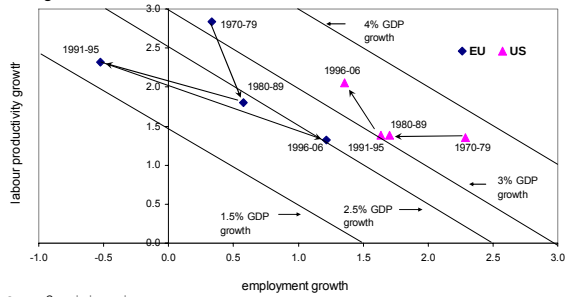
	GDP		Population		GDP per Capita		Employment		Productivity	
	1996 -2000	2001 -2007	1996 -2000	2001 -2007	1996 -2000	2001 -2007	1996 -2000	2001 -2007	1996 -2000	2001 -2007
Euro Area	3.2	1.8	0.3	0.5	2.6	1.2	1.6	0.9	1.6	1.1
Germany	-2.3	-1.2	-0.1	0.0	-1.9	-1.2	-0.8	-0.1	-2.3	-1.7
France	-3.4	-1.9	-0.4	-0.6	-2.5	-1.2	-1.4	-0.5	-1.6	-1.3
Italy	-2.3	-0.9	0.0	-0.6	-1.9	-0.3	-1.0	-1.2	-1.1	-0.1
Rest of EU15	3.5	2.8	0.4	0.7	3.5	2.0	2.0	1.4	1.8	1.5
UK	-3.5	-2.8	-0.3	-0.5	-3.1	-2.2	-1.3	-0.9	-2.0	-1.8
EU15	3.3	2.0	0.3	0.5	2.7	1.5	1.5	0.9	1.7	1.3
EU10	4.4	5.3	-0.2	-0.1	4.9	5.4	-0.3	0.9	5.1	4.3
EU25	3.3	2.2	0.2	0.4	2.8	1.7	1.2	0.9	2.0	1.4
US	4.5	3.0	1.2	1.0	3.1	1.7	-2.1	-1.1	2.1	2.0

Source: Commission services. AMECO database.

they also took place in response to the reforms implemented during the period, as suggested by the trend increase in labour force participation and the reduction in the levels of structural unemployment (i.e. a fall in the NAIRU ([50])). The interaction between increasing labour force participation, the change in the skill and gender composition of the labour force and greater availability of new types of contracts also facilitated employment-intensive growth. Flexible working hour arrangements (including temporary and part-time contracts) contributed to the raising employment and participation rates, especially for those groups with low labour market attachment. However, it is difficult to account for the fall in the NAIRU without invoking the role of more employment-friendly wage bargaining (e.g. ECB, 2007 and OECD 2007).

It might be believed that high employment growth would naturally lead to lower productivity growth. The US experience of the second-half of the 1990s, however, challenges this view. Graph 3.2.2 reports on the horizontal and on the vertical axis respectively the employment and the productivity growth. Each dotted line displays the combination of employment and productivity growth consistent with a given GDP growth ([51]). Along the iso-growth line movements in one direction of employment growth are outweighed by movements in the opposite direction of productivity growth and vice versa.

Graph 3.2.2: **Contribution of labour productivity growth and employment to GDP growth in the EU and the US**



Source: Commission services.

raised from 31% to 34% while for those aged 50-64 population increased from 26% to 27%.

([50]) NAIRU stands for non-accelerating inflation rate of unemployment and is an estimate of the rate of unemployment that is consistent with stable inflation, i.e. the amount of unemployment that can be considered to be of a structural, as opposed to cyclical, nature.

([51]) At any time, the following identity holds Y=N*Y/N, where N stands for employment, Y for GDP and Y/N for the GDP per employed person. From this identity one can get a relationship between employment, productivity and GDP growth: g=π+n. Hence, for any growth rate g there is a negative relationship between employment and productivity growth.

Table 3.2.2

Key labour market indicators

	1995	2006	Changes 1995-2006
Activity rate (as % of population 15-64)	**67.2**	**71.6**	**4.4**
Young (15-24)	47.2	47.8	0.6
Prime age (25-54)	80.7	84.6	3.8
Older (55-64)	39.0	48.3	9.2
Male	77.7	79.2	1.5
Young (15-24)	50.4	51.1	0.7
Prime age (25-54)	92.8	92.7	0.0
Older (55-64)	51.3	57.6	6.4
Female	56.8	64.1	7.4
Young (15-24)	44.0	44.4	0.4
Prime age (25-54)	68.6	76.4	7.8
Older (55-64)	27.5	39.3	11.8
Employment rate (as % of pop. 15-64)	**59.9**	**66.0**	**6.1**
Young (15-24)	37.2	40.1	3.0
Prime age (25-54)	73.2	78.8	5.6
Older (55-64)	35.8	45.3	9.4
Male	70.3	73.5	3.2
Young (15-24)	40.3	43.1	2.8
Prime age (25-54)	85.3	87.2	1.8
Older (55-64)	47.0	54.1	7.1
Female	49.6	58.6	8.9
Young (15-24)	34.1	37.1	3.1
Prime age (25-54)	61.0	70.5	9.5
Older (55-64)	25.3	36.8	11.5
Employed persons (age15-64)			
Male (as % of total)	58.5	55.6	-2.9
Female (as % of total)	41.5	44.4	2.9
Temporary employment (as % total)	**11.8**	**14.7**	**2.9**
Male	11.1	14.0	2.9
Female	12.8	15.5	2.7
Part-time (as % of total employment)	**15.6**	**20.0**	**4.4**
Male	4.7	7.3	2.6
Female	31.0	35.9	4.9
Unemployment rate *(Harmonised:15-74)*	**10.0**	**7.4**	**-2.6**
Young (15-24)	21.2	16.1	-5.2
Prime age (25-54)	9.3	6.8	-2.5
Older (55-64)	8.2	6.2	-2.0
Long-term unemployment rate (as % of total unemployment)	**47.8**	**42.1**	**-5.7**
Employment by skills (Total 15-64) 1000 pers.			
High skilled	28721	45257	57.6
(as % of total population)	19.6	26.8	7.3
Medium skilled	58649	75992	29.6
(as % of total population)	40	45.1	5.1
Low skilled	51340	46987	-8.5
(as % of total population)	35	27.9	-7.1
Employment by skills (Males 15-64) 1000 pers.			
High skilled	16624	23586	41.9
(as % of total population)	19.4	25.2	5.8
Medium skilled	34079	42053	23.4
(as % of total population)	39.7	44.8	5.2
Low skilled	30411	27892	-8.3
(as % of total population)	35.4	29.7	-5.7
Employment by skills (Females 15-64) 1000 pers.			
High skilled	12097	21671	79.1
(as % of total population)	19.9	29	9.1
Medium skilled	24569	33940	38.1
(as % of total population)	40.3	45.3	5.0
Low skilled	20929	19094	-8.8
(as % of total population)	34.4	25.5	-8.8

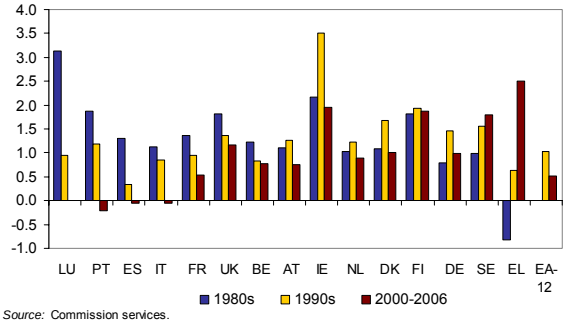
Source: Commission services. Data refer to 1996.

Because of the sizeable decline of the EU productivity growth in the 1980s, the increase in the average employment growth was not sufficient to avoid a decline in GDP growth from an average rate above 3% in the 1970s to an average below 2.5% in the 1980s. Similarly, the increase in productivity growth that followed the intense restructuring of the early 1990s occurred at the expense of severe job destruction, which brought the implied GDP growth below 2%. In contrast, in the last decade GDP scored the highest average rate since the 1970s, owing to the labour market recovery which made employment to grow to such an extent that more than compensated the significant decline in productivity growth.

The US experienced rather the opposite pattern. The fall in employment growth throughout the mid 1995 was not accompanied by major changes in productivity growth, leading to a decline in GDP growth from an average rate slightly below 4% in the 1970s to an average of 3% in the 1980s and the first half of the 1990s. The substantial increases in productivity of the following decade pushed GDP growth toward the average of the 1970s, while employment decelerated only to a very minor extent ([52]).

So far the decline in productivity growth has been related only to changes in the labour market. In practice, changes in productivity are also related to the pattern of technological change including the overall efficiency with which inputs are combined in the output of the economy. As evidenced from Graph 3.2.3, several countries experienced a significant decline in total factor productivity.

Graph 3.2.3: **Total factor productivity**
Countries are ranked in descending order on the basis of the largest change in TFP growth between 80s and 2000-2006



Source: Commission services.

All in all the stylised facts presented in this section suggest that there is indeed in the recent years a mild trade-off between employment and productivity. However, this relationship is influenced by favourable labour market shocks and adverse total factor productivity shock which may have occurred more or less simultaneously.

In Lisbon the EU launched its comprehensive strategy of structural reforms. The renewed Lisbon Strategy sharpened the Lisbon Agenda putting more focus on economic growth and job creation. Measures to increase labour supply, promote investment in human capital, improve the adaptability of the workforce, encourage regulatory reform and stimulate innovation aim at creating the conditions for high employment and productivity growth. The question is how well this has been implemented. The next session will develop an analytical framework to identify the effect of policies that boost employment and TFP growth.

([52]) The EU-US comparison resembles the distinction between so-called "market-reliant countries" and "other countries with successful labour market performance". Trend labour market productivity was 0.4 percentage points faster in the first group than in other successful performers. In contrast, labour utilisation (i.e. both hours worked and employment) was 0.6 percentage points lower in "market-reliant countries". This implied a GDP growth 0.2 percentage points slower than in other successful countries; (see OECD, Employment Outlook 2007, page 61).

3. A framework for analysis

Structural reforms can make a significant contribution to the achievement of the twin challenges of raising both employment rates and productivity growth. By extending and improving the functioning of markets, structural reforms can remove impediments to the full and efficient use of resources and allow for higher dynamic efficiency, making it easier to achieve faster sustainable growth with high levels of employment.

Given that technical progress determines our standards of living in the long run, clearly policy makers want it to grow faster than in recent years. In the long run, employment is determined principally by the functioning of the labour market as well as broad influences on labour supply (such as growth of the working-age population and cultural factors influencing, for example, the participation of women and older workers). Over the medium term, there is substantial scope for a large contribution to GDP growth from improved functioning of labour markets in the EU.

To single out the mechanisms that may drive the employment-productivity trade-off it might be useful to distinguish between exogenous shocks to technology (i.e. TFP shocks) and exogenous shocks to employment (i.e. labour supply, for example, in the form of declining working age populations). This section provides an illustrative framework for analysing the possible productivity effects due to technology or labour supply shocks, with Table 3.3.1 providing a quick summary of the key points.

Table 3.3.1

Relationship between employment and productivity growth

	Long run effect	Short to medium run effects
	Exogenous shocks (standard results)	
Positive technology shock (e.g.: ICT revolution)		
a) If labour augmenting	a) No effect on employment, positive for productivity.	Positive or negative effects possible (result depends largely on price and wage adjustment speeds).
b) If capital augmenting/skill biased	b) Negative for employment, positive for productivity.	
Labour supply shock (e.g.: an increase in the level of the labour force)	No effect on productivity if constant returns to scale is assumed, positive for employment.	Positive or negative effects possible (result depends largely on price and wage adjustment speeds).

Industrialised economies are subject to trend increases in TFP. Most of the technological improvements are of labour-augmenting nature, i.e. equivalent to an increase in the productivity of workers, which leads to higher wages. The increase in wages has both a substitution and an income effect on labour supply of similar magnitude, which implies that in the long-term, labour supply is not affected. Thus, increases in labour productivity tend to increase wages and not employment and modify the capital-labour ratio. Because of this wage response, and because the positive shock to TFP makes capital more productive, firms respond with an increase in the capital stock. Thus capital intensity increases after a positive technology shock. Over long-time spans, we observe an increase in TFP (labour-augmenting) which is similar to the increase in capital intensity and real wages while the employment rate does not show any trend. Hence, employment is neutral with respect to technical progress in the long-run.

In the short-and medium-term this neutrality does not hold. Keynesians stress market imperfections (in particular price and wage nominal rigidities and insufficient monetary accommodation of growth shocks) as possible reasons why positive technology shocks can lead to temporary increases in employment. For example, if there is (downward) price rigidity then real income does not rise sufficiently in order to absorb the increased supply (with a given level of employment) and it is optimal for firms to lower employment. As prices adjust employment rises again to the pre shock level. If on the other hand, nominal wages adjust rigidly then a technology boom can be associated with a temporary increase in employment (as in the US in the mid-1990s). Neoclassical economists stress another mechanism, namely a positive labour supply effect associated with an increase in income. Especially, if rates of technical progress are temporarily high then it is optimal for workers to reduce leisure in these times when exceptionally high wage increases are coming through. However, as income rises the wealth effect sets in and shifts the labour supply curve back to the initial position.

An exogenous increase in labour supply has no productivity effects in the long run when there are constant returns to scale (which is the standard assumption). If there are increasing returns then a positive labour supply shock has positive effects on productivity. The short-run effects on productivity, in both the case of constant and increasing returns, could be positive or negative depending on the degree of rigidities in the economy. But for productivity not to decline, the increase in labour supply would have to be accompanied by an increase in the savings/investment rate.

The effect of these shocks on productivity can be easily demonstrated with the Solow-Swan model. In this model, output is assumed to be given by a production function with constant returns to scale ([53]), such as the following Cobb-Douglas function: Y = AK^(a)L^(1-a) , where A is TFP, K is capital and L labour; a is between 0 and 1.

In growth terms this equation can be written as:

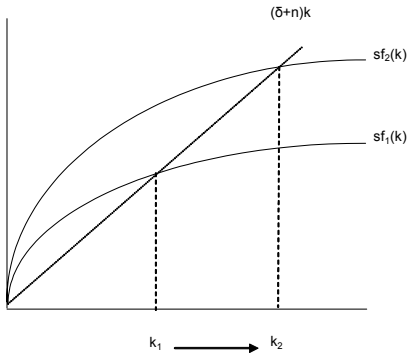
g(Y) =g(A)+ag(K)+(1-a)g(L).

Thus technological progress, capital growth and labour growth are the main drivers of output growth. In the Solow model the growth of labour (n) and of TFP (a) are exogenously given while the growth of capital (namely investment) is determined by the saving rate and the amount of output. In steady state the capital labour ratio and productivity grows at the rate of technological progress:

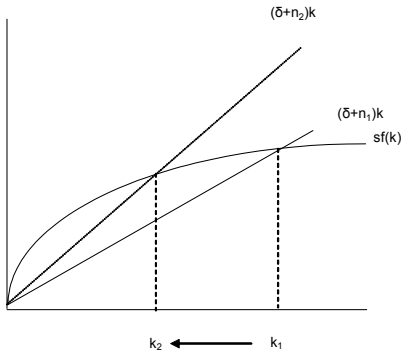
g(Y)-g(L)=g(K)-g(L)=g(A).

The Figure below depicts the saving function in intensive form – sf(A,k) where s is the saving rate. The concavity is implied by diminishing marginal returns. The straight line from the origin represents the investment required to have each worker endowed with the same amount of capital (including the capital depreciation). The steady state is achieved where the saving curve intersects the investment curve, i.e. sf(k,A)=(δ+n)k. In steady state, the capital labour ratio grows at the same rate as the exogenous technological progress.

In response to a favourable TFP shock, the saving function shifts upward triggering an increase in the capital-labour ratio that stops when the new equilibrium is achieved {k2, f(k2)}. Since employment remains unchanged the capital intensity grows at the same rate of the technological progress.



In contrast, a favourable labour supply shock which increases the level of employment rotate upward the straight line. In this case, the capital-labour ratio falls and this triggers a fall in labour productivity. The decline in labour productivity is temporary if the favourable shock in the growth rate is transitory, i.e. if following the shock there is a permanent higher level of employment. In terms of the graph below, the straight line returns to the pre-shock level.



([53]) A production function with constant return to scale in capital and labour is concave in the capital labour ratio, i.e. diminishing marginal returns: as capital grows relative to labour, the marginal product of capital declines and that of labour increases.

4. Gauging the trade-off between employment and productivity

4.1. Possible sources of employment-productivity trade-offs

One of the major stylised facts in economic history is that, in the very long run, technical progress is neutral with respect to employment. The massive capital accumulation and technological innovation achieved since the industrial revolution has not meant the "end of work" and, despite notions of "factories without workers", it is clear that workers have not on the whole been replaced by machines. Yet there appear to be episodes in the short or medium-term during which a trade-off is apparent. This section examines a number of possible explanations for this phenomenon and the economic policy challenges associated with it.

In line with the observed long-run relationship, Neoclassical growth theory, which is often used as a benchmark for more elaborate analysis, assumes that technological progress is labour-augmenting, i.e. technical progress raises the "effective" input of labour while leaving the actual use of labour unchanged ([54]). The state of technology (also known as total factor productivity, or TFP) reflects the overall efficiency with which factors of production are combined, typically treated as exogenous. TFP growth will initially raise the productivity of both workers and machines to the same extent, but the resulting increase in the demand for labour will boost real wages up to a point where the labour market is cleared (i.e. in the long-run employment grows at the same rate as the population). Hence, the impact on overall employment should be negligible ex post. As a result, there is a balanced growth path, along which labour productivity, real wages and the capital intensity of production (i.e. changes in the amount of physical capital per worker) all grow at the same rate, driven by technical progress, while full employment prevails. Changes in the rate of labour force participation will affect the rate of growth of employment but not the steady state growth rate of labour productivity. Hence there is no trade-off in the long-run ([55]).

Even so, in the very short-term, productivity growth often appears to vary inversely with employment growth, for example due to downward wage rigidity during recessions or labour hoarding during upswings. Moreover, in the medium term – perhaps up to a decade or more – trend productivity growth may be above or below the balanced rate owing to capital-labour substitution. Economies with temporarily higher growth of employment (or of the labour force) should experience a labour productivity slowdown because of the need to endow new workers with existing capital. For example, a sharp increase in the employment rate would imply that the amount of labour in the economy grows faster than the amount of capital. In this case, labour productivity growth would be temporarily below the steady state rate. The opposite is valid when employment falls. For example, the wage push of the late 1960s has been considered as the main cause of the sharp increase in the labour share and unemployment (Blanchard 1998, and Caballero Hammour (1998)) ([56]). The resulting increase in wages induced a substitution of labour input with capital, i.e. an increase the capital intensity of production, and an increase in average productivity growth.

Graphs 3.4.1-3.4.5 illustrate for several EU countries how in practice actual, trend and balanced labour productivity growth (under the assumption of

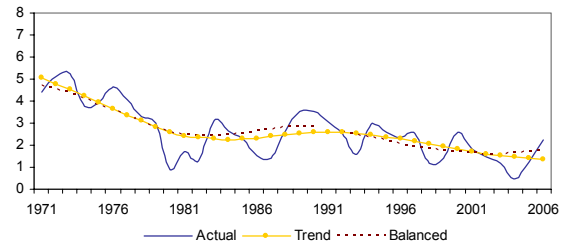
([54]) In the Solow-model, there is only one homogeneous good, consumers save a constant fraction of their income and provide one unit of labour. Population growth is exogenous and equal to the growth of employment, i.e. there is no unemployment and no retirees. In this framework, the only technical progress compatible with a steady state is of a labour augmenting (so-called Harrod neutral) type. With a Cobb-Douglas production function labour augmenting, capital augmenting (also called as Solow-neutral) and output-augmenting (Hicks – neutral) coincides.

([55]) In the short- and medium-term, actual labour productivity growth may deviate from the balanced growth due to changes in the capital-labour ratio. Given the same consumers' preferences and technology being freely available, the standard Solow neoclassical theory predicts an inverse relationship across countries between productivity growth and the capital labour ratio, implying that low income countries grow faster than high income countries. Hence, productivity growth varies inversely with productivity level implying convergence of income per capita. Similarly, employment can also deviate from its potential or structural rate (as determined by the functioning of the labour market, including factors influencing structural unemployment and incentives to participate in the labour force).

([56]) Blanchard, O. (1998), "The Medium Run" Brookings Papers on Economic Activity; Caballero, R J. and M. Hammour; "Jobless Growth: Appropriability, Factor Substitution and Unemployment" Carnegie-Rochester Conference Proceedings (1998) vol. 48, pp. 51-94.

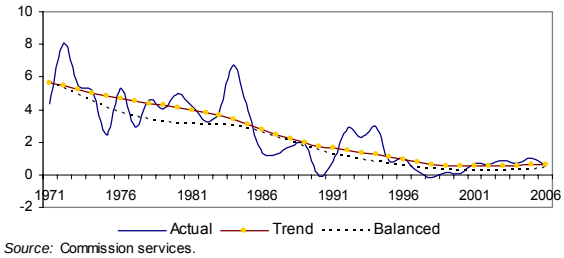
neoclassical growth) have behaved ([57]). The left-hand panels show how actual productivity growth can fluctuate significantly around its trend in the short-term. The right-hand panels compare the trend of actual productivity growth to what productivity growth would be along the balanced growth path. It is immediately evident that the uninterrupted decline in the trend growth rate of productivity, especially in continental European countries, is determined entirely by a fall in the rate of technological progress (see Chapter 2 for further evidence).

Graph 3.4.1: **Hourly productivity – comparisons of actual, trend, and balanced productivity growth – Germany**



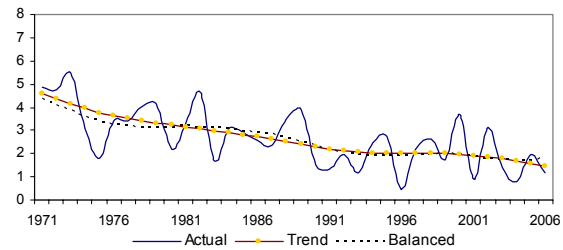
Source: Commission services.

Graph 3.4.2: **Hourly productivity – comparisons of actual, trend, and balanced productivity growth – Spain**



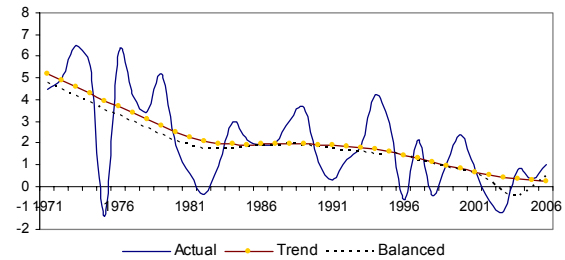
Source: Commission services.

Graph 3.4.3: **Hourly productivity – comparisons of actual, trend, and balanced productivity growth – France**



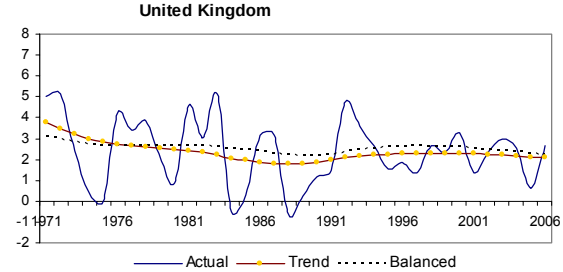
Source: Commission services.

Graph 3.4.4: **Hourly productivity – comparisons of actual, trend, and balanced productivity growth – Italy**



Source: Commission services.

Graph 3.4.5: **Hourly productivity – comparisons of actual, trend, and balanced productivity growth – United Kingdom**



Source: Commission services.

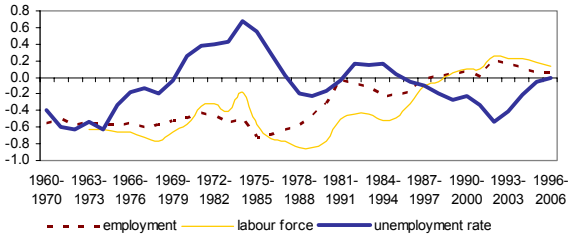
The key issue is, however, to what extent these trends and fluctuations in productivity relate to developments in employment. Graph 3.4.6 reports the cross-country correlation between rates of growth of employment and productivity computed over a 10-years window starting from 1960 ([58]). This correlation was strongly negative up to the mid-1980s when it started to diminish; countries with high productivity growth had low employment growth while countries with high employment growth

([57]) For a Cobb-Douglas production function, the balanced productivity growth rate may be expressed as the rate of TFP growth divided by the share of labour in output. TFP growth is the smoothed TFP obtained from a Cobb-Douglas production function where output level is at its potential level and the labour input is consistent with the nairu, the trends in participation and hours worked per employee. The share of Labour is fixed at 0.65.

([58]) By focusing on the correlation between average growth rates over ten years, we focus only on a medium-term trade-off.

experienced low productivity growth ([59]). The cross-country correlation between productivity growth and labour force shows roughly the same pattern and that between unemployment and productivity roughly the mirror image ([60]). This changing pattern in the correlation may be related to the cross-country heterogeneity in the response to the shocks of the 1970s and 1980s due to differences in labour market institutions (Blanchard and Wolfers (2000), Bertola, Blau and Kahn). Hence, labour market institutions contributed prolonged the adjustment to these shocks, and, by capital labour substitution, induced higher labour productivity growth at the expense of poor labour market outcomes. However, the recent smaller correlations should not be taken as evidence that the trade-off has disappeared, but rather that countries have achieved different levels of success in tackling it.

Graph 3.4.6: **Correlation between productivity growth and employment, labour force and unemployment rate**



Source: Commission services.

The analysis so far has assumed exogenous technical progress or TFP growth. However, in reality TFP growth is determined by economic decisions and should be considered endogenous to the economic process and this can again be a source of employment-productivity trade-offs. For example, the interaction between technical progress and learning and diffusion processes can be a source of a temporary trade-off between employment and productivity growth.

TFP growth can be influenced by investments in physical assets, education, training and R&D as well as by the effectiveness of the regulatory system in fully exploiting the benefits of such investments. Innovations are the outcome of costly investments which require specialised knowledge and accumulated skills as well as adequate physical infrastructures. Conversely, innovations expand the set of production possibilities and generate incentives for acquiring the new skills needed to implement such technologies. In turn, the acquisition of skills reduces the cost of implementation of existing technologies and generates the incentives for new technologies to be developed.

When a new technology is introduced, there can be a phase during which industries producing with new and old technologies coexist and workers are not fully endowed with the skills required by the new technology. At the same time, new technologies are only used by a limited number of enterprises. When innovations have universal and far-reaching applications (i.e. the so-called general purpose technologies (Helpman and Trajtenberg, 1994), productivity growth may decline as resources devoted to their discovery are not immediately profitable ([61]). During this learning period output per worker may actually fall. The longer is the lag between the invention and its adoption in "mass production" the longer is the period during which productivity growth declines.

The effect of technological progress on employment also depends on whether initially a job destruction effect prevails over a "capitalisation effect". When firms cannot easily adapt to the new technology, faster technological progress increases the rate of job destruction (Aghion-Howitt, 1994). However, when firms can gradually introduce new technologies their rates of return rise with faster technological progress, which encourages the creation of new firms and vacancies and decrease unemployment (the so-called capitalisation effect, Pissarides, 2000). The interaction between skills upgrading (i.e. learning costs) and technological progress – i.e. TFP growth – influence also the capital endowment of high- and low-skilled (i.e. their relative capital-labour ratio) and their relative wage (Caselli, 1999) ([62]). When labour

([59]) The correlation coefficient is significant until 1988. Since then it is never significantly different from zero.

([60]) However, in this case the correlation is statistically significant throughout the mid-1990s.

([61]) This may happen because production is concentrated on non-improving technologies or workers need time to get acquainted with or trained for the new technology.

([62]) Caselli, F (1999), "Technological Revolutions" *American Economic Review, March* explores the interaction between skills upgrading and technological progress. In a model of general purpose technological progress, individuals with low-learning costs start to use immediately the new technology

market institutions, motivated by distributional concerns, cause wage compression, the adjustment in the capital labour-ratio of individuals with high learning costs is achieved through lower employment. Hence, high productivity growth would go along with low employment growth and a negative correlation will appear during the period of adoption and diffusion of new technologies.

The introduction of general purpose technology has also been invoked to explain how the interaction between technological adoption and technological opportunities may change the determinants of labour productivity differences in cross-country growth regressions. This interaction may create growth cycles with periods dominated by income divergence and trade-off between employment and productivity growth followed by periods with convergence and no trade-off (Beaudry and Collard, 2002). Hence there is a medium-run dynamics that explain the time instability in the cross-country relationship between productivity growth and employment and labour force growth found in the literature (e.g. Beaudry et al 2002, 2003, 2005 and Cavelaars, 2003).

It is a stylised fact that over the period of the information technology revolution, countries with higher growth of the population experience a higher rate of adoption of new technologies, a better performance in terms of employment but worse in terms of wages. Some have argued that the interaction between technological change and demographic factors can explain the observed pattern. Beaudry, Collard and Green, (2005) contend that the differences in productivity growth observed between industrialised countries are related to differences in the rate of transition towards new technologies, which are endogenously determined by the relative supply of labour input. The introduction of a new technology triggers a temporary drop in productivity because it takes time to learn the new way of production. Thus more people are on training and output and productivity drop. In addition, since the rental rate of the capital produced with the old technology is lower than in the new technology there are few incentives to invest in the old capital which only depreciates, further reinforcing the productivity losses due to learning. Hence, when a new technology is introduced, economies with a relative high growth of the labour force allocate more people to training. The more rapid increase of the population raises the rate at which the old technology capital-labour ratio declines, which implies faster decline in productivity growth. Thus, the incentives to substitute old with new technologies are stronger in high population growth economies. By the same token, countries with high growth of the population are first in adopting new technologies and experiencing a decline in labour productivity growth during the adoption phase.

A negative relationship between employment and productivity may also take place as a result of changes in the structure of employment by level of education and skills not associated to increases in the average productivity per unit of skills. Given that the low-skilled are over-represented among the unemployed and the inactive, a move towards full employment is likely to entail job creation for relatively low-productivity workers. Indeed, part of the recent increase in employment has occurred in the traditional service industries. In the past at least, some of these sectors have been characterised by relatively low productivity growth, though of course many services are high-productivity activities and moreover serve as inputs into other sectors with high productivity growth. Besides, the larger service sector in the US has not precluded high productivity growth there.

Efforts to improve the quality of work, in particular through investment in human capital will therefore also be an aspect of the productivity challenge. However, even if governments can successfully upgrade the skills of part of this group, it is unrealistic to suggest that this is the source of the solution for the group as a whole. Large numbers of low-skilled jobs will continue to exist, with clear benefits for society that such workers are actively engaged in the EU's job market. Manifestly, it is not by keeping a large share of the working-age population jobless that the EU will improve its overall productive potential.

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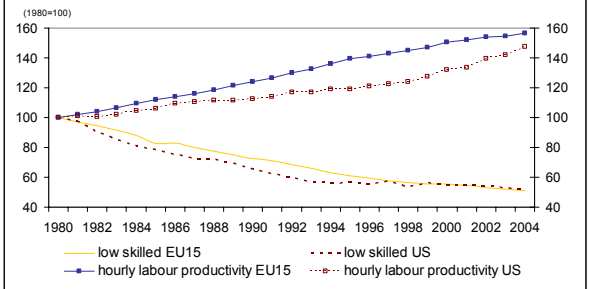
while those with high costs of learning remain attached to the low-technology industry. After the introduction of a new GPT, the fraction of the labour force that remains unskilled can be employed only in the old technology industries. Since both new and old technologies co-exist, in equilibrium the rental price of the new technologies should be equal. Since there is technological progress, the capital labour ratio for the old and the new technologies should differ, otherwise the new technologies would enjoy higher labour productivity and higher returns. Because of lower capital labour ratio and lower productivity high-learning costs workers experience a decline in their wages.

While appealing to account for the decline in productivity growth due to marginal reforms ([63]) (i.e. over short time-horizons), this explanation is less valid to account in the medium for the negative relationship between employment and productivity growth. As suggested by Graph 3.4.7, the hours worked by low-skilled as a share of total hours worked have been declining both in the EU and in the US since 1980. In the US, this share stabilised around the mid 1990s (i.e. the low skilled labour input grew by as much as total hours worked), yet hourly productivity accelerated. In contrast, productivity growth declined in Europe while the total hours worked by low skilled continued to fall.

Graph 3.4.7: **Hourly labour productivity and hours worked by low skilled: share in total hours**



Source: Commission services.

What can be inferred from this is that during technological transitions, the costs of equipping workers with the new technology may not be profitable. This implies a stronger employment-productivity trade-off with actual labour productivity growth varying around the balanced growth path owing to capital-labour substitution. Out of this transition phase (i.e. in the long run), technical progress determines productivity growth while the substitution between capital and labour is less binding.

4.2. Measuring the employment-productivity trade-off

The evidence above based on a simple correlation between employment and productivity growth is only sketchy and not informative of the direction of causality from employment to productivity growth.

([63]) See section 3 for a discussion and fresh empirical evidence of this effect.

To shed more light on this relationship and further explore its stability overtime, a simple econometric test is carried out to verify how strong the employment-productivity trade-off is. The starting point is the Solow-Swan model which predicts a negative relationship between the growth rate of output-per-worker and its initial level. Countries lagging behind have higher returns to capital and, under the assumption of freely mobile capital, can adopt technologies of the most developed countries. This implies that low income countries grow faster than high income countries. Thus, some insight in the relationship between productivity growth and employment growth can be obtained from simple regression relating the productivity growth to the initial level of output-per-worker augmented with the growth of either the labour force or employment ([64]). The estimates are based on a cross section of the EU15 Member States.

Because of the instability in the relationship reported above, the cross-country growth regression is estimated over a ten years window which shifts over time starting from the 1960-1970 period until the 1996-2006 period. In symbols the following equation is estimated:

$$\Delta_{10}\frac{Y_{it}}{N_{it}} = -\alpha_{1,t}\log\left(\frac{Y_{it}}{N_{it}}\right) + \alpha_{21,t}\Delta_{10}Z_{it} + \varepsilon_{it+10} \text{ for } t = 1960...1996$$

where: Z is the size of the labour force or of employment; the initial level of output-per-capita is in PPPs and the average growth rate is $\Delta_{10}\frac{Y_{it}}{N_{it}} = \left(\log\left(\frac{Y_{it+10}}{N_{it+10}}\right) - \log\left(\frac{Y_{it}}{N_{it}}\right)\right)/10$

This expression exploits the cross-country heterogeneity in the relationship between employment and productivity. It tells how much of differences in the employment growth across countries are reflected in the productivity growth differential across countries. Thus, by looking at how this relationship evolves over time, it is possible to detect the scale of the trade-off in cross country comparisons. However,

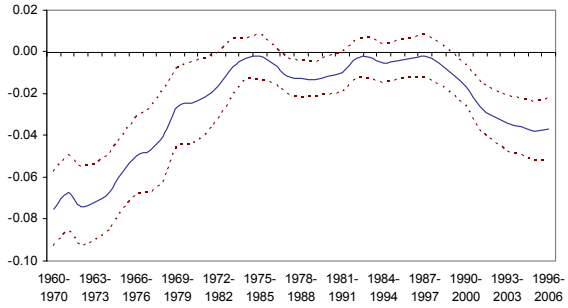
([64]) This approach has been applied on industrialised countries by Beaudry and Collard (2002) "Why has the employment-productivity tradeoff among industrialised countries been so strong?" NBER Working Paper 8754. For an application to OECD countries, Cavelaars, Paul (2005), "Has the trade-off between productivity gains and job growth disappeared?", Kyklos, 58 (1), pp. 45-64.

it is not informative of how for any specific country the relationship between productivity and employment growth developed over time.

With this caveat in mind, Graphs 3.4.9 and 3.4.10 report the response of productivity growth to a 1% increase in respectively the employment and labour force growth. Graphs 3.4.8 and 3.4.11 display the speed of convergence. As is well known, at the beginning of the sample period, in the 1970s, there was rapid convergence between the EU15 member States' output per worker, which gradually diminished over time, and it was statistically insignificant throughout the 1980s. The speed of convergence picked up again in the 1990s and stabilised around 4% in the 1996-2006 period, with no major difference between the growth regression augmented with the employment or the labour force growth.

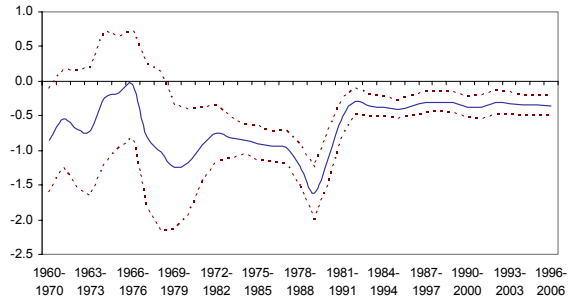
Contrary to what found for the speed of convergence, employment growth and labour force growth have until the 1980s an increasingly negative effect on productivity growth. However, the elasticity declined over time and stabilised around the mid 1980 respectively at about 0.3 and 0.5. Thus, a country with a growth of employment or labour force around 1% would experience a decline in productivity respectively by 0.3% and 0.5% per-year less than a country with lower growth of employment and labour force ([65]).

Graph 3.4.8: **Speed of convergence controlling for employment growth (rolling regression over 10-years window)**



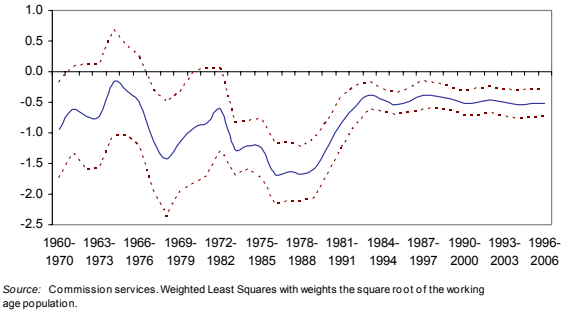
Source: Commission services. Weighted Least Squares with weights the square root of the working age population.

Graph 3.4.9: **Effect of 1% employment growth on yearly productivity (rolling regression over 10-years window)**



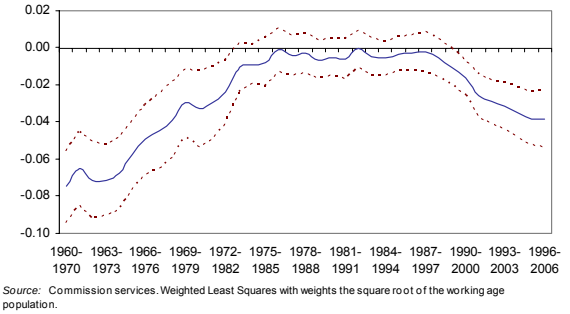
Source: Commission services. Weighted Least Squares with weights the square root of the working age population.

Graph 3.4.10: **Effect of 1% labour force growth on yearly productivity (rolling regression over 10-years window)**



Source: Commission services. Weighted Least Squares with weights the square root of the working age population.

Graph 3.4.11: **Speed of convergence controlling for labour force growth (rolling regression over 10-years window)**



Source: Commission services. Weighted Least Squares with weights the square root of the working age population.

To get a better gauge of the time at which the trade-off started to decline, Graphs 3.4.12 and 3.4.13 show the cumulative effect of a 1% (cross-country) difference in the labour force or in the employment

([65]) These findings are consistent with the results of Beaudry and Collard (2002) that apply to a sample of industrialised countries the same methodology, but with a 18-years window starting from 1960 until 1997.

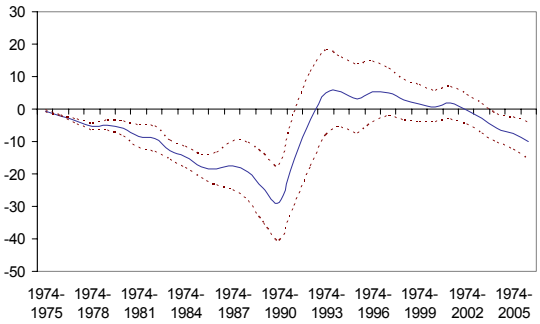
growth on labour productivity ([66]). A sequence of growth regressions was estimated whereby the dependent variable is growth rate between 1974 and a year t where t is changing over time from 1975 to 2006; explanatory variables are the (log) level of productivity in PPS at time t and the growth rate of employment (labour force) is calculated as the growth rate of productivity. In symbols,

$$\frac{\log y_{it} - \log(y_{i,1974})}{t-1974} = -\alpha_{1,t}\log(y_{i1974}) + \alpha_{21,t}\frac{\log Z_{it} - \log(Z_{i,1974})}{t-1974} + \varepsilon_{it}$$

$$\text{for } t = 1975...2006$$

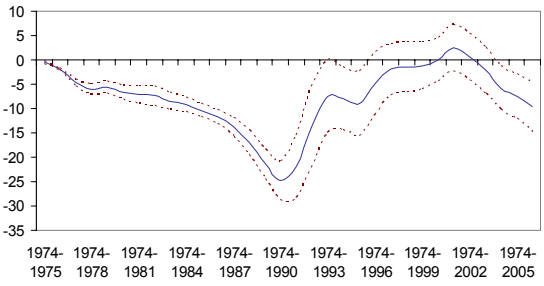
Thus Graph 3.4.6 shows the effect of employment (labour force) on productivity growth as we move forward from 1974. The effect on productivity growth was clearly small at the beginning of the sample and increases until 1990. The point estimate tells that a country with 1% growth of employment over the 1974-1990 period experienced a up to 25% less productivity growth than a country with zero employment growth ([67]). Subsequently, the negative effect of employment and labour force growth declined, implying that, compared to the previous periods, countries with faster growth of employment have faster productivity growth than countries with slower employment growth. From the mid 1990s until 2003 the point estimate of the coefficient turned out to be small and statistically insignificant (i.e. no-effect of employment growth on productivity growth. In the recent years that there seems to be a reversal, but consistently with what already found, the trader-off appears less binding compared to the years of intense job destructions and high productivity growth that followed the supply shocks of the early 1970s and 1980s.

Graph 3.4.12: **Cumulative effect of a 1% labour force growth on labour productivity growth**



Source: Commission services. Confidence interval are calculated from the coefficients +- one standard error.

Graph 3.4.13: **Cumulative effect of a 1% employment growth on labour productivity growth**



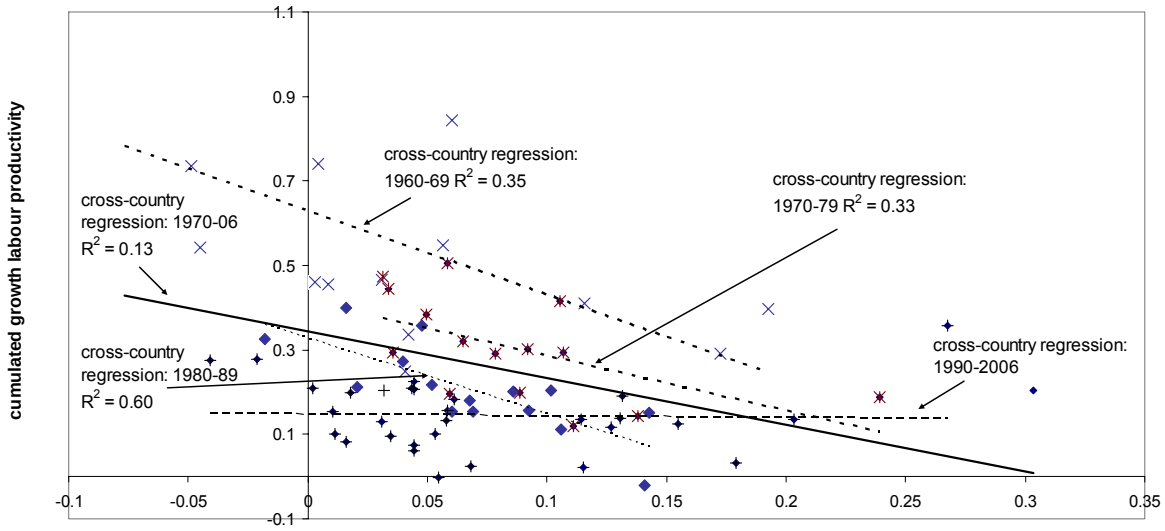
Source: Commission services. Confidence interval are calculated from the coefficients +- one standard error.

Thus, the trade-off between employment and productivity was stronger in the late 1970s and in 1980s but it vanished over time. This conclusion is also supported by the simple scatter plot reported in Graph 3.4.14.

([66]) We follow the same estimating procedure used by Beaudry, P. F. Collard and D.A. Green (2005), "Demographics and recent productivity performance: insights from cross-country comparisons.

([67]) Beaudry et al. find for a panel of 17 OECD countries that over the period 1975 to 1990 a 1% rate of population (15-64) growth is associated with a 10% less productivity growth.

Graph 3.4.14: **Employment and productivity trade-off: an unstable relationship**



Source: Commission services.

Horizontal axis stands for the cumulated growth rate and the vertical axis the cumulated growth of labour productivity. The dark solid line shows the negative relationship between employment and productivity calculated over the entire sample (i.e. from 1960 to 2006), while the dotted lines display the same relationship over different sub-periods. There was a clear trade-off in the 1960s, in the 1970s and, especially, in the 1980s but not in the 1990s.

The evidence based on the scatter plot contrasts with the findings of the rolling growth regressions. It is possible that the chosen window of ten years is too small and captures cyclical developments (i.e. a temporary trade-off) rather than a medium- to long-term negative relationship (i.e. a genuine substitution between employment and productivity growth). To test whether the negative influence of employment and productivity found with the growth regression reflect this genuine trade-off, the regression was repeated over the period 1990-2006 (i.e. over a window of 16 years). Table 3.4.1 suggests that the negative relationship does not survive to the simple extension by six further years of the window, implying that the trade-off is due only to short-term factors. Obviously the above regressions do not tell anything about the factors that have led to the disappearance of the employment-productivity trade-off over time. Since the mid-1990s the EU has been experiencing a trend change in labour input (i.e. in terms of total hours worked), while in previous decades its growth rate was negative on average.

Table 3.4.1

Cross-country growth regression controlling for employment and labour force growth

	1990-2006		1996-2006	
Initial output per capita	-0.024	-0.025	-0.040	-0.040
	(0.013)	(0.014)	(0.015)	(0.015)
Employment growth	-0.190		-0.350	
	(0.18)		(0.15)	
Labour force growth		-0.080		-0.510
		(0.21)		(2.31)

Source: Commission services. Standard error in parenthesis; Weighted Least Squares with weights the square root of the working age population.

A number of commentators have suggested that this positive change in employment trend, driven by a reform induced boost to labour supply and by wage restraint, could be responsible for the deterioration in productivity trends. Under this interpretation, recent productivity developments could be judged as healthy, with slower wage growth leading to a temporary decline in the capital-labour ratio. Once full employment is reached, wage and productivity growth could accelerate again and the economy could go back to a higher growth rate of labour productivity at a higher level of employment.

An alternative more pessimistic view regards the labour market story as incomplete. According to this view, the productivity slowdown is a continuation of the previous adverse productivity trends, either in the form of a decline in the growth rate of TFP or in the form of a positive shock to capital productivity, with the latter shock induced by higher required rates of return for investors. The recent increase in employment simply had an additional temporary, negative, effect on productivity. A trend decline in TFP could be due to a further increase in the size of the service sector; a reduction in the quality of labour as more low skilled workers are brought into the labour force; a reduction in the quality of matches between unemployed and vacancies as more low productivity entry-level jobs are created (Blanchard and Landier, 2001); and/or a trend decline in technological advances in traditional manufacturing industries. Also with globalisation and increased international capital mobility, the higher returns which can be earned outside Europe may exert pressure on capital productivity. Both developments could explain why capital-labour substitution declined.

Evidence on the employment induced fall in labour productivity at the sectoral level can be gained from the EU KLEMS database. Respectively for the total industries, manufacturing and for market services, Graphs 3.4.15-3.4.23 show on the horizontal axis the change between the average growth rates of the total hours worked in periods 1996-2004 and 1985-1995. On the vertical axis it is shown the change between the average growth rate of the same periods of the hourly productivity (3.4.15), of the capital labour substitution (3.4.16), and of TFP (3.4.17). Hence the focus is on the acceleration of productivity and employment over before and after 1996.

Although not very strong, there is indeed a link between changes in labour input and changes in productivity growth. However, there are interesting differences between labour input growth and TFP on the one hand and labour input growth and capital services growth on the other. In the case of labour market reforms that change temporarily the capital labour ration, we would expect the latter relationship to be stronger. This is indeed is what is shown in the Graphs for all sectors and services. For the total industries and for the private services between 25% and 35% of the overall decline in productivity growth could be explained via the capital-labour substitution channel ([68]). In contrast, for manufacturing the capital-labour substitution explains less than 5% of the trade-off ([69]). This finding suggests that wage moderation has contributed to the increase in employment in services while it may have avoided further declines in industry.

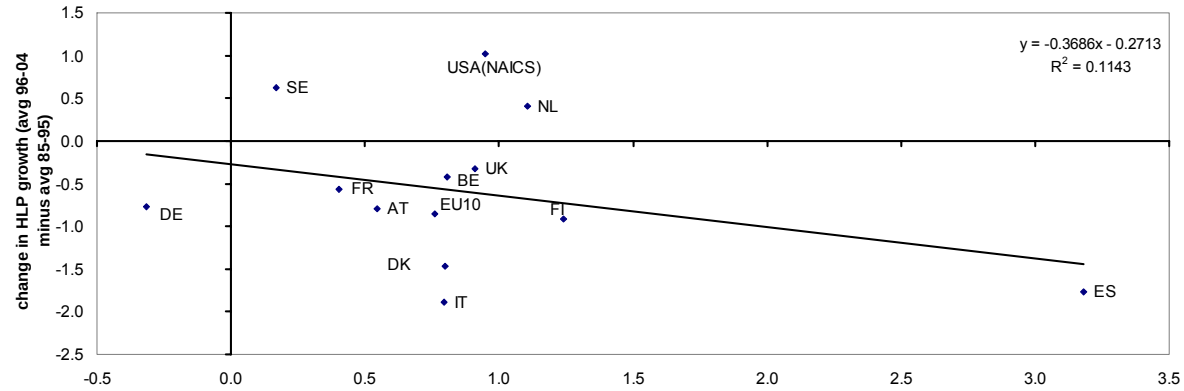
Regarding the relationship between hours worked and TFP, apart from some evidence of a link for the manufacturing sector, the remaining Graphs suggest that trends for both variables are largely unrelated. These findings are consistent with the theoretical prediction of the neoclassical growth model, which predict a temporary decline in productivity via lower capital/labour substitution over the adjustment period to a higher labour content of growth. In contrast, similar short run links between the labour input and TFP are less supported in the literature, although they can occur due to, for example, sectoral output shifts or to the integration of low skilled workers into the workforce.

In overall terms therefore, whilst the analysis suggests that there are negative trade-offs between EU labour market and labour productivity trends since the mid-1990s, it would appear, on the basis of a number of different estimation approaches, that only between 10-40% of the decline in productivity can be associated with this phenomenon. Consequently, alternative explanations must be explored to understand a large fraction of the decline in productivity, with factors such as the role played by information and communication technologies (ICT) and the overall structure of production in the Member States needing to be examined.

([68]) Contributions of employment to productivity of this order of magnitude can also be obtained using alternative methods. For example, an earlier VAR decomposition for the euro area (Dennis et al., 2005) suggested that the increase in hours worked could explain only about 10% of the decline in productivity, whilst model simulations using DG ECFIN's macroeconomic model QUESTII suggested an employment related decline in productivity of 35%.

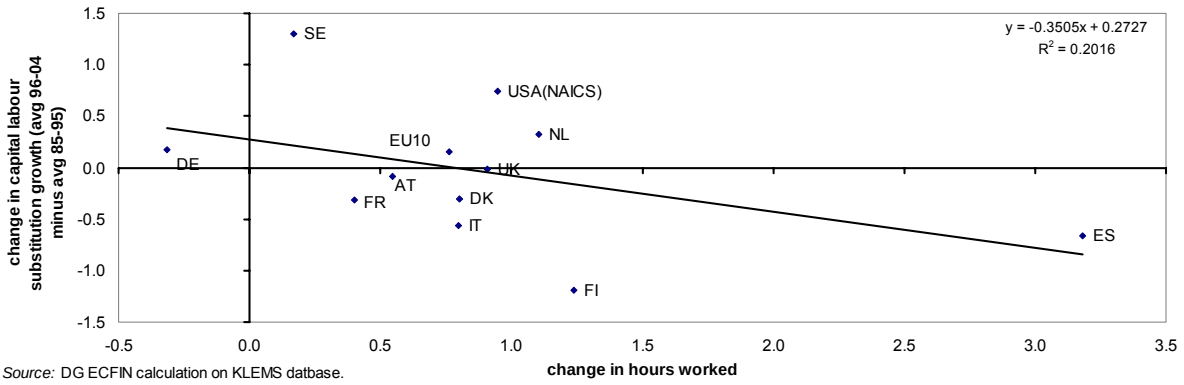
([69]) These findings are robust to the exclusion of Spain from the sample. In the case of Private services, with the exclusion of Spain the capital-labour substitution explains about 50% of total change in productivity growth in the two periods, while the change in the labour input growth accounts only for 9%. For the manufacturing, the exclusion of Spain form the sample implies that the hourly productivity is unrelated with the capital-labour substitution while the labour input growth accounts only for 8% of the change in productivity growth.

Graph 3.4.15: **Employment productivity trade-off: all sectors – change in HLP growth (avg 96-04 minus avg 85-95)**



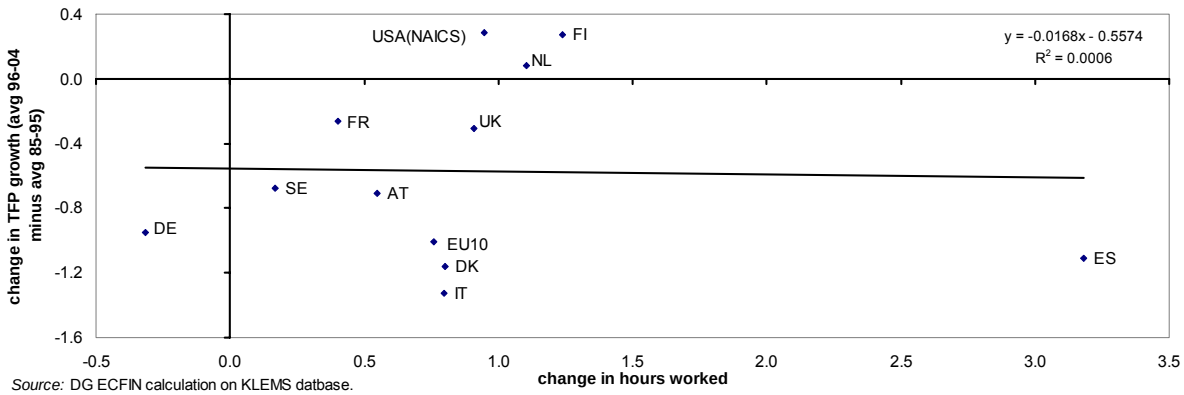
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.16: **Employment productivity trade-off: all sectors – change in capital labour substitution growth (avg 96-04 minus avg 85-95)**



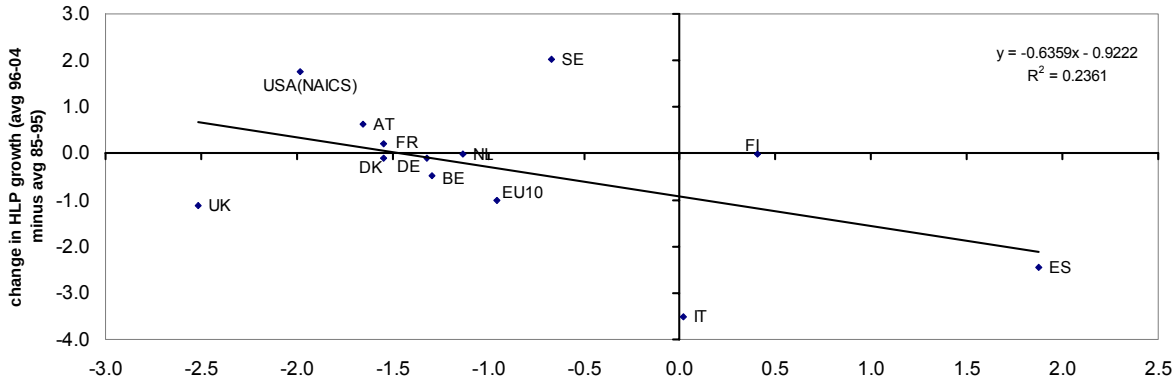
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.17: **Employment productivity trade-off: all sectors – change in TFP growth (avg 96-04 minus avg 85-95)**



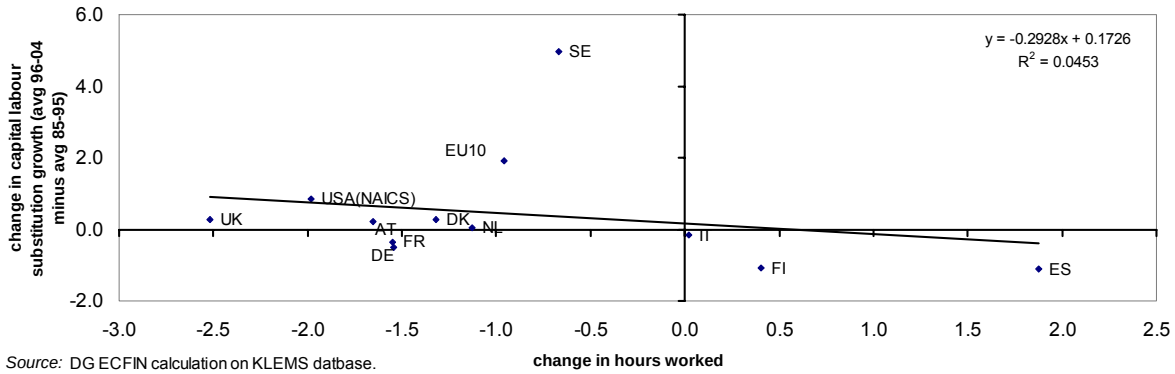
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.18: **Employment productivity trade-off: manufacturing – change in HLP growth (avg 96-04 minus avg 85-95)**



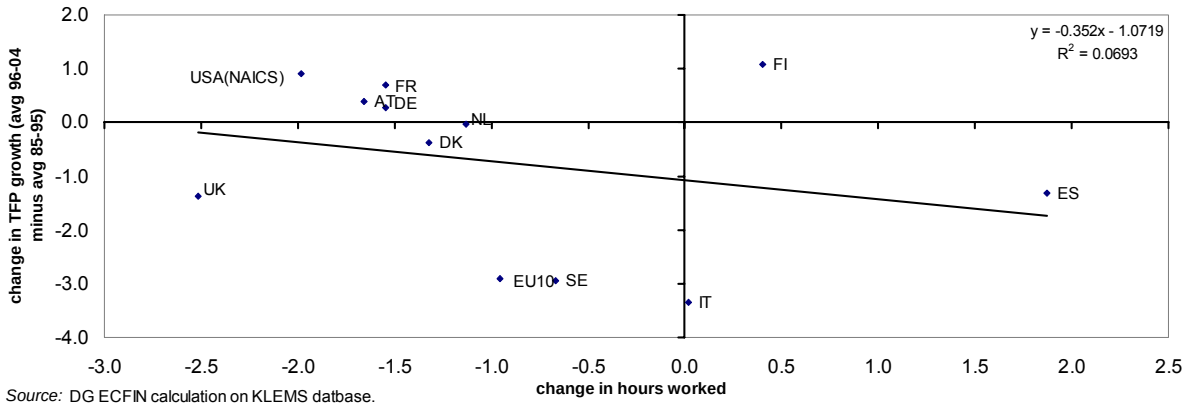
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.19: **Employment productivity trade-off: manufacturing – change in capital labour substitution growth (avg 96-04 minus avg 85-95)**



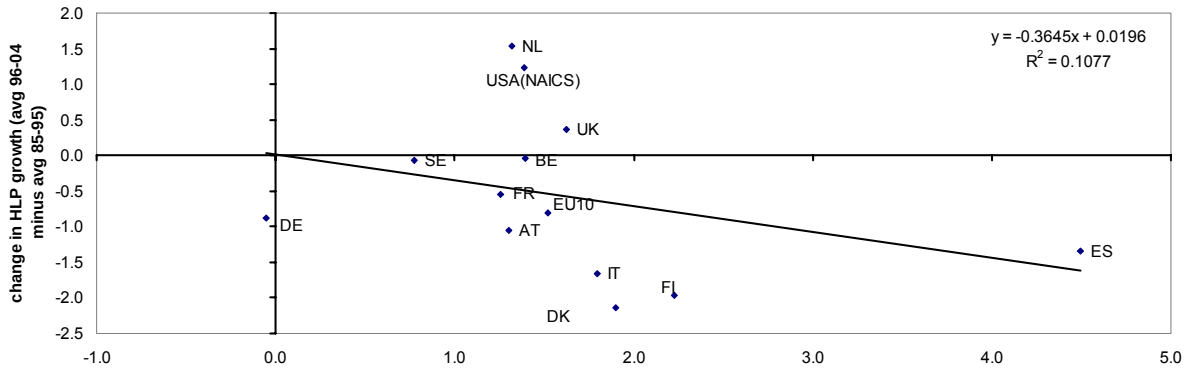
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.20: **Employment productivity trade-off: manufacturing – change in TFP growth (avg 96-04 minus avg 85-95)**



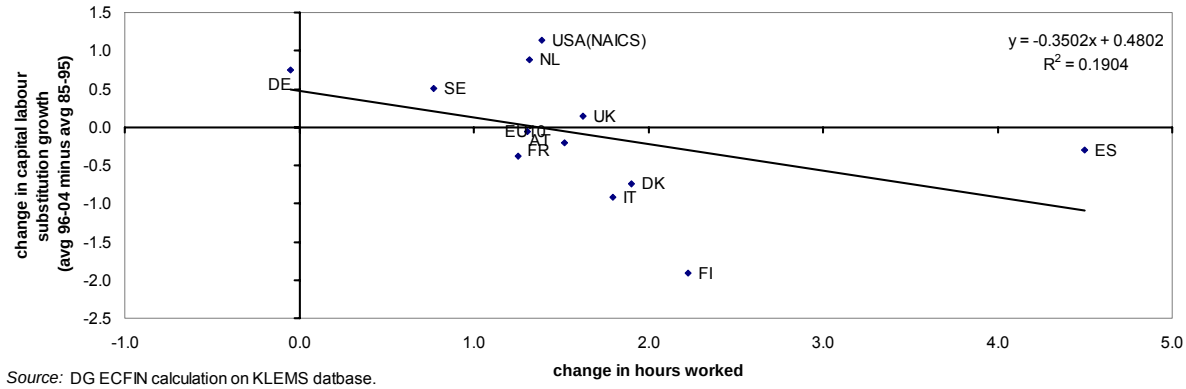
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.21: **Employment productivity trade-off: private services – change in HLP growth (avg 96-04 minus avg 85-95)**



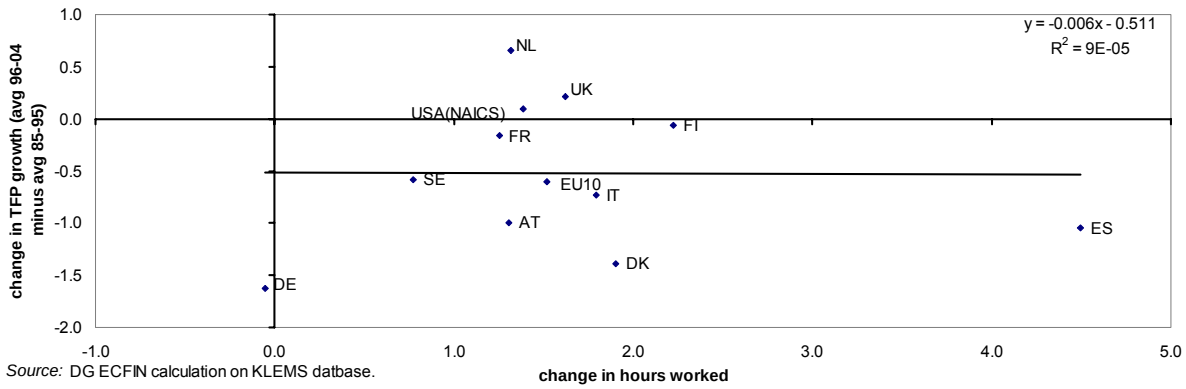
Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.22: **Employment productivity trade-off: private services – change in capital labour substitution growth (avg 96-04 minus avg 85-95)**



Source: DG ECFIN calculation on KLEMS datbase.

Graph 3.4.23: **Employment productivity trade-off: private services – change in TFP growth (avg 96-04 minus avg 85-95)**



Source: DG ECFIN calculation on KLEMS datbase.

4.3. The role of labour market reforms in boosting employment and productivity growth

Labour and product market reforms can of course influence the economic activity. Structural reforms on goods and labour markets affect labour supply and productivity indirectly. For example, goods market reforms which reduce entry barriers and increase competition will lead to an increase in both employment and capital formation. Because they increase both capital and employment, they tend to be fairly neutral with respect to productivity. In contrast, the employment effect can be negative, at least temporarily, when reforms reduce excess employment in certain industries (e.g. in government enterprises).

With regard to labour market reforms, two different though interconnected perspectives may be distinguished. an employment-enhancing channel and a productivity-enhancing channel. In the firstly channel, employment-friendly institutional arrangements provide stronger incentives to participate in the labour market, break down insider-outsider barriers and reduce structural unemployment, basically by lowering the mark-up of wages over the reservation wage. The main expected impact is on employment. There might be an additional negative effect on productivity because of the higher employment of low skilled workers. On the other hand, one would expect a more flexible labour market to improve resource allocation by facilitating the entry of new firms and speeding up the exit of unproductive firms.

In the productivity-enhancing channel better working labour markets reduce search and matching frictions and allow for an efficient (re-)allocation of labour and increase human or physical capital accumulation, thus raising growth and real incomes, as well as employment. Organisational changes in the work process and new forms of work organisation may contribute to improving the matching between labour and capital, especially where new technologies are concerned, and may thus have a positive impact on productivity growth. Box 3.4.1 below gives a description of the possible reforms that may improve the functioning of the labour market, with Table 3.4.2 providing a quick summary of the key points.

Table 3.4.2

Relationship between employment and productivity growth

	Long run effect	Short to medium run effect
	Stylised structural reform shocks (standard results)	
Product market reforms:		
a) pure decrease in the price mark-up	a) and b): Increase in employment and capital formation, but broadly neutral with respect to productivity.	a) positive employment effects / no change in productivity.
b) decrease in the price mark-up combined with efficiency gains		b) negative for employment and positive for productivity in the case of stronger efficiency gains.
c) strengthening of innovative capacity and dynamic efficiency	c) similar to a positive technology shock	c) similar to a positive technology shock
Labour market reforms:		
a) a positive shift of the labour supply curve, for example via a reduction of wage mark-ups or higher participation rates	a) Increase in employment and capital formation, but broadly neutral with respect to productivity.	a) positive for employment and negative for productivity.
b) a positive shift of the labour demand curve, for example via a reduction of adjustment rigidities	b) Some additional long-run productivity gains possible	b) positive employment and productivity effects.

Box 3.4.1: **The effects of product and labour market reforms on the relationship between productivity and employment**

Without being exhaustive, reforms aiming at improving the labour market performance entail

- Changes in the tax and benefit systems to make work pay that enhance the financial incentives to take up a job or to seek a more productive one. These reforms aim to reduce unemployment and poverty traps by reducing marginal effective tax rates (i.e. the combined incentive effect of taxes and benefits), and to strengthen the administration of benefit systems (eligibility criteria, enforcement of job-search requirements, etc.). Targeted reductions in the tax burden on labour may stimulate the demand for labour, especially for those groups with low labour market attachment.

- Cost-effective active labour market policies (ALMPs). Empirical evidence suggests that the longer people remain unemployed or inactive, the more detached they become and the harder it is for them to find a productive job. The resulting long-term unemployment and inactivity are an important cause of low employment rates. ALMPs are designed to improve people's employability and re-attach them to the labour market. While some of the evaluations of ALMPs have been disappointing, reforms in this area seek to improve efficiency, for example by integrating them better with 'making work pay' policies.

- A modernisation of work organisation including flexible work arrangements. To stimulate labour supply (in persons), many countries have introduced more flexible working arrangements – including part-time contracts, more flexible working time-schedule. Others have implemented asymmetric labour market reforms (i.e. reforms that have changed the regulation only for part of the eligible population, namely for the most disenfranchised groups). Reforming overly restrictive elements of employment legislation may help to improve the functioning of the labour market and facilitate productivity-enhancing adjustment.

- Efforts to encourage geographical and occupational labour mobility. Better labour mobility could reduce search and matching frictions in the labour market, thus improving employment performance. Reforms such as mutual recognition of diplomas, assistance with the costs of seeking work in another region, improved information on job vacancies in other EU countries and transferability of pensions and social security rights may be considered as improving labour mobility.

- Efforts to make collective bargaining systems more employment-friendly. Bargaining influence labour market through the overall wage determination and through the differentiation of wages according to productivity. Wage moderation has played an important role in the last decade, in particular by stimulating employment-friendly substitution of labour for capital. However, aggregate wage moderation through centralised wage bargaining may have reduced the margins of adjustment of relative wages to productivity differentials at the sectoral and at the local level. In addition, wage compression may reduce individual incentives to invest in human capital and to participate in training. This effect could be partly offset by the incentives for firms to finance general training, since if wages do not fully reflect productivity they are able to appropriate part of the benefits.

Efforts to enhance human capital formation and training. The development of human knowledge and competencies remains central to equipping workers with the tools required in a modern economy. By making the workforce more productive and by enabling greater flexibility in adapting to technological and organisational change, the formation of human capital remains a crucial determinant of productivity growth. By improving the employability of certain groups of workers, such as the low-skilled and older workers, investment in human capital could also make a significant contribution to raising the employment rate.

Labour market policies and institutions may influence employment and average labour productivity through a number of complex channels which will not be analysed in this chapter ([70]). For the purpose of our analysis, it is however useful to remind that labour market policies may influence labour productivity in three different ways. Firstly, they can influence directly firms' hiring or individuals' participation decisions (i.e. compositional effects that change the aggregate capital-labour ratio or the composition by skills of the labour force) ([71]). Secondly, labour market policies can modify the quality of the labour input ([72]) or of the matches between job vacancies and unemployed people, with indirect effect on productivity. Thirdly, they labour market policies modify the aptitude of firms to undertake risky activities in highly productive sectors ([73]).

Of course, the final impact on productivity and employment growth will depend on the design of the specific policy measures, and further potential benefits are likely to be available in the case of well-designed, comprehensive package of reforms. In addition, reforms of the labour market aiming at increasing its flexibility are only gradually implemented over time through a series of incremental measures. The above mentioned elements make the evaluation of these reforms more uncertain.

With this caveat in mind, this section provides estimates on the possible quantitative effects on GDP and unemployment of certain concrete reform measures, which have already been undertaken (and were we can already observe positive outcomes). Since the late 1990s, many studies have tried to explain the dynamics of the unemployment rates in industrialised countries (increasing until the 1995 and gradually decreasing thereafter). In a popular paper, Blanchard and Wolfers (2000) argued that labour market institutions alone cannot explain the high unemployment rates as many of these institutions where already present when unemployment was low ([74]). They argue that the interaction between common shocks (e.g. a decrease in the rate of technological progress) and country specific institutions explain the differences in the unemployment rates observed for several European countries after the shocks of the early 1970s and 1980s ([75]). Nickell et al. (2005) extended the analysis looking at how labour market institutions themselves influence equilibrium unemployment ([76]). For the

([70]) A recent review can be found in OECD (2007) , "More jobs but less productive: The impact of labour market policies on productivity" Employment Outlook.

([71]) For example, when the tax and benefits system puts a wedge between labour demand and labour supply, the decline in employment is accompanied by an increase in average productivity.

([72]) For example, unconditional unemployment benefits create unemployment traps that increase the duration of unemployment and cause skills' deterioration, ultimately influencing negatively the level of labour productivity. However, generous unemployment compensation may reduce people uncertainty and make them to take more risky and productive decisions. Similarly, a binding (i.e. too high) minimum wage may reduce the demand for low skilled relative to high skilled, raising average productivity. However, a high level of the minimum wage compress the wag e distribution from below and reduce workers' incentives to acquire skills and invest in training.

([73]) It is well known that the effect of tight employment protection legislation on the average employment is both theoretically (e.g. Bentolila and Bertola, 1990. "Firing costs and labour demand: how bad is the eurosclerosis" Review of Economic Studies 57, pp. 381-402) and empirically (e.g. Nickell, S.J.,L. Nunziata and W. Ochel, 2005. "Unemployment in the OECD since the 19960s: What do we know?" Economic Journal 115(500), pp 01-27) uncertain. Yet, there is by now some agreement that the tightness of the labour market regulation influences the reallocation of labour from low- to high-productivity industries (Hopenhayn and Rogerson, 1993). In addition, by reducing the employment chances of outsiders, namely young people, older workers and women (Bertola Blau and Kahn, 2005), thigh EPL causes a greater loss of their human capital However, stringent EPL may increase their tenure on the job and improve their as well as firms' incentives to invest in job-specific skills and training with positive effects on workers' efficiency and productivity (Belot, Boone and Van Ours, 2002). In this case EPL stabilises jobs for the insider making them to accumulate human capital which should increase productivity also because it reduces the employment chances for the outsider inducing capital deepening (again only for the insiders).

([74]) Based on a detailed reading of legislation through history, Allard and Lindert (2006) challenge this view showing that strict EPL and generous unemployment benefits were presented only few years before the shocks of the early 1970s. Rather strict EPL and generous unemployment benefits antedate poorer macro-economic performance by few years. .G.J. Allard and P.H.Lindert (2006), "Euro-productivity and Euro-jobs since the 1960s: which institutions really mattered?", WP 12460 NBER.

([75]) For example, when large negative shocks occur, the availability of open-ended unemployment benefits hinder the structural adjustment of the economy, leading to deterioration of workers' skills (Ljunqvist and Sargent, 1999), long-term unemployment, non employability, and longer lasting effects of the shocks.

([76]) A survey of the literature on labour market institutions and labour market performance can be found in Arpaia, A and G. Mourre (2005) " Labour Market Institutions and Labour

revised Jobs Strategy, the OECD has conducted an extensive research on the impact of policies and institutions on employment and unemployment in the OECD countries ([77]).

This section uses simulations from DG ECFIN macroeconomic model QUEST II (see Box 3.4.2) to quantify the effect of policy changes on unemployment and GDP for individual EU Member States. Table 3.4.3 describes changes in the OECD indicators on labour market institutions between 1995 and 2003. The unemployment benefit replacement rate ([78]) has on average increased in the EU. There are some outliers for Ireland, Italy and Denmark. At an aggregate macroeconomic level it appears therefore that there have been increases in benefit generosity in some countries ([79]). The tax wedge measure applied here is derived from National Accounts and covers both labour and consumption taxes ([80]). On aggregate there has been a reduction in the tax wedge in the EU, a small increase in labour taxes more than compensated for by a reduction in consumption taxes.

Table 3.4.3

Changes in labour market variables

	Average replacement rate	Tax wedge (NA)	Labour tax rates (NA)	Cons. tax rates (NA)
Austria	-1.0	1.7	1.2	0.6
Belgium	3.4	0.2	0.9	-0.6
Germany	0.9	-1.6	-1.0	-0.6
Denmark	-15.4	3.1	1.4	1.8
Spain	-4.7	2.0	0.6	1.4
Finland	-0.2	-1.8	-2.2	0.3
France	2.0	-1.2	-0.1	-1.1
UK	-1.4	0.0	1.6	-1.6
Ireland	11.8	-6.8	1.3	-8.2
Italy	14.4	0.4	2.2	-1.8
Netherlands	0.0	-4.5	-5.7	1.2
Portugal	5.4	0.0	0.6	-0.6
Sweden	-2.4	0.2	1.1	-1.0
EU unweighted average	1.0	-0.6	0.1	-0.8
EU weighted average	1.8	-0.5	0.2	-0.7

Source: Commission services. Database OECD (see Bassanini and Duval (2006), OECD Working Paper 486); changes 2003-1995.

To capture the employment effects of product market regulations, Bassanini and Duval (2006) include the OECD PMR indicator in their regression. This indicator measures regulatory impediments to product market competition in seven non-manufacturing industries (energy and service industries). We use information from Griffith and Harrison (2004) to establish a link between mark-ups and the indicator measuring the ease of starting a new business and price controls only. According to these calculations, average mark-ups in the EU15 have declined by 1.3 percentage points ([81]). Mark-ups have fallen most in Sweden, the UK and Austria, France and Germany.

Market Performance A survey of the Literature" Economic Paper No. 238.

([77]) Bassanini, A. and R. Duval (2006), "Employment Patterns in OECD Countries: Reassessing the Role of Policies and Institutions", OECD Economics Department Working Papers, No. 486, OECD. With the help of cross-country/time series techniques, this work has explored the impact of structural policies and labour market institutions on the unemployment and employment rate, the latter disaggregated by main age groups. Through a comprehensive evaluation in terms of coverage, time span and robustness checks of labour market institutions, the study looks at the role played by the generosity of the welfare system (replacement rate), labour taxation (tax wedge), labour market institutions (EPL), and product market competition (PMR) and identifies the replacement rate, the tax wedge and PMR among the important determinants of structural unemployment.

([78]) The average unemployment benefit replacement rate is measured across two income situations (100% and 67% of APW earnings), three family situations (single, with dependent spouse, with spouse in work) and three different unemployment durations (1st year, 2nd and 3rd years, and 4th and 5th years of unemployment).

([79]) This measure may not fully reflect significant changes in benefit replacement rates for low earnings and low skilled groups, which have in many countries become less generous and raised employment levels for these groups.

([80]) Although tax measures derived from National Accounts can suffer from endogeneity problems, this should be less of a problem when we take differences between 1995 and 2003. The measure derived from National Accounts is wider than the alternative measure in the OECD database, the labour tax wedge for a single-earner couple, with two children at average earnings levels, which is derived from OECD tax models and captures labour taxes (income taxes and social security contributions) but not consumption taxes.

([81]) The calculated mark-ups have also been rescaled to correct for differences in the mean value of the mark-ups, which are higher in the Griffith&Harrison study than in the QUEST model baseline.

Box 3.4.2: **QUEST II model**

The estimates of the effect of changes in labour market institutions on GDP and unemployment are based on the QUESTII model. This is a typical New Keynesian model which combines neoclassical and Keynesian characteristics. The supply side of the economy is modelled explicitly via a neo-classical production function. However, the model differs from a pure neoclassical growth model by taking product and labour market imperfections into account. Firms are monopolistically competitive and charge a mark-up over marginal cost. Firms equate the marginal revenue product to real factor costs, i.e. they take into account that by expanding output marginal revenue declines. This reduces the demand for labour and capital and the level of GDP compared to an economy operating under perfect competition. Imperfect competition also prevails in the labour market. A bargaining framework is used to describe the interaction between firms and workers/trade unions and wages are set as a mark-up over the reservation wage. Firms and workers share the rents from a successful job match. Market power of (incumbent) workers arises because of search frictions and labour adjustment costs. In the labour market, the level of the reservation wage is also related to policy measures such as labour taxation and social benefits. Labour taxation and unemployment benefits are distortionary since they increase the value of leisure relative to the net return from working and therefore reduce labour supply and increase wages. The model therefore can take account of the factors which have been found to be significant in the recent empirical studies on the determinants of unemployment.

Simulation results

Table 3.4.6 below shows the resulting long run changes in GDP and unemployment for each separately and when all are scenarios combined ([82]). In all cases, the simulations include spillovers from reforms in other EU member states which further enhance growth effects.

The strongest employment effects are generated by product market reforms, explaining a fall of the unemployment rate of 0.7 percentage points. Also reducing taxation has played a crucial role. According to the model, this has led to a decline in the unemployment rate of 0.2 percentage points for the EU15. However, tax reductions have been less universal across Member States. For some countries, the tax indicators point to a negative impact on employment (Denmark, Italy, Austria, Spain, Sweden, UK, Belgium).

On an aggregate macroeconomic level, the unemployment benefit replacement rate has increased on average in the EU, and this leads to an increase in the unemployment rate of 0.3 percentage points for the EU15. As mentioned above, this measure may not fully reflect substantial differences in benefit generosity for different skill levels and hence not properly capture reforms that have taken place.

To be consistent with the observed reduction in the NAIRU, we calculate a shock to the wage mark-up which yields an additional reduction of the structural unemployment rate of 0.5%. This simulation also sheds light on the unemployment productivity trade off implied by wage moderation. As can be seen from Table 3.4.5, increasing employment occurs at the expense of lower productivity. Roughly speaking the QUEST simulation suggests that the elasticity (over the medium run) of productivity with respect to changes in employment is about -0.2.

([82]) Note that there was no data on labour market variables for Greece and hence the results shown are pure spillovers.

Table 3.4.4
Changes in the Fraser Institute Indicators of product market reform and estimated changes in mark-ups

	Change in Fraser Institute Indicators 1995-2003			Estimated change in mark-ups 1995-2003	
Countries:	Starting new business	Price controls	Mean tariff rate	Starting a new business + Price controls	Starting a new business + Price controls + Mean tariff rate
Austria	1.8	0.0	1.1	-0.022	-0.050
Belgium	-0.1	0.0	0.7	0.001	-0.018
Denmark	-0.2	-2.0	1.1	-0.014	-0.042
Finland	-0.9	-1.0	1.1	0.002	-0.026
France	1.1	-1.0	1.1	-0.021	-0.049
Germany	0.2	-2.0	1.1	-0.019	-0.047
Greece	-0.5	-2.0	1.1	-0.010	-0.041
Ireland	-1.6	-4.0	1.1	-0.013	-0.033
Italy	-0.3	-1.0	1.1	-0.005	-0.020
Netherlands	-1.4	-1.0	1.1	0.008	-0.028
Portugal	0.0	0.0	1.1	0.000	-0.022
Spain	-1.2	-1.0	1.1	0.006	-0.063
Sweden	2.3	-1.0	1.1	-0.035	-0.056
United Kingdom	-0.4	-4.0	1.1	-0.027	-0.050
EU15 (average)	-0.03	-1.7	1.05	-0.013	-0.041

Source: Commission services. Gwartney&Lawson (2006). Economic Freedom of the World: 2006 Annual Report. Vancouver: The Fraser Institute (data retrieved from www.freetheworld.com) and estimates based on Griffith&Harrison (2004), "The link between product market reform and macro-economic performance", European Economy Economic Paper 209, Table 9.

On average for the EU15, all scenarios combined yield a reduction in the structural unemployment rate of almost 0.6 percentage points, but for the Euro area only 0.3 percentage points (Table 3.4.7). This falls short off the estimated reduction of the NAIRU of -0.8% points over the same period. This suggests that other policies not accounted for by the reform indicators considered above may have contributed to the decline in the structural unemployment rate ([83]).

Table 3.4.5
Productivity and growth effect of wage moderation

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10
GDP	0.17	0.28	0.34	0.38	0.39	0.44
Labour productivity	0.00	-0.15	-0.19	-0.19	-0.19	-0.18
Unemployment rate	-0.13	-0.32	-0.40	-0.44	-0.45	-0.48

Source: Commission services. QUEST II Model.

These is a similar order of magnitude as reported in the Table, showing results from a cross section analysis and coincide with the upper value of the confidence interval of the estimate based on the rolling growth regression of the previous section ([84]).

As is clear from the tables, not all changes in labour market and product market policies have been favourable. In some member states tax rates and replacement rates have increased and this has a negative impact on employment in the model. Therefore it is interesting to see what the estimated effect of only the favourable changes has been. For that purpose the final column in Table 3.4.6 shows the results of a separate simulation in which all unfavourable changes that went 'in the wrong direction' have been excluded, and this could be interpreted as representing the effects of 'true reforms'. This can be compared to the net effects of all changes in policy variables and the difference can be attributed to 'unfavourable' changes in policies which have partly (or completely) counteracted the positive effects of reforms.

Including only the favourable changes for each of the member states yields much larger positive effects (see final column Table 3.4.6), with the largest gains for Denmark, Ireland and the UK. For the EU15 on average, reforms are estimated to have contributed 2 per cent to output and 1.4 percentage points to the reduction in the structural rate of unemployment. For the euro area the estimated contributions are only slightly smaller, 1.7 percent higher GDP and 1.1 pp. lower NAIRU. Comparing this to the 'net' effects of all policy changes in the previous column shows the extent to which unfavourable policy changes have offset the gains from reforms.

For individual countries, the results mainly reflect the changes in labour and product market set out in Tables 3.4.3 and 3.4.4, For Germany, interestingly, the contribution of these policy changes on unemployment and growth are estimated to have been significant (with reductions in the structural unemployment rate of -1.6 and -1.9 respectively). The estimated effects for Italy and Portugal are the most disappointing.

([83]) Notice that the union density and the OECD EPL indicators have also contributed to a reduction in the unemployment rate, however, they are not significant in the baseline unemployment regression of Bassanini and Duval.

([84]) Note that in Graph 3.4.5 the confidence interval is 1 standard error around the point estimate. Had we chosen the standard 90% two sided confidence interval (i.e. centered around 2 standard errors) the coefficient would have been statistically not significant form zero with the value obtained with the Quest simulations well behind this confidence interval.

Table 3.4.6

Simulated long-run effects of changes in labour and product markets 1995-2003 on GDP and unemployment rate

	Benefit replacement rate		Labour and consumption tax rates (NA)		*Of which: labour taxes*		*Of which: consumption taxes*		Mark-up		All changes combined		Favourable changes only	
	GDP	U	GDP	U	*GDP*	*U*	*GDP*	*U*	GDP	U	GDP	U	GDP	U
BE	-0.52	0.60	-0.07	0.21	*-0.21*	*0.37*	*0.14*	*-0.15*	0.37	-0.20	-0.23	0.62	0.81	-0.53
DK	1.93	-2.75	-0.95	1.34	*-0.62*	*0.86*	*-0.32*	*0.47*	1.63	-0.95	2.61	-2.34	4.00	-3.91
DE	-0.29	0.25	0.55	-0.75	*0.39*	*-0.57*	*0.16*	*-0.18*	1.75	-1.13	2.00	-1.62	2.46	-1.94
GR	-0.06	0.01	0.02	-0.01	*0.01*	*-0.00*	*0.01*	*-0.01*	0.10	0.03	0.06	0.03	0.63	-0.15
ES	0.25	-0.57	-0.21	0.31	*-0.07*	*0.14*	*-0.14*	*0.17*	-0.03	0.11	0.01	-0.16	0.82	-0.62
FR	-0.38	0.38	0.27	-0.30	*0.06*	*-0.05*	*0.22*	*-0.25*	1.72	-0.72	1.61	-0.64	2.10	-1.05
IE	-2.39	3.07	1.07	-1.13	*-0.35*	*0.48*	*1.42*	*-1.61*	1.31	-0.54	-0.11	1.53	2.91	-2.22
IT	-1.53	1.91	-0.21	0.37	*-0.46*	*0.64*	*0.25*	*-0.27*	0.45	-0.09	-1.32	2.22	0.80	-0.37
NL	-0.11	0.04	1.19	-1.62	*1.31*	*-1.81*	*-0.13*	*0.19*	-0.31	0.17	0.77	-1.41	1.70	-2.01
AT	-0.03	-0.03	-0.21	0.35	*-0.18*	*0.29*	*-0.02*	*0.06*	1.29	-0.47	1.05	-0.20	1.48	-0.60
PT	-0.38	0.47	0.00	0.03	*-0.05*	*0.08*	*0.05*	*-0.05*	0.08	-0.00	-0.31	0.50	0.16	-0.06
SF	-0.16	0.01	0.73	-0.95	*0.71*	*-1.00*	*0.01*	*0.04*	0.51	-0.16	1.07	-1.10	1.69	-1.35
SW	0.25	-0.28	-0.22	0.27	*-0.41*	*0.47*	*0.19*	*-0.21*	3.55	-1.38	3.58	-1.40	4.11	-1.94
UK	0.21	-0.26	0.20	0.22	*-0.49*	*0.60*	*0.29*	*-0.37*	2.71	-1.45	2.72	-1.49	3.25	-2.12
EU12	-0.52	0.52	0.25	-0.29	*0.10*	*-0.14*	*0.15*	*-0.15*	1.04	-0.52	0.76	-0.28	1.68	-1.14
EU15	-0.34	0.30	0.14	-0.16	*-0.02*	*0.02*	*0.17*	*-0.18*	1.38	-0.71	1.18	-0.56	2.04	-1.38

Source: Commission services.

Table 3.4.7

Simulated long-run effects of changes in labour and product markets on GDP and the unemployment rate: 1995-2003

	Simulated contribution of all observed policy changes	Simulated contribution of favourable policy changes	*1995-2003*
Cumulative GDP growth :			
EU12	0.76	1.68	*18.48*
EU15	1.18	2.04	*19.66*
Change in NAIRU			
EU12	-0.28	-1.14	*-0.75 (9.22 - 8.47)*
EU15	-0.56	-1.38	*-0.78 (8.71 - 7.93)*

Source: Commission services.

4.4. The effect on employment and productivity of policies for marginally attached people

Since the launch of the European Employment Strategy in 1997, EU countries have implemented a host of reforms aiming at increasing the flexibility of the labour market and at mobilising the underutilised labour resources. These reforms did not involve a radical change of the labour market but partial and incremental policy innovations, which aimed at introducing marginal adjustment of the existing policy settings (e.g. fine tuning of benefits levels and rules for eligibility) or small changes in the regulatory framework ([85]). These reforms involved only specific segments of the workforce, usually those groups with low labour market attachment (women, older workers, low-skilled). This section assesses whether these measures entailed an increase in employment and a decline in productivity growth.

Some commentators have claimed that the emphasis put on the labour market reforms is responsible for the decline in productivity growth experienced during the last years by several European Countries (e.g. Heckman, Ljunge and Ragan, 2006). Others have argued that the attempt to change the functioning of the labour market with partial reforms can lead to labour market duality and permanently lower labour productivity (Blanchard and Landier, 2002). Apart from effects on the steady state, two-tier labour market reforms may also have transitory effects on employment and productivity – the so-called honeymoon effect on job-creation (Boeri and Garibaldi, 2007) ([86]). The availability of flexible labour contracts gives firms the opportunity to build a "buffer stock" of flexible workers during upturns. In contrast, during downturns they are not able to exploit downward flexibility because constrained by the stock of insiders. Hence, right after the introduction of flexible contracts the average productivity declines (due to decreasing marginal returns of labour). During

([85]) For a review of the political economy arguments of labour market reforms see Arpaia, A and G. Mourre (2005) "Labour Market Institutions and Labour Market Performance A survey of the Literature" Economic Paper No 238.

([86]) T. Boeri and P. Garibaldi (2007), "Two tier reforms of employment protection: a honeymoon effect?", *Economic Journal, 117, F357-F358* . Using a panel of 1300 firms between 1995 and 2000, the authors find a sizeable negative effect of temporary contracts on changes in productivity at the firm level.

bad times firms do not react and let the number of insider workers to decline at the attrition rate (e.g. because of retirement). The increase in employment – and the decrease in labour productivity (averaged over good and bad times) – last as long as the stock of permanent workers is at the level that would maximise profits in good times (as permanent workers cannot be fired in bad times in a two tier regime).

Macro-econometric panel data have been largely used by researchers to show that labour market institutions and their interactions with macroeconomic developments matter for the overall employment performance (among the most prominent Blanchard and Wolfers, 1999 and Phelps et al., 2000), and, consequently, to identify that certain configurations of labour market institutions are more employment- and participation-friendly than others. Under the assumptions of stable relationships over time and across countries, the elasticity of employment and participation rates to quantifiable policy variables, estimated usually over sufficient long time horizon to be statistically reliable, are used in policy simulations to detect, for the average representative country, the contribution of quantifiable policy measures on labour market outcomes. Thus, the approach is appropriate when policy measures do not entail changes in the underlying institutional parameters. In contrast, they are less able to capture fundamental changes in the deep parameters, i.e. occurring at relatively short-horizons after a reform has been implemented. Moreover, some of the reforms undertaken have changed the regulatory framework and no simple indicator can easily capture these changes.

To assess whether reforms for marginally attached people have increased employment at the cost of lower productivity growth we adopt a difference-in-difference approach (Dif-in-Dif) ([87]). Each policy intervention is considered as a discrete event occurred at a specific point in time. The Dif-in-Dif compares the difference in outcomes after a certain reform or legislation has taken place with its value before such intervention. To control for other determinants not related to specific policy interventions, the outcome of the before-after comparison are contrasted with the comparable contemporaneous changes in outcomes in countries that did not enact any of these reforms.

With the dif-in-dif approach we will verify whether after there reforms the employment rate rises. To conduct a dif-in-dif approach, we first need to identify the relevant dates of the reforms. To this end we exploit the information on dates at which a measure is formally enacted (i.e. the date of the passage of the law establishing the measure) available from the LABREF database ([88]). We consider all measures enacted by the 25 Member States between 2000 and 2006 that implied a change in the regulatory framework or fiscal incentives for temporary and part-time work; targeted tax cuts for the low-skilled/low-income workers; use of employment subsidies and direct job creation schemes; the introduction of in-work-benefits.

Of course, there is no direct relationship between each formal act, which we call a reform, and its effectiveness. The formal dimension covered by the LABREF database represents only the first layer of the reform policy. Implementing decrees often follow more general laws, implying the presence of lags between the policy action and the final outcomes. Moreover, firms may react in advance to anticipated changes in the legal environment and delay hiring decisions if they can hire later at lower costs. In this case there will be a decline in employment growth just before the reform is enacted followed by pick up thereafter, which, however, if not taken into account may lead to an over-estimation of the average effect of the reform. Finally, since the database covers only 6 years for the 25 countries, it is not possible to take into account the effects of reforms implemented in the

([87]) An application of the diff-in-diff approach to macro-panel data can be found in A. Bassanini and D. Venn (2007) "Assessing the impact of labour market policies on productivity: a difference-in-difference approach" mimeo and in OECD (2007) "More jobs but less productive? The impact of labour market policies on productivity" Employment Outlook. Autor et al (2007) draw on establishment data from longitudinal databases to study the adoption of wrongful-discharge protections on the employment flows and entry rates in the US. D. H. Autor, W.R.Kerr and A. D.Kugler (2007) "Do employment protection Reduce Productivity? Evidence form US States.

([88]) LABREF records, on an annual basis, information on labour market and welfare reforms. The database provides information on the design and scope of reforms, on selected characteristics of reform measures and their expected implementation phase. Data collected for the years 2004-05 have already been validated by national authorities, while information for years 2000-03 and 2006 is still provisional. The database can be freely accessed at: http://europa.eu.int/comm/economy_finance/indicators/labref_en.htm

mid-1990s. To control for the effect of past reforms, the lagged dependent variable is also included as an explanatory variable. Alternatively, country specific time-trends are introduced to account for trending omitted variables potentially correlated with the adoption of the law (i.e. controlling for an "effect" of the measure before the law takes an effect).

With these caveats in mind, we estimate the effect of reforms for marginally attached people with the following equation

$$\Delta n_{i,t} = \alpha_i + \mu_t + \beta\, reforms_{i,t-1} + \varepsilon_{i,t}$$

where $\alpha_i + \mu_t$ are country specific and period specific effects that capture the cross - country heterogeneity and common shocks;
$n_{i,t}$ is the employment rate

$$reforms_{i,t} = \begin{cases} 1 \text{ if a refrom occurred at time t in country i} \\ 0 \text{ otherwise} \end{cases}$$

Thus β captures the differential effect of reforms for marginally attached people on the employment rate. We estimate this equation respectively for the total, the female and the older workers employment rates. Later the same exercise is carried out on the productivity growth and the capital intensity.

Table 3.4.8 reports for the full sample of 25 countries over the period 2001-06 the estimates of the effects reforms for marginally attached people on respectively total, male and female employment rates. The results for the whole period show that the employment rates increase by 0.3 percentage points one year after reforms aimed at increasing the employability of marginally attached people have been enacted ([89]). By accounting for unobserved country-specific differences that are constant over time or period-specific common shocks, the response of the employment rates becomes slightly stronger.

These finding can be spurious as they may simply capture the effect of the many measures implemented for these groups right before 2001. To identify whether these reforms really represent a source of discontinuity in the evolution of the employment rate, we added country specific trends (column 4) or the employment rates lagged by one year (column 5). In the first case, we find for the total employment a coefficient which is of the same order as that obtained with OLS (column 1). Including the lagged employment rates leads to a statistically significant coefficient which is not far from those obtained controlling for country- and period-specific fixed effects. Within all the specifications, the effects on the male employment rate are slightly higher than on the female one.

Table 3.4.8

Effects of reforms for marginally attached people on employment rate: EU25 countries, 2001-2006 (difference in difference estimation)

				(2) + country-specific time trends	(3) + lagged dependent variable (country specific slopes)
	(1)	(2)	(3)	(4)	(5)
	Effects on total employment rate				
Reforms (-1)	0.32	0.49	0.48	0.33	0.5
	(2.77)	(3.98)	(5.32)	(2.23)	(8.11)
	Effects on male employment rate				
Reforms (-1)	0.27	0.55	0.52	0.39	0.52
	(2.49)	(3.58)	(3.57)	(1.76)	(2.44)
	Effects on female employment rate				
Reforms (-1)	0.34	0.4	0.4	0.25	0.48
	(2.4)	(2.46)	(3.42)	(1.26)	(3.6)
Obs.	150	150	150	150	125
Cross-section dummies	No	Yes	Yes	Yes	Yes
Period dummies	No	No	Yes	Yes	Yes

T-statistic in parentheses

Source: Commission services.

These findings are confirmed when the sample is restricted to the EU15 Member States (Table 3.4.9). However, in this case the response of the total employment rate is much higher. In our preferred specification (that one that controls for country-specific time trends), the introduction of reforms for marginally attached people implies an increase in the total employment rate by 0.8 percentage points or in total employment growth by 1.3% ([90]). Finally, although both female and male employment rates rise one year after reforms have been enacted, the Female component rises by much less.

([89]) Assuming an average growth rate of 0.5% for the 15-64 population - corresponding to the average change of the EU25 working age population effectively observed from 1995 to 2006) and a level of employment rate of 63.2% (equivalent to the average EU15 employment rate over the 1995-2006 period) one gets a change in the employment growth by about 0.5%.

([90]) This number is obtained as above but in this case using the values of the EU15 aggregate for the employment rate and the change in the population.

Table 3.4.9

Effects of reforms for marginally attached people on employment rate: EU15 countries, 2001-2006 (difference in difference estimation)

				(2) + country-specific time trends	(3) + lagged dependent variable (country specific slopes)
	(1)	(2)	(3)	(4)	(5)
	Effects on total employment rate				
Reforms (-1)	0.71 (3.78)	0.69 (3.2)	0.53 (2.78)	0.82 (3.05)	0.62 (2.62)
	Effects on male employment rate				
Reforms (-1)	0.81 (3.77)	0.86 (3.39)	0.66 (2.79)	1.02 (3.3)	0.87 (2.86)
	Effects on female employment rate				
Reforms (-1)	0.59 (2.79)	0.52 (2.21)	0.42 (2.1)	0.61 (2.07)	0.54 (2.03)
Obs.	90	90	90	201	90
Cross-section dummies	No	Yes	Yes	Yes	Yes
Period dummies	No	No	Yes	Yes	Yes

T-statistic in parentheses

Source: Commission services.

If reforms have increased employment along a temporary productivity employment trade-off, we should expect that after one year these reforms have effectively led to a decline in labour productivity growth. Table 3.4.10 reports the results of the dif-in diff estimation where the dependent variable is the year over year growth rate of labour productivity, respectively for the EU25 and the EU15 during the 1993-2006 and 2001-06 periods ([91]).

Table 3.4.10

Effects on productivity growth of reforms for marginally attached people

				(2) + country-specific time trends	(3) + lagged dependent variable (country specific slopes)
	(1)	(2)	(3)	(4)	(5)
	Effects on productivity growth of EU25: 1993-2006				
Reforms (-1)	-0.9 (2.86)	-0.54 (2.42)	0.26 (1.25)	-0.54 (2.06)	-0.59 (2.20)
Obs.	338	338	338	338	313
Cross-section dummies	No	Yes	Yes	Yes	Yes
Period dummies	No	No	Yes	No	No
	Effects on productivity growth of EU25: 2001-2006				
Reforms (-1)	-0.92 (4.04)	-0.13 (1.01)	-0.28 (1.60)	-0.35 (1.73)	-0.03 (0.14)
Obs.	150	150	150	150	150
Cross-section dummies	No	Yes	Yes	Yes	Yes
Period dummies	No	No	Yes	No	No
	Effects on productivity growth of EU15: 1993-2006				
Reforms (-1)	-0.6 (3.14)	-0.59 (3.26)	0.22 (0.85)	-0.43 (1.72)	-0.63 (3.29)
Obs.	210	210	210	210	195
Cross-section dummies	No	Yes	Yes	Yes	Yes
Period dummies	No	No	Yes	No	No
	Effects on productivity growth of EU15: 2001-2006				
Reforms (-1)	0.03 (0.11)	0.02 (0.05)	0.1 (0.35)	-0.37 (1.43)	0.13 (0.33)
Obs.	90	90	90	90	90
Cross-section dummies	No	Yes	No	Yes	Yes
Period dummies	No	No	No	No	No

Robust standard error in parentheses

Source: Commission services.

For the EU25 the evidence suggests that reforms for marginal groups have a significant negative effect on labour productivity growth, with a weaker effect in the later period in the case of our preferred equation (i.e. when we control for country-specific trends in column 4). Our estimates suggest that one year after these partial reforms have been enacted labour productivity growth declines by 0.5 percent in the whole period and by 0.35 in the last years. The effect is much stronger for the EU15, but only on the entire time period. When we control for the effects of past reforms with country-specific trends, the effect of

([91]) So far The LABREF database, which is the reference source for the chronology of reforms needed in the diff-in-diff exercise, covers only the 2000-2006 period. We assumed that before 2001 no reforms were implemented for the marginally attached people. This implies that our estimates can be biased as we do not capture the reforms enacted before the year 2000. However, in this case the bias is likely to be downward (i.e. the effect of the reforms is higher than what estimates). Thus the estimates obtained form equations that include country specific trends to control for the effects of past reforms not accounted by our indicator variable should be more reliable.

reforms on labour productivity growth for recent is years negatively signed but imprecisely estimated.

To check for robustness and identify the mechanism through which partial reforms lead to a decline in productivity Table 3.4.11 explores the effect of these reforms on the capital labour ratio. From the theory we should expect that partial reforms by reducing firms' adjustment costs leads to a decline in the price of labour relative to capital. Hence, a substitution of capital with labour occurs which, in the short-term, brings down productivity growth. Not surprisingly, reforms for marginally attached people are followed by a decline in the capital labour ratio.

Table 3.4.11

Effects on the growth rate of the capital-labour ratio of reforms for marginally attached people: EU15 countries

				(2) + country-specific time trends	(3) + lagged dependent variable (country specific slopes)
	(1)	(2)	(3)	(4)	(5)
	2001-2006				
Reforms (-1)	-0.58	-0.5	-0.23	-0.74	-0.54
	(2.74)	(2.65)	(1.25)	(4.25)	(2.47)
Obs.	90	90	90	90	90
Cross-section dummies	No	Yes	No	Yes	Yes
Period dummies	No	No	No	No	No

Robust standard error in parentheses

Source: Commission services.

Concluding remarks

Both economic theory and the experience of EU Member States and the US suggest that there is no need for an exclusive focus on either employment growth or productivity growth. GDP per capita – a measure of the standard of living – depends on both GDP per person employed and the employment rate. From a policy perspective, the key objective must be to raise productivity levels using all the available instruments to stimulate growth of total factor productivity, whilst at the same time encouraging the labour-intensive growth pattern over the medium term that is needed to move towards full employment. A higher employment rate implies an unambiguous increase in GDP per capita with no negative implications for the long-run productivity growth of the existing workforce. Furthermore, progress on labour market reforms does not impede efforts to stimulate investment and technical progress. Thus, there is no reason why policy makers cannot act on both fronts simultaneously.

In the medium term, the response of productivity to positive labour supply and wage shocks may entail a temporary reduction in productivity growth rates, which, in principle, could be considered as benign; in any case, the size of a negative effect of this type is estimated to be fairly small. The increase in employment in the EU-15 since the mid-1990s has indeed been to a significant extent the result of such positive labour market shocks. This implies that countries with lower productivity growth than average may also have a better employment performance.

The evidence of this chapter suggests that the employment-productivity trade-off has been less pronounced in recent years, confirming what has been found by others (e.g. O. Cavelaars, 2003). This finding comes as good news for European policy makers, because it implies that their efforts to boost per capita GDP via an increase in labour utilisation and labour productivity are only slightly constrained by a negative relation between employment and productivity.

The chapter also shows that reforms improving the employability of people who are marginally attached to the labour market are equivalent to a reduction in firms' adjustment costs, which induce firms to substitute capital with labour and, consequently, lead in the short term to a decline in labour productivity growth. On a normative side this finding suggests that when reforms are not part of a comprehensive policy package, it may take time to reverse the decline in productivity growth that follows policy measures that improve the labour utilisation of specific groups.

Hence, measures to price workers into the labour market should go along with measures to improve the quality of the labour input. Efforts to improve the quality of work, in particular through investment in human capital, will therefore also be an aspect of the productivity challenge. However, even if governments can successfully upgrade the skills of some of the marginally attached, it is unrealistic to suggest that this is the source of the solution for the group as a whole. Low-skilled jobs will continue to exist, and there is a clear benefit to those people being actively engaged in the EU's job market. It is manifestly clear that it is not by keeping a large share of the working-age population jobless that the EU will improve its overall productive potential.

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Chapter 4

Policies in the pursuit of higher productivity: another look

Summary

Policies in pursuit of "a knowledge society" figure prominently on the European policy agendas, as exemplified by the EU's Lisbon process. Consistent with the empirical finding of TFP growth as the most important driver of growth, a host of policies have been adopted or announced by the governments of the EU Member States to strengthen the institutional factors shaping TFP growth. Though actual policy strategies vary considerably across countries, there are three areas which feature prominently across the board. These concern (1) R&D and education policies in order to foster investment in knowledge, (2) policies to enhance the impact of competition on innovative activity, and (3) policies to facilitate reallocation of resources in product and labour markets.

In parallel with the growing attention policy makers are paying to these areas, their economic foundations have become clearer. The black box surrounding the empirical concept of TFP has been somewhat lifted after economic research established that these three areas can be considered crucial determinants of TFP growth in the endogenous growth literature. Numerous empirical studies, often with firm-level or sectoral data, have shown that changes in policy-relevant structural variables can have a significant impact on productivity and growth performances. Macroeconomic model simulations revealed that structural reforms can yield sizeable growth gains. They also demonstrated that the diffusion of reform effects to the entire economy has a considerable impact on macroeconomic aggregates, especially on employment and investment. In order to arrive at a full understanding of the impact of structural reforms on economic activity however, there is still a missing link between actual policy reforms and their effect on economically meaningful structural variables. There have so far been few case studies addressing this knowledge gap. Therefore, quantifying the likely economic effect of specific reforms remains difficult.

In addition to identifying the relevance of different policy areas, economic analysis has come up with important insights about the extent to which the effectiveness of policies depends on the conditions under which they are framed. First, the efficiency of fiscal measures to foster R&D depends on the availability of suitable researchers. Thus, investment in education and facilitating labour market mobility emerge as important complementing policies. Second, investment in R&D is characterised by spillover. Social returns are higher than private returns and welfare effects are higher if many countries undertake policy action at the same time, rather than acting in isolation. Third, although economic theory suggests that the impact of higher competition on innovative activity can be ambiguous, empirical analysis provides strong support for the notion that policies to increase competitive pressure, especially impacting on the behaviour of incumbents, are conducive to innovation and growth. Fourth, the impact of some policies, exemplified by a reduction in administrative costs, can be magnified if they are undertaken in contestable markets, i.e. when the increased cost efficiency leads to dynamic gains through higher market entry. Fifth, there are positive linkages between product market reforms, organisational change and labour market regulation, as evidenced by several empirical studies that show that the impact of product market reforms on productivity or on employment tends to be stronger when labour markets are deregulated. Sixth, since the realisation of productivity gains is influenced by the least productive entities exiting the market, policies that foster reallocation are important. If productivity gains lead to higher income, consumer demand can be expected to shift towards services and the economy can afford to create new jobs in sectors with genuinely low productivity.

1. Introduction

In Chapter 2 of this Review, TFP growth has been identified as the most important driver of growth in developed economies. Each country at every point in time is positioned at a certain distance to the production possibility frontier, which describes what can be produced with the existing factors and technical knowledge (Graph 4.1.1). Developing countries move towards this frontier by adopting the technology used by the most advanced countries either by importing physical capital or acquiring existing knowledge. By contrast, in developed countries growth largely depends on expanding the frontier itself through innovative activity. Here, incentives to innovate are crucial, which in turn depend on the institutional environment and the competitive pressure incumbent firms are exposed to.

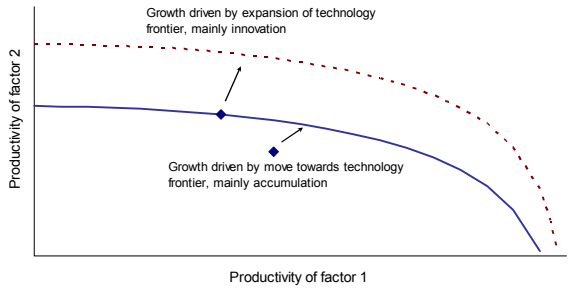
It is a widely accepted view that, Europe has been lagging behind the United States, which has been rather successful in expanding its technology frontier through its rapid adoption of newly developed technologies (primarily ICT). Therefore, policy in Europe should aim at fostering innovation and reducing obstacles to the diffusion of new technologies. Not surprisingly, policies in the pursuit of "a knowledge society" figure prominently on the European policy agendas, as exemplified by the EU's *Lisbon process*. A host of policies have been adopted or announced by the EU Member States' governments to strengthen the institutional factors shaping TFP growth. These are included in the National Reform Programmes and Implementation Reports thereof, which Member States have agreed to submit for discussion in the EU within the framework of the Lisbon process, also called "*Growth and Jobs Agenda*" ([92]).

While an evaluation of these measures is the subject of specialised reports, for example the Commission's Annual Progress Reports, this chapter aims to give a more general assessment of the effectiveness of TFP-oriented policies. For this purpose, the chapter draws on existing academic research and presents a set of model simulations to gauge the general equilibrium effects of such policies ([93]).

The discussion is divided in three parts, each focussing on a broad policy area that is relevant for productivity, specifically:

- R&D and education policies (Section 2),
- policies to release competition forces (Section 3), and
- policies to facilitate reallocation of resources in product and labour markets (Section 4).

Graph 4.1.1: **Technology frontier and sources of growth**



A reform focus on capital accumulation as a means to approach the technology frontier remains warranted for some of the catch-up countries ([94]). This is, however, beyond the scope of this chapter.

([92]) National Reform Programmes were submitted in 2005. Reports on their implementation were issued in autumn 2006 and 2007. Similar information, albeit at a more aggregated level, for earlier years can be found in the EPC's annual Structural Reform Reports and the Commission's Implementation Reports on the Broad Economic Policy Guidelines.

([93]) See Chapter 2 in the European Commission's 2007 Competitiveness Report for a complementary microeconomic analysis of reforms in the European Union with a more detailed elaboration of policy measures.

([94]) For an analysis of growth drivers in the new Member States, see Chapter 2 in EU Economy 2004 Review.

2. Policies to foster investment in knowledge

Policy interventions in the areas of R&D and education are motivated by the notion of positive externalities. Markets may undersupply investment in research and human capital because the agents that undertake this investment will only accrue part of the fruits. Other agents will also benefit and the economy would be better off, if public activity corrects for this market failure. This is usually done by governments financing of basic research. Another important tool is the protection of patent rights that allow researchers to either restrict use of their inventions or to benefit financially from the imitation of their products. As regards education, financial market imperfections may prevent workers from taking out credit to finance investment in their human capital. As confirmed in empirical research, the social returns of R&D and education exceed the private returns by a wide margin (see for an overview Box 4.2.1) ([95]). Different methods, however, yield a wide variation of results, with private returns from R&D in the range of 10 to 30% and social returns varying from 10 to above 100% ([96]).

2.1. Policy lines in the areas of research and education

Public support for education and research is among the least controversial strands of growth policies and consequently these items feature prominently in Member States' Reform programmes. It is prominent also in the EU policy agenda, with efforts to create a European Research Area and ensure comparability of academic qualifications (Bologna process) having preceded the Lisbon reform agenda. In this context, Member States committed to increase spending to 3% of GDP by 2010, from less than 2% in 2005. Two third should stem from private sources, i.e. from 1% in 2005 to 2% of GDP in 2010, because the comparatively low score on R&D investment in the EU is due largely to lagging private sector R%D spending. Targets have also been agreed to raise both formal educational attainment and skills of the labour force, establish lifelong learning policies and reduce the number of school drop outs.

Member States' research policies combine a number of elements covering inter alia the financing of basic research, the creation of regional clusters, creating framework conditions and favourable access to finance for innovative SMEs ([97]). Concerning the use of fiscal incentives for conducting R&D, private R&D can be stimulated either through direct measures (like grants targeted at a specific technologies, academic disciplines or industries) or through indirect measures which aim to reduce the costs of R&D investment (tax incentives). There are considerable differences in the policy mix of across countries. Interestingly, countries endowed with the lowest (ES and PT) and highest business R&D intensities (JPN and to lesser extent USA) are biased towards generous tax incentives. Overall, there has been a trend decrease in direct subsidies to R&D although it remains non-negligible in the US and in the EU countries, especially in the new Member States and in France. Several countries, notably the Netherlands, Germany, Denmark and Belgium, have switched from direct public funding towards indirect stimulus of R&D through tax incentives.

So far the literature has not provided unambiguous evidence in favour of one or the other fiscal instrument ([98]). Direct subsidies continue to be the favoured instrument to support the development of technologies that are of strategic importance or with clearly identified knowledge spillovers and network effects ([99]). But it is not obvious that the government will be better able to accurately select R&D projects that are worth developing than the private sector does. Tax incentives, in contrast, leave more room for market forces to select research projects. However, this comes with a disadvantage that tax breaks affect potentially all firms investing in R&D, including those that would have done the investment even

([95]) See for example Bloom et al. (2002), Guellec and Pottelsberghe (2000), Khan and Luintel (2006) on the returns of R&D and Woessmann and Schuetz (2006) for a review of the economic returns of education.

([96]) For an overview of results with different methods, see Schultz (2006).

([97]) See also Chapter 2 in the 2007 Competitiveness Report (European Commission (2007)).

([98]) See David *et al.* (2005), Hall and van Reenen (1999), Klette *et al.* (2000), Garcia-Quevedo (2004).

([99]) Network effects occur when a user's utility from using a technology directly increases with the total size of the network like in the case of using the telephone or the e-mail (direct network effects) or when the users' utility increases due to the wider availability of a complementary good like in the case of hardware-software complementarities (indirect network effects).

Box 4.2.1: **The impact social return of R&D on productivity growth: a brief review of the literature**

Many recent studies have focused on the social return to R&D, which is defined as the total return to innovation, including the return earned by the original innovator and the corresponding spillover gains. A special interest of this approach is focused on the international technology diffusion and international R&D spillovers.

I. Estimates of private returns to R&D based on micro and macro level data. Comprehensive survey study by Nadiri (1993) concludes that micro and macro level estimates for rate of return are mostly in the range of 20-40% while the elasticities vary in the range of 8 to 30%. Coe and Helpman (1995) used a sample of OECD countries and found an average domestic R&D elasticity of 8 % for non-G7 countries and 23% for the G7 countries. More recent studies by Botazzi and Perri (2007), Guellec and van Pottelsberghe (2001), and Keller (2002) provide qualitatively consistent estimate with Coe and Helpman (1995) findings in the 8-23% interval.

II. Estimates of R&D spillovers and social rate of returns. Majority of the recent R&D spillover literature focuses on the international knowledge spillovers. The benchmark study by Coe and Helpman (1995) regressed TFP on measures of foreign and domestic R&D stocks for 22 industrialized countries and found evidence that in large countries, the stock of foreign R&D affected TFP less strongly (3-8%) than in small countries (5-26%). Later studies argue that the strength of foreign R&D spillovers is determined by the country's openness to imports from and the outward FDI intensity to R&D-intensive countries (see Lichtenberg and van Pottelsberghe (1998), Keller (2004) and Griffith et al. (2006)). Estimates of the social rate of returns based on interfirm technology spillovers focusing on industry levels vary between 17% (Sveikauskas (1981)) and near 100% (Jones and Williams (1998)). Griffith et al. (2001) estimate for most OECD countries social rates of return on R&D of about 50%. Jones and Williams (1998) claim that social rate of return estimates in the literature are too conservative because they do not take account of the full dynamic effects of R&D. Their study implies for the US that the socially optimal level of R&D intensity should be two to four times higher than the current one.

without the tax advantage. That is, substitution may occur, with the private sector using the fiscal windfall to cut own funding, leading to "dead weight cost" in the form of the government subsidising R&D investment that would have been carried out anyway.

Aside from R&D, there are issues with regard to the effectiveness and cost-efficiency of education in the European Union. Waste in education systems appears to be high as the same output could be obtained with considerably less resources – or put differently, better results could be achieved with similar resources. This is all the more concerning since human capital is not only an important determinant of the quality of labour force and productivity in its own right, but also because it may enhance the capacity of economies to innovate. Notably countries that are close to the technology frontier – and aside from countries that are still catching up, most EU Member States are in that situation – need to enhance their capacity to adopt new technologies, and this requires major efforts to keep up or improve the quality of (notably higher) education.

The vast majority of countries provide public education which naturally absorbs the bulk of public funding: The Netherlands, Belgium and to a lesser extent UK excepted, where large shares of public funding is for private institutions (although to varying degrees at the primary, secondary and tertiary education levels). In most countries, conditional transfers to private households (grants, family or child allowances) represent less than 10% of total public education expenditures as far as primary, secondary and post-secondary non-tertiary education is concerned. Regarding tertiary education, public transfers to the private sector are more common, especially in Denmark, the Netherlands, UK and Sweden. In these countries public funded scholarships and grants are relatively predominant (e.g. vouchers). This type of funding is usually found to enhance the competition between education providers and enhance the quality of teaching.

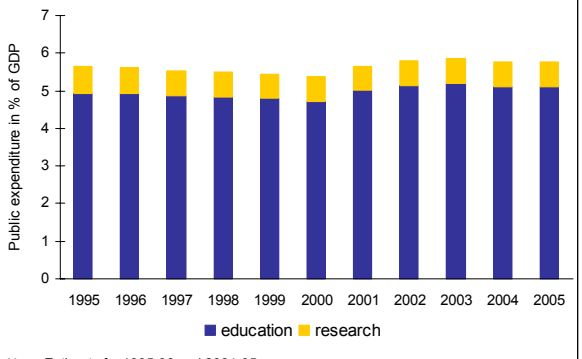
2.2. Trends in inputs and outputs

The productivity gap between Europe and the United States is broadly matched by gaps in expenditures on research and education. The US invests almost 3% of its GDP in R&D compared to less than 2% in the EU ([100]). Meanwhile, total public spending on human capital formation amounts to around 5.5 % of GDP in the EU-15 and roughly 7.25 % in the USA.

As noted before, the comparatively low R&D expenditure in Europe is mainly due to lower business investment in R&D with, as discussed in Chapter 2, European companies being less present in R&D intensive industries, especially IT. Moreover, more EU multinational companies are carrying out their research in the US than *vice versa*. Strikingly also, the share of the service sector in business R&D is 40% in the USA, compared to 15% in the EU.

Interestingly, while the GDP share of spending on research in the EU hardly moved over the last decade, the share of researchers in employment slightly increased, from 0.8% in 1996 to 0.9% in 2004, suggesting that research has become more labour-intensive in the EU.

Graph 4.2.1: **Public spending on education and R&D, EU-15**



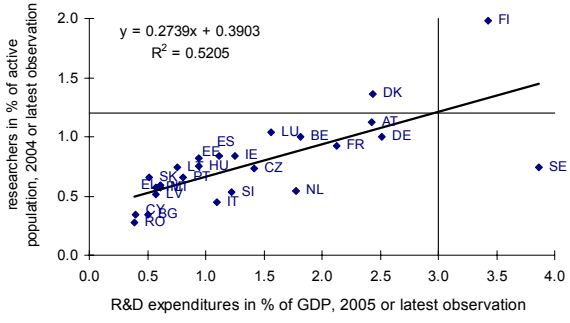
Note: Estimate for 1995-96 and 2004-05.

In some respects, the numbers for output of research in the EU are somewhat more favourable. For example, the number of scientific articles on science and technology grew by 14% between 1996 and 2003. Meanwhile, the number of patent applications to the European Patent Office (EPO) per million inhabitants grew by almost 50% between 1996 and 2003. However, most of the increase took place before 2000 and may well be linked to the ICT boom and institutional changes, such as expanded patentability criteria and better enforcement against infringement.

The level of government funding of R&D as % of GDP is still substantial in many mature and technology-oriented economies such as the three Nordic states, Austria, Germany and France. In some new Member States such as Cyprus, Lithuania, the Czech Republic or Hungary, it has been growing very fast between 1997 and 2003, indicating increasing efforts to gradually build up their science base through public funds. Conversely, in Poland, Latvia and Slovakia it has clearly decreased and remained at a rather low level.

There is obviously a direct link between R&D and education to the extent that the latter delivers educated researchers. If more investment in R&D was not accompanied by an expansion in the number of researchers, the likely effect would be higher salaries rather than higher research output. Empirically, there is indeed a strong positive link between R&D expenditures and the numbers of researchers (Graph 4.2.2). It is estimated that the targeted increase of R&D expenditure from currently below 2% of GPD to 3% in the EU requires one third or 700 000 more researchers than currently disposable.

Graph 4.2.2: **R&D expenditure and researchers in EU Member States**

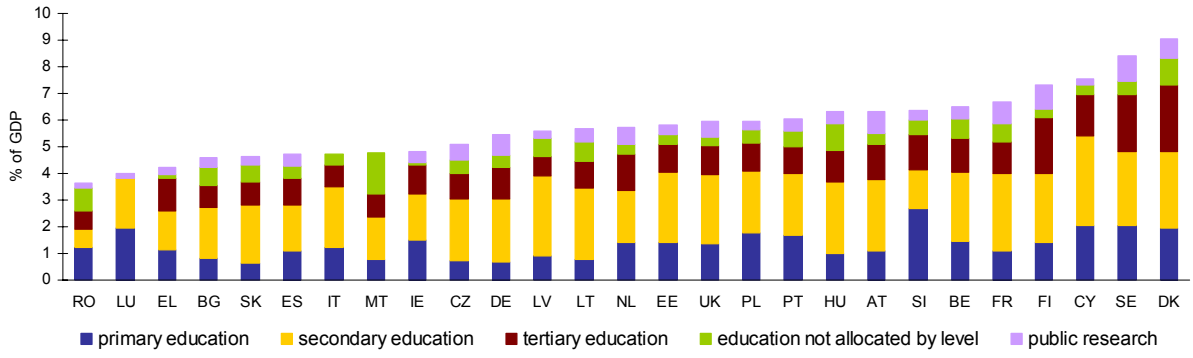


Source: Commission services.

While expenditures on research stalled at 1.9% of GDP over the past decade, EU-25 public expenditures on education (including all levels of education) have increased since the launch of the Lisbon Strategy in 2000, from 4.7% to 5.2% of GDP in 2003 (Graph

([100]) Doughtery et al. (2007) argue that when R&D spending is corrected for differences in prices, cross-country differences decline.

Graph 4.2.3: **Public expenditure on research and education by Member States**



Note: 2003 for education, 2005 or most recent observation for research expenditures. *Source:* Commission services.

4.2.3) ([101]). Accordingly, educational attainment has improved considerably in the EU during the 1990s although since 2000 the trend seems to have faltered ([102]). As well, according to the estimates of Schwerdt and Turunen (2006) for the euro area, the quality of the labour force has improved since the early 1990s ([103]).

However, there is a significant variation amongst the EU Member States on several of these score, reflecting different starting positions and policy strategies. Interestingly, a high level of income does not seem to be a major determinant of spending on education.

2.3. Assessing the effectiveness and efficiency of public spending on the knowledge economy

2.3.1. The efficiency of R&D spending

Many outputs of R&D investment, i.e. knowledge, skills and experience, are intangible, which makes it very hard to assess the effectiveness and efficiency of R&D spending ([104]). Even so, a bias towards public R&D spending can be challenged on three main grounds ([105]). Firstly, public funds allocated to R&D projects induce higher demand for researchers, which drives the researchers' salaries up and thus increases the costs of R&D ([106]). In reaction to higher R&D costs, firms may reallocate their funds to other investment projects, i.e. a classical "crowding-out" effect. Secondly, a substitution effect may occur as some firms will merely use public support to cut their own funding, while undertaking the same amount of R&D. Thirdly, governments may not necessarily allocate resources more efficiently than market forces do.

([101]) National accounting figures suggest that government expenditure on education went up from 5.1% of GDP in 2000 to 5.3% in 2004. This is the same share than in 1996. The data quoted in the text stem from Eurostat's structural indicators, and the latter from the COFOG classification in national accounts.

([102]) The share of persons aged 20-24 that has completed at least upper secondary education rose from 68.1% in 1996 to 73.7% in 2000. Between 2000 and 2005, it improved by a further percentage point to 74.6%. The number of total students in tertiary education grew by 14% between 2000 and 2004 in the EU25 and the share of science and technology graduates in the population aged 20-29 increased from 1 to 1.2%.

([103]) The measure of labour quality used by Schwerdt and Turunen (2006) is based on an estimate that links educational attainment and age of persons employed to the wage they earn. The wage is used as a proxy of the productivity of individual workers. The authors estimate that approximately a third of labour productivity growth in the euro area can be attributed to the improvement in labour quality over the period 1984-2004.

([104]) Moreover, the realisation of their benefits may be delayed in time and their impact may occur in seemingly unrelated areas because many scientific instruments developed in basic research for very specific purposes are transferred to other scientific disciplines, e.g. from physics to chemistry like in the case of electron microscopy, or to the industry, e.g. lasers or the Internet.

([105]) See Guellec et al. (2000).

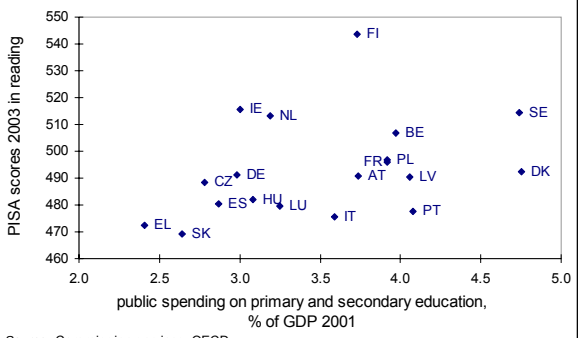
([106]) See Goolsbee (1998), David and Hall (2000).

Despite these reservations, most governments expect positive effects from public R&D. Such positive effects could emerge in principle if public R&D can be shown to be genuinely "additional" ([107]). The empirical debate on the additionality has not been unambiguously resolved ([108]). Even so, there are some EU economies that are considered as highly innovative, such as Sweden and Finland, while maintaining high levels of both government private funding of R&D. This may illustrate that efficiency and effectiveness of public spending in support of R&D is determined by complex factors related to the institutional settings in which private and public actors operate. Protection of the intellectual property rights, a well-educated and highly skilled labour force, competition and the quality of linkages between public research and private sector are crucial in this respect.

2.3.2. Efficiency of spending on primary and secondary education

An important stylised finding is the absence of any clear link between spending on education and the observable performance of pupils, at least within the EU. For instance Graph 4.2.4 shows that countries such as FI, AT and PT which spend roughly the same amount on education, show very different PISA test scores ([109]). While such findings may point to cross-country differences in the effectiveness and efficiency of education, this kind of comparison is way too simplistic to be able draw reasonable conclusions. Yet cross-country differences do exist in this regard and overall point to significant scope for efficiency gains in most, if not all, developed countries.

Graph 4.2.4: **Efficiency of public spending**



Source: Commission services, OECD.

Owing to OECD work ("Education at a glance, PISA) education is one of the areas for which most systematic and consistent cross-country data have become available and research methodologies employed have also significantly improved ([110]). Some of the most quoted results are summarised in Table 4.2.1. For example, Clements (2002) finds that the most efficient countries within Europe are Hungary, Norway, Ireland, Finland and Greece. Afonso and St. Aubyn (2005) also place Hungary[111] on the efficiency frontier along with Japan, Korea, Mexico and Poland. Using a different method, Afonso et al., 2006) situate Finland and Sweden at the

([107]) The literature distinguishes between three types of additionality: input, output and behavioral additionality. Input additionality refers to the situation when public R&D grant complements private R&D expenditure. Output additionality occurs when firms generate more output after carrying out publicly and privately co-financed R&D than without public funds. Behavioral additionality refers to "the change in a company's way of undertaking R&D which can be attributed to policy actions", i.e. changes in the organisation and R&D strategy. See Buisseret et al. (1995).

([108]) For a comprehensive review of empirical evidence, please see David, Hall, Toole (2000) and García-Quevedo (2004).

([109]) Since the results from PISA 2003 may depend on the money spend on education the years before the testing phase, the figure compares the spending in 2000 with the PISA results from 2003 in "reading".

([110]) Clements (2002) compared total primary and secondary expenditures per student with the percentage of the population finishing secondary school at the normal graduation age in European countries. Afonso/St. Aubyn (2006) investigated the cross-country efficiency of secondary education provision by comparing the efficiency of education spending of 25 OECD States with the latest PISA results (2003). The OECD has done extensive analysis on efficiency of education spending. Their latest paper (2007) investigates the linkage between performance and institutions in primary and secondary education. Earlier papers by the OECD assessed technical and cost-efficiency. They used teaching resources and socio-economic background of parents as input indicators to measure technical efficiency. They replaced non-monetary inputs by monetary inputs to measure cost-efficiency. As output indicators served the PISA scores, but also school enrolment and homogeneity of PISA scores. A more in-depth investigation by the OECD of the country-specific results clearly illustrates the impact of the indicators used. For some countries, like the Czech Republic, Poland, the Slovak Republic, inefficiencies seem to be lower when education spending is used as an input. This result, however, is largely due to the fact that the wage costs (teaching remuneration) are relatively low in these countries.

[111] This could simply be due to methodology reasons. Hungary seems to be efficient when using FDH technique; however, with the DEA approach Hungary disappears from the efficiency frontier. See Afonso et al. (2006).

efficiency frontier while Finland and Ireland score best in a study by the OECD (2007). However, all investigations point to a lack of efficiency in European education systems overall. For example Afonso and St. Aubyn (2005) estimate that the same output can be obtained with 61% of the inputs used, with Italy, Portugal, Germany and Austria displaying the poorest score in this regard.

Table 4.2.1

Efficiency gains of education spending using the same resources (in % of output)

	Clements (2002)(1)	OECD (2007)(2)	Afonso et al. (2006)(3)
	Possible efficiency gains using the same resources		
BE	-	2.0	5.5
CZ	0.9	6.0	6.8
DK	1.7	4.9	9.3
DE	1.3	9.1	8.3
IE	0.0	2.2	7.9
FR	1.3	5.4	7.2
EL	0.0	7.0	8.2
ES	2.0	3.4	2.9
IT	1.4	6.9	5.1
HU	0.5	4.7	10.5
NL	1.1	5.1	3.7
AT	1.3	6.0	9.5
PL	-	3.8	-
PT	5.3	2.2	6.1
SK	-	5.3	1.8
FI	0.0	1.6	0.0
SE	1.7	6.0	0.0
UK	-	6.1	-
US	2.4	8.2	-

Source: based on results by OECD (2007), Afonso et al. (2006), Clements (2002).

Note: (1) Education spending to GDP and educational attainment levels; FDH methodology, (2) Teachers per 100 students and socio-economic background as input and PISA scores and homogeneity of Pisa scores as output; DEA methodology, Bootstrap estimates, non-increasing returns to scale, (3) Teachers-students ratio, hours in school as input and PISA 2003 as output; DEA methodology.

2.4. The relationship between the knowledge economy and economic growth

2.4.1. Knowledge in new growth theories

In modern growth theory technical progress is no longer considered to be an exogenous factor outside the scope of economic analysis. Endogenous growth theories recognise the factors that drive the production of knowledge and describe how this knowledge affects economic growth. Usually this is done by introducing a knowledge "production function" that designates capital and (skilled) labour as inputs into producing patents or specialised goods that are used as intermediate inputs by other sectors to raise their efficiency ([112]). Since research uses specialised labour, the education system is also an important determinant of TFP. But education has an indirect role as well, in enhancing the capacity to adopt and adapt technologies in specific settings ([113]). Obviously not all research leads to new knowledge or "marketable" products and the assumption of a production function that relates the number of researchers to a number of interventions is therefore a heroic one. Even so, empirical research does provide evidence of "production-function like" relationships between TFP and its inputs.

A further point to bear in mind is that motivations to undertake research in a certain direction can vary substantially dependent on the economic and social context. For example, technical progress in the second half of the last decade is generally thought to have favoured skilled over unskilled workers, probably in response to income redistribution policies that tend to make unskilled work too costly ([114]). In the 18th and 19th century, by contrast, technological change tended to replace skilled artisans by unskilled labour that had become abundantly available ([115]).

([112]) Although the idea that technical change is endogenous was already put forward in the 1950s, endogenous growth theory became influential only with the contributions by Romer (1986) and Lucas (19888), which demonstrated how endogenous technical progress can be modelled.

([113]) Higher educational attainment is also related to higher labour market participation and a number of non-economic benefits. See Woessmann and Schuetz (2006).

([114]) However, a recent study which investigated the impact of ICT on productivity with Dutch firm data found that the effects are ambiguous. ICT led to higher skill requirements when it was associated with increasing division of work. In firms that benefited from better communication possibilities, skill requirements declined. Borghansel and ter Wel (2006). In contrast to this, Bartel et al. (2005) find that skill requirements increase if new IT equipment is installed in US firms.

([115]) See Acemoglu (2001).

Globalisation and the ICT revolution have discredited some widely-held beliefs, and the emerging new paradigm can be summarised as follows ([116]):

- *Small countries can be a technology leader*. Analysts have been puzzled for a long time why most research was carried out in mainly the three largest economies (USA, Germany and Japan). The absolute magnitude of R&D, the share of R&D relative to GDP and the concentration of patents in these countries suggested that these countries were the prime innovators. The theoretical explanation for this observation was that market size matters for the profitability of R&D investment. Over the past decade, however, many smaller technological advanced countries recorded a strong increase in R&D investment and became technology leaders.

- *Small firms can be innovation drivers*. Traditionally, firms active in R&D were often large firms and it was argued that their ability to both absorb the costs of research and bear the risks of failing research was responsible for this. Nowadays, young and small enterprises are considered to be important drivers of innovation, especially in new technologies.

- *As technological progress is globalising, national differences matter less and less*. Innovation systems had been considered to vary greatly across countries, with national determinants having a key influence on firms' innovative activity. However, over the past years, the internationalisation of R&D has considerably gained in importance, at least within the OECD countries. Stern et al. (2000) document that over the past decades, a convergence of innovative capacity in OECD countries can be observed. This view found confirmation in a recent review of innovation systems in Griffith et al. (2006), which showed that firms' reactions to different R&D determinants are remarkably similar in Germany, France, Spain and the UK ([117]).

- *Mobility of researchers a,d capital rather than trade is the main vehicle for diffusion of new technologies*. In the past, it was widely assumed that the exports of products that incorporate new technologies have a crucial role for spreading technical progress. Meanwhile it has become accepted that it is principally the flow of ideas that counts and mobility of researchers, foreign direct investment and foreign ownership, or licensing agreements important vehicles to ensure this. While multinational enterprises still concentrate research efforts at their home base, research facilities have increasingly been established abroad.

Human capital, as noted, is an important driver of technology diffusion. When analysing differences among countries in the adoption of new technologies Comijn and Hobijn (2006) identify educational attainments and trade openness both being strong determinants of adoption lags. Ciccone and Papaioannou (2006) find that in those industries that are intensive users of human-capital, human capital accumulation had a significantly positive effect on output and employment growth. These results are consistent with the findings in Gunnarsson et al. (2001), which attributed the long lag between IT investment and its visibility in productivity figures to human capital developments.

2.4.2. Empirical evidence on the impact of knowledge on productivity growth

Empirical research has documented a robust positive link between education/human capital and R&D on the one hand and economic growth and productivity growth on the other hand, although there are tricky data issues. R&D expenditure or educational attainments usually turns up as significantly positive factors in growth regressions. For example, the growth regressions in OECD (2003) suggested that a permanent increase in R&D intensity by 0.1% would increase labour productivity by 1.2% and per capita output growth by 0.2%. De la Fuente (2003), who contributed importantly to better data on educational attainments, estimated that one year of additional education would raise labour productivity by a direct 4 to 6% in the EU. A further 3 percentage point contribution increase could result in the long run from

([116]) For a review of traditional determinants, see Eaton (1999) or Hanel and Niosi (1998). Recent trends are analysed in OECD (2004, 2006).

([117]) A different picture emerges from Mohnen et al. (2006). They, however work with data from the early 1990s.

the contribution of higher education to TFP growth ([118]). Other studies investigated the direction of causality, finding strong evidence that higher education is the cause of higher growth and not its consequence ([119]). Analysis with micro data has confirmed the positive impact of education on individual performance, assuming that higher individual productivity is reflected in higher wages. Woesmann and Schuetz (2006) in a review for the European Commission describe the positive relationship between education and earnings as "probably the most robust findings of all empirical economics", quoting an estimate according to which each additional year in education is associated with more than 8 percent higher wages ([120]).

As concerns education, in countries close to the technology frontier higher education is an important growth determinant whereas primary and secondary education are more important determinants in ctch-up countries. High returns can be obtained from investment in early education, albeit gestation periods are long ([121]). However, recent economic analysis supports the notion that the returns from different forms of education are determined by an economy's stage of development. Economic growth through imitation requires education in primary and secondary education. In economies close to the technology frontier, which are more dependent on research and innovation, patenting activity is higher. For these economies a large share of labour force with tertiary education and especially with graduates in science and engineering is wanted ([122]). Aghion and Howitt (2005) also present evidence for US states that the productivity-impact of an increase in the share of the highest educated labour force is higher the closer the state is to the technology frontier. Therefore, they argue, higher education becomes more important the more economic growth relies on expanding the stock of knowledge.

([118]) The results of De la Fuente (2003) and their policy implications are discussed in chapter 3 of the EU Economy 2003 Review.

([119]) For reviews, see Woesmann and Schuetz (2006) and Gonard (2007).

([120]) Few studies exist that analyse the impact of work-related training. An exception is Dearden et al. (2006), which estimates that a 1% point increase in training is associated with an increase in hourly productivity of about 0.6% and an increase in wages per hour of around 0.3%, using data of British industries 1983–96.

([121]) See Chapter 3 in EU Economy 2003 Review and Woessmann and Schuetz (2006).

([122]) Note, however, that a recent survey in six EU countries found that only a quarter of the surveyed inventors have a PhD (see Mariani et al. (2007).

2.5. The effect of higher R&D spending in the QUEST III model

The link between R&D and growth identified in empirical analysis stems from the observation of differences across countries and or sectors in R&D investment and economic performance. Since the results rely strongly of the quality of the underlying data, this method has obvious limitations. This section provides supplementary evidence in form of macroeconometric simulations with the QUEST III R&D model, which is an expanded version of the QUEST III model and encompasses endogenous R&D investment, following the endogenous growth literature (see Box 4.2.2 for a description of this model. The advantage of the use of model simulation resides in the possibility to study the general equilibrium effects, i.e. including the feed-back effects from changed macroeconomic variables. Moreover, the impact of different framework or financing conditions can be examined.

2.5.1. Assumptions and simulation design

The simulation exercise starts from the assumption that the current level of private R&D spending that we observe in the EU is optimal given available resources, in particular the number of high skilled workers (engineers and natural scientists), the technological environment for generating new knowledge (the efficiency of knowledge production in the EU), the level of taxation and subsidies given to firms which undertake R&D activities. However, because of positive externalities associated with the creation of knowledge the level of R&D spending is assumed to be suboptimal from a welfare point of view. Therefore government policies to support private R&D investment is likely to be welfare improving.

Governments dispose of various policy instruments to influence the R&D decision of the private sector (apart from conducting R&D investment directly). Broadly a distinction can be made between tax incentives to undertake R&D and improvements in the research infrastructure (e.g. increasing the pool of

Box 4.2.2 : **A description of the QUEST III R&D-model**

In order to assess the effect of R&D stimulating policies in the European Union DG ECFIN's QUEST III model with endogenous R&D is used. R&D investment is introduced following the literature on semi-endogenous growth (see, for example, Jones (1995)). For modelling R&D investment as a decision of the private sector, the characteristics of the innovation process must be captured. What distinguishes an innovation- which can be traded in the form of a patent- from a standard good is essentially its sunk cost nature. I. e. a firm which buys a patent and starts production of a new good must recuperate the initial sunk cost via monopoly rents over the product life cycle. This defines an arbitrage condition between the present discounted value of profits of the patent holder and the initial sunk cost which effectively determines the net market entry of new firms. In addition, the creation or production of new knowledge is modelled in terms of current research inputs (scientists and engineers for example) plus knowledge capital accumulated in the past.

As highlighted in the endogenous growth literature there are two distortions in the innovation process, namely monopoly rents required to cover the cost of patents and the knowledge spillovers embedded in the knowledge capital stock, which will generally lead to a market outcome with too little R&D spending. Thus policy measures can be devised to improve upon the non interventionist market solution.

In order to capture these features of the innovation process, it has proven useful to distinguish between the following sectors: A research sector which produces blueprints or patents. A sector which buys patents from the research sector to produce new goods and services and third a final goods sector which combines and uses old and new investment goods for producing final output. Resources are only partially mobile across sectors. For example, skilled workers can be employed both in the research and the final goods sector while unskilled workers can only work in the final goods sectors.

The main behavioural parameters on consumption, labour demand investment, prices, wages and production have been estimated using time series information. The parameters on R&D production have been calibrated using information from regression studies (Bottazzi and Peri (2007) and Coe and Helpman (1996)).

workers qualified to work in the R&D sector via increased expenditure on education). The simulations presented below explore the first alternative. Among the fiscal measures essentially a choice can be made between subsidising the production or the use of R&D. The results presented below are based on policies geared towards subsidising the use of R&D. More specifically, they explore the impact of tax cuts for R&D using industries, financed by an increase in consumption taxes. Consumption taxes have been chosen since they constitute the least distortionary financing instrument.

As regards the size of the shock introduced in the model, it is assumed in the simulations that EU governments intend to gradually close the gap between the R&D intensity in 2005 (1.8%) and the EU15 target of the National Reform Programs (2.7%) by 2015, and to maintain the achieved higher R&D intensity in the medium and long term.

In order to study the benefits of joint policies within the EU two experiments are conducted. In scenario 1 a single country (the Netherlands) is pursuing an active innovation policy, while in scenario 2 all EU countries engage in a policy of subsidising the use of R&D.

2.5.2. Simulation results

Table 4.2.2 shows the results from the first scenario with only one EU country increasing R&D expenditures. This policy would lead to an increase of GDP after 20 years of about 4% (which represents an average increase in the growth rate of 0.2% ([123]) p. a.). The R&D subsidies could be financed in a budgetary neutral fashion by a permanent increase in

([123]) The growth effect continues far beyond 2025 and levels off at around 25% higher GDP after more than 200 years.

consumption taxes of about 2.3% points ([124]). The consequence of this policy would be in a shift from physical investment towards R&D investment. While physical investment would only increase by slightly more than 1%, R&D investment would increase by about 50%.

Such a policy would induce an increase of employment in the R&D sector by more than 40%. This result is in line with the findings of Sheenan and Wyckoff (2003) which estimated that in order to reach the Lisbon R&D targets, the EU15 needs to employ 30% to 60% additional researchers. Such a restructuring of employment would not be achieved by an increase in the supply of high skilled labour. A reallocation of labour from the final goods production sector to the R&D sector would also be necessary as evidenced by declining employment in medium and low-skilled employment in Table 4.2.2.

Table 4.2.2

Tax-cut financed from consumption tax *single country* scenario (percent deviations from baseline)

	2005	2010	2015	2020	2025
GDP	-0.06	0.40	1.41	2.63	4.04
TFP	0.04	1.07	2.52	4.21	5.90
Capital	0.00	0.06	0.21	0.47	0.84
Employment	0.02	-0.01	-0.03	-0.10	-0.11
Employment-low	0.02	-0.02	-0.05	-0.14	-0.15
Employment-medium	0.02	-0.02	-0.03	-0.11	-0.11
Employment-high	0.09	0.02	0.04	0.07	0.07
Employment-R&D	9.34	31.26	40.11	45.53	44.81
Consumption	0.09	0.30	0.86	0.97	1.80
Investment	0.05	0.30	0.72	1.28	1.89
Wages-low skilled	0.09	0.67	1.80	3.20	4.63
Wages-high skilled	2.09	4.80	7.11	9.15	10.37
Prices	0.09	-0.10	-0.68	-1.49	-2.33
Terms of trade	0.07	-0.15	-0.84	-1.75	-2.70
Taxes on consumption	-0.21	-0.32	-0.04	2.32	2.33
Gov. budget	-0.01	-0.04	-0.05	-0.04	-0.06
R&D intensity	0.34	0.66	0.85	0.98	0.95

Welfare effect: 0.94 (2005); consumption equivalent welfare effect: 2.06

The increased demand for high skilled labour would increase the skill premium (high skilled wages increase by about 10%, low skilled wages increase by about 4%). Total employment would in fact decline slightly (-0.11% in 2025) because of the financing of the R&D expenditure leads to costly distortions.

The simulations also reveal that the reallocation of resources from production to research would result in a slight GDP loss in the first years of the implementation of the policy. However, the GDP loss would remain below -0.1% p. a. and would last over a period of about 5 years. The net welfare effect of such a policy would be equivalent to a permanent increase in consumption per capita of about 2.2%.

If all EU member states tried to pursue their R&D targets simultaneously, the welfare effects would about double and would be equivalent to a permanent increase of consumption of 4.3%. Initially this would not show up in higher GDP growth since it takes longer for the international spillovers to become effective. However, consumers would realise some of the additional income gains already in the short run, which leads to further temporary crowding out effects on investment.

Overall, the long run welfare effect would be about double compared to the scenario where only one country goes ahead. As can be seen from Table 4.2.3, both the financing costs and changes in employment and real wages would be fairly similar under both options. A noticeable difference occurs for the evolution of the terms of trade which would fall less under a combined policy (which adds to the additional welfare gain).

Table 4.2.3

Tax-cut financed from consumption tax *all member states* scenario (percent deviations from baseline)

	2005	2010	2015	2020	2025
GDP	-0.14	0.28	1.21	2.48	4.06
TFP	0.04	1.02	2.44	4.15	5.92
Capital	0.00	-0.02	0.01	0.26	0.76
Employment	-0.09	-0.18	-0.25	-0.28	-0.25
Employment-low	-0.10	-0.23	-0.32	-0.36	-0.33
Employment-medium	-0.09	-0.18	-0.25	-0.28	-0.25
Employment-high	0.00	-0.07	-0.09	-0.03	-0.01
Employment-R&D	8.81	29.68	38.77	45.35	45.20
Consumption	0.56	1.11	1.80	2.30	3.46
Investment	0.01	-0.07	0.25	1.27	2.26
Wages-low skilled	0.43	0.80	1.86	3.14	4.60
Wages-high skilled	2.03	4.60	6.96	9.16	10.62
Prices	0.19	1.43	2.82	3.82	4.45
Terms of trade	0.72	0.74	0.28	-0.50	-1.14
Taxes on consumption	-0.21	-0.25	0.05	2.24	2.21
Lump sum taxes	0.00	0.00	0.00	0.00	0.00
Gov. budget	-0.02	-0.20	-0.29	-0.23	-0.24
R&D intensity	0.32	0.63	0.83	0.98	0.96

Welfare effect: 1.98 (2005); consumption equivalent welfare effect: 4.27

2.5.3. Comparison with other results and conclusions

In view of the strong variation of the social returns of R&D reported in the empirical literature, it appears useful to compare the results of the model simulation

([124]) Initially a tax increase would not be required because of a frontloaded increase in consumption in anticipation of higher future income.

with other attempts to model the effect of increasing R&D investment. For example, in a similar exercise using the World Scan model of the CPB ([125]), Wobst (2006) estimated an increase of EU wide GDP of 2.6% and consumption of 1.1% in 2025 from implementing the R&D targets as outlined in the National Reform Programmes, using a conservative estimate on the social returns of R&D investment. It is also interesting to compare these results to other results that can be obtained from simply increasing TFP and using estimates of the social return of R&D. Such an exercise has been conducted recently by A. Bayar et al. (2007). Under these assumptions, the GreenMod model arrives at an increase of GDP of more than 10% in 2025. Thus, the simulation results presented above are in the middle between those obtained by Wobst (2006) and Bayar et al. (2007). All three model results have in common that they predict substantial positive effects.

Public support for R&D investment and education is motivated by the positive effects such activities have on welfare and growth. The simulations with DG ECFIN's QUEST model indeed provide evidence that tax breaks provided to R&D investment, financed by higher consumption taxes, could significantly raise economic and productivity growth. Specifically, if EU governments were to close the gap between the R&D intensity in 2005 (1.8% of GDP) to the EU target of 2.7% of GDP by 2015 enshrined in the National Reform Programs, growth in both GDP and productivity would be raised by 0.2 percentage point per annum. Taking favourable cross-border effects into account, the GDP growth effect could be even twice as high.

Such simulations should not be taken at face value, however, as the favourable effects may not materialise if certain preconditions are not met. For example, substitution may occur, with the private sector using the fiscal windfall to cut own funding. The use of targeted grants implicitly assumes that the government will be able to accurately select R&D projects that are worth developing. This problem is less pertinent if support takes the form of tax incentives. However, in the case of tax incentives there is a greater risk of "deadweight losses", with the government subsidising R&D investment that would have been carried out anyway.

In practice, government need to aim at higher levels of better targeted R&D investment, with more market based financing systems. Where feasible fiscal incentives to R&D should take over from direct budgetary support if deadweight losses can be contained and the R&D induced is genuinely 'additional'. To raise the odds of this happening, strong linkages between public and private research are need in combination with the more effective protection of intellectual property rights.

Moreover, if R&D activity is to expand more skilled researchers are needed. Otherwise the increase demand for these skills would merely raise wage costs and squeeze other investment activities. The initiatives in the framework of the Bologna Process towards the creation of the European Research Area and harmonised academic qualifications deserve all the support they can gather since the international mobility of skilled researchers urgently needs to be boosted. Initiatives to introduce the EU 'blue card' (following the example of the US Green Card) are welcome but further streamlining is required. Waste in education systems needs to be reduced and better results achieved.

([125]) The WorldScan version applied for the R&D simulations features endogenous firm decision on R&D spending and R&D spillovers. It has been developed at The CPB Netherlands Bureau for Economic Policy Analysis (www.cpb.nl).

3. Policies to enhance the impact of competition on innovation

3.1. Introduction

Competition in product markets is generally found to raise both the level and growth rate of productivity, although this finding needs to be qualified to the extent that some degree of market power may be required to raise sufficient funding for innovation. Against this backdrop, the sections below look at the transmission channels from competition onto productivity and reviews the broad strands of product market reforms in the EU – pertaining to the single market, deregulation of network industries and competition policy – in the pursuit of productivity performance and the empirical evidence on their impact.

3.2. The link between competition and economic growth

Competition determines firm behaviour

Competition affects productivity through three main channels ([126]):

- Allocative efficiency. If markets are contestable the market power of incumbents is reduced, thus leading to lower monopoly rents and lower prices. Market contestability also boosts productivity by more productive firms entering and the least productive firms exiting the market.
- Productive efficiency. Contestability of markets forcing incumbent firms to adopt best practices (productive efficiency). As a result so-called x-inefficiencies are reduced, contributing to greater efficiency in the organisation of work. Intensified competition also forces managers to adopt new technologies quicker.
- Dynamic efficiency. Competition induces firms to innovate so as to establish or maintain a competitive advantage, either in terms of lower cost or more sophisticated and differentiated products.

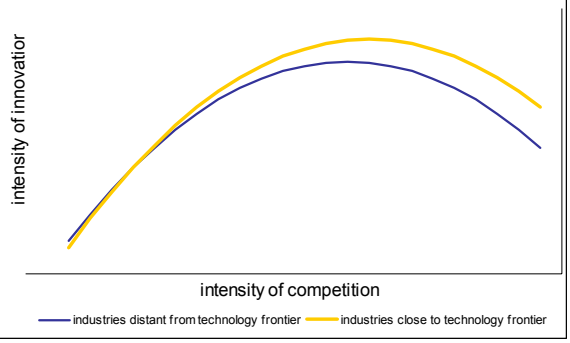
Although competition is not always easy to gauge empirically, there is evidence of a positive correlation between a range of competition indicators and productivity. For instance, Griffith and Harrison (2004) found that easier market entry, lower tariff rates and less public involvement reduce mark-ups and increase productivity ([127]). Griffith and Haskel (2006) were able to attribute 40% of the productivity variation across wholesale firms in the UK to differences in management practices. Similarly, Bloom and van Reenen (2006) found evidence of a strong correlation between productivity performance and management practices across firms.

However, an important qualifier is in order. It is sometimes argued that in fact innovation and monopoly rents would be positively correlated as first mover advantages may produce rents while, moreover, firms with high mark-ups typically command easier access to R&D funding. In fact, the relationship between competition and innovation is probably hump-shaped (see Aghion and Howitt 2005): too little competition hampers innovation and too much of it may do so as well (Graph 4.3.1). If competition is too weak, firms have few incentives to innovate and an increase in competition would stimulate innovation. At the other extreme of the curve, too intense competition reduces the incentives for innovation because the innovating firm would not be able to accrue any rents. Even so, Aghion et al. (2005) predict that most industries would be on the upward-sloping leg of the hump-shaped curve, i.e. more competition would be associated with more innovation. They also predict that for industries close to the technology frontier the relationship would be located more to the north-east, i.e. the link between competition and innovation is likely to be even stronger.

([126]) See also Chapter 5 in the EU Economy 2004 Review and Nicodeme and Sauner-Leroy (2007).

([127]) In follow up estimations, Griffith et al. (2006) found that higher mark-ups reduce TFP. But the estimate is not significant in all specifications.

Graph 4.3.1: **Relationship between competition and innovation according to Aghion**



Both hypotheses are broadly confirmed by empirical research. Blundell, Griffith and Van Reenen (1999) find that, while innovation activity is generally stronger in industries which are more competitive, the dominant firms appear to be the most innovative ones within any given industry. Griffith et al. (2006) confirm that competition increases innovative activity by incumbents, but also discourage market entry. The hypothesis that the relationship between competition and innovation is strongest in countries or industries that operate close to the technology frontier is also broadly confirmed. For instance, empirical results reported by Griffith et.al. (2006) presented in Table 4.3.1 show that patenting activity is more intense in a more competitive environment as gauged by lower rents. But it also shows the impact of competition is smaller the further away the industries are from the technology frontier.

Table 4.3.1

Griffith results (dependend variable: patents per 1000 population,and interaction with competition)

	GMM estimates		
	all	entrants	incumbents
Rents	-2,25	-0,93	-1,54
Distance to technology frontier	-6,68	-3,89	-4,68
Distance to frontier * rents	5,95	3,97	4,20

Note: All coefficients significant at 1% level. GMM estimates with control for output gap, with country, year and technology effects.

Source: Griffith et al (2006), p. 48.

3.3. Policies to foster competition and their effects

The Internal Market and trade integration ([128])

The single market programme is a key initiative in the pursuit of more competition in the EU. The elimination of non-tariff trade barriers has been a decisive step towards the creation of a large integrated market for goods and services. Ongoing reforms target *inter alia* of the remaining barriers to cross-border trade and investment in services and the adoption of common standards, mutual recognition and the development of an Internal Market for knowledge.

The single market affects productivity through three main channels:

- *Exposure to foreign competition:* Competition from imported disciplines the market behaviour of domestic firms and forces them to innovate rather than seeking rents in a context of trade and investment restrictions ([129]).
- *Economies of scale:* By increasing the size of markets, the internal market spurs firms to better capture the potential benefits of scale effects in production, distribution and marketing ([130]).
- *Technology transfers:* Openness to foreign investment is a major source of technology transfer and managerial skills, R&D and innovations also benefit from scale effects ([131]).

([128]) See also Chapter 2 in the 2007 Competitiveness Report (European Commission (2007)).
([129]) See Harrison (1994), Tybout (2003).
([130]) See Ades and Glaeser (1999), Alesina et al. (2000).
([131]) See Ahn and Hemmings (2000).

EU-initiated research generally confirms the positive impact of the single market and productivity and growth. A simulation carried out ten years after the launch of the SMP concluded that GDP would have been 1.8% lower in 2002 if the SMP had not been implemented over the period 1992-2002 ([132]). Ilzkovitz et al. (2007) suggest that the removal of remaining Internal Market barriers would double the effect of the enlarged Internal Market over the period 1992-2006, with their simulations pointing to a GDP increase of 2.2% in the EU-25. Sauner-Leroy (2003) showed that the rise in competition induced by the implementation of the Single Market Programme led EU manufacturing firms to increase their productive efficiency to compensate for lower prices and profit margins. A recent study provides estimates of the medium-term impact of the opening up of services to competition. A study by Copenhagen Economics (2005) calculated that freedom of establishment for service providers and free movement of services between Member States would raise GDP and employment by 0.6% and 0.3% respectively.

Such positive findings are also underpinned by research on the impact of trade-openness on growth more generally reported in the economic literature. For example, Frankel and Romer (1999) estimated that a 1 percentage point increase in the trade to GDP ratio causes almost a 2 percent increase in the level of per capita income. Wacziarg and Welch (2003) in a panel of countries extending from 1950 to 1998, find that, on average, a country grows at 1.5 percent per annum higher rate in the liberalized phase than in the protected phase, controlling for country and year effects. According to the OECD (2005), cuts in tariff rates would give a boost to output, even if tariff rates are already relatively low in some countries, increasing GDP per capita in the EU 15 by 0.4 percent. Moreover, the estimates suggest that the lowering of barriers to foreign direct investment to best practice levels could raise GDP per capita by 0.5 percent in the EU 15. Research focusing more specifically on the relationship between trade-openness and productivity using firm data also find strong evidence of a positive correlation, even when properly controlling for reverse causality (as more productive firms are likely to gain market share abroad). Box 4.3.1 provides an overview of these findings ([133]).

([132]) See European Commission (2002).

([133]) On the exogeneity issue, see for example Karacaovali (2006, World bank).

Box 4.3.1: **Recent evidence on the link between trade openness and productivity growth with firm data**

A number of recent studies found evidence that trade openness fosters productivity growth. By using data on firm performance, these studies confirm earlier research at more aggregated level. Taken together, it is remarkable that the effects from trade openness on productivity are both visible in various empirical set ups and work through a number of different channels. For example, Boulhol et al. (2006) presents evidence that import competition reduced profit margins and workers' bargaining power in UK manufacturing firms. The study by Griffith and Simpson (2003) showed that firms engaged in international trade tend to be more productive, have higher employment growth, and are higher wage firms than domestically oriented firms. Pavnic (2002) and Bernard et al. (2003) demonstrated that a lowering of trade barriers generates a reallocation of resources in favour of more productive firms, i.e. more productive firms enter and less productive firms shrink or exit the market. The paper by Bernard and al. (2003) further estimated that when aggregated, these reallocation effects could be quite large, making up over 40% of total factor productivity growth in the manufacturing sector. Selection effects from trade integration were also found in Del Gatto et al (2006) Gustavson and Segerstrom (2006). The latter argued that trade liberalisation caused the least productive firms to exit but also slowed the development of new products.

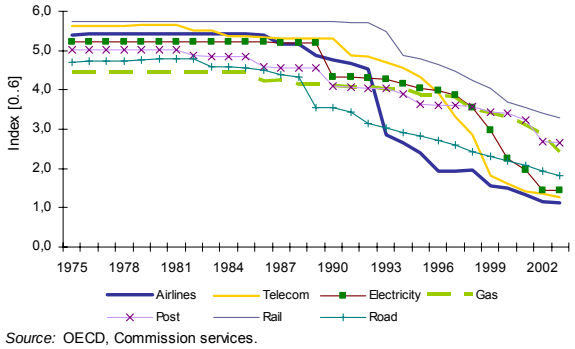
More evidence of further channels through which trade liberalisation has a favourable effect on productivity has been issued recently:

- According to Brambilla (2006), the activity of multinational enterprises increases the variation of goods;
- Differences in management practices may make foreign owned multinational enterprises more productive than domestically owned firms argue Bloom and van Reenen (2006) and Bloom et al. (2007). Thus, openness may foster productivity through a faster diffusion of more efficient management techniques;
- Girma and Goerg (2006) analyse whether higher productivity of multinational enterprises compared to domestic entities is motivated by scale or technology effects with UK plant data. Their results suggest that technological efficiency matters more than scale effects;
- Bernard et al. (2006b) argue that trade liberalisation fosters productivity growth through selection. The firms with lowest productivity are forced to exit and remaining firms are induced to dispense the production of the least productive goods;
- In a panel with Italian manufacturing firms, Altomonte et al. (2007) detect that productivity improvements through increased openness are more pronounced in vertical integrated firms, i.e. trade in intermediate goods, whereas the effect of stiffer competition and more imitation on productivity in horizontal industries in much smaller;
- Arnold et al. (2006) presented evidence from Czech firm-level data that liberalisation of services leads to productivity gains in downstream manufacturing. Higher competition in services increases the volume of goods trade also in the study done by Francois and Wooton (2007);
- The results of the study by Bassanini and Ernst (2002) with 18 industries in 18 OECD countries suggest that non-tariff barriers have a negative effect on R&D intensity;
- Egger et al (2005) reason that if increased openness is associated with capital market integration, it also fosters participation in higher education.

Liberalisation and regulation of network industries ([134])

Liberalisation and regulation of network industries is the second major strand of co-ordinated policies in the EU that potentially contribute to productivity via greater competition, although progress has varied. Liberalisation of network industries such as telecommunication, electricity, gas, but also port and postal services, rail and road transport have all been subject to reforms in the EU. Airlines have been deregulated in the early 1990s, telecommunication in the mid-1990s and electricity from the late-1990s onwards. Typically, liberalisation was stepwise, starting with the privatisation of public enterprises. Subsequently, regulation was adopted to ensure a level playing field for new market entrants against a dominant market position of incumbents. Since market conditions have proven to remain difficult with respect to market contestability and price levels, a third step involved the split of ownership between managing the networks and the provision of network services.

Graph 4.3.2: **OECD deregulation index for network industries, EU-15 aggregate**



Source: OECD, Commission services.

The available empirical evidence points to substantial positive effects of this policy on productivity . Hourly productivity increased in all network industries throughout the 1980s and 1990s and the average growth of productivity outpaced the average performance of the economy as a whole. The European Commission (2002b) found that the liberalisation of the telecommunication and electricity markets would lead to an increase of the GDP levels by 0.4% 4 years after the liberalisation and by 0.6% 10 years after liberalisation. In a study for the European Commission, Copenhagen Economics (2005) estimates productivity gains from market opening in the different network industries varying between 6% in urban passenger transport and 8% in electricity up to more than 250% in rail transport.

Table 4.3.2
Forecasted changes in sectoral prices and productivity as a consequence of market opening

	Change in sectoral productivity		
	short run	long run	
		min	max
Electricity	2	7	8
Urban passenger transport	1	2	6
Rail passenger	-7	-9	-12
Rail freight transport	47	83	261
Telecom	24	57	75
Air passenger transport	13	15	17
Postal services	28	36	37

Source: Copenhagen Economics (2005).

Some other studies looked at the effect of deregulation in network industries on investment, which is of particular interest because investment is an important determinant of labour productivity. Alesina et al. (2003) found that regulatory reforms have had a significant positive impact on capital accumulation in the transport (airlines, road freight and railways), communication (telecommunications and postal services) and utilities (electricity and gas) sectors. Using the results by Alesina et al., Nicoletti and Scarpetta (2005) predict that if Germany, France and Italy were to align regulation in non-manufacturing industries with US standards their investment rate would increase by 2.3 percentage points in the long-run.

Reducing public ownership is identified as another factor behind rapid productivity growth in network industries. OECD (2005) estimated that reducing public ownership in the EU15 could increase TFP levels by 1.7 percent. Using the parameters estimated by Griffith and Harrison (2004), Nicodeme and Sauner-Leroy (2007) compute that reforms that would put the EU 15 at par with the USA as regards public ownership would boost labour productivity by 1.1 percent.

([134]) See also Chapter 2 in the 2007 Competitiveness Report (European Commission (2007)).

Competition policy

The third major strand of EU policies that affects innovation through competition is competition policy. Competition policy aims at limiting market power and preventing the abuse of dominant market position. Although the effect of competition on innovation is theoretically ambiguous, the available evidence presented above points to market power generally being associated with allocative, productive and dynamic efficiency.

Efficiency considerations are not the prime driver of EC competition policy, but they are taken into account indirectly ([135]). Antitrust and merger control policy typically aims to maximise consumer welfare, rather than total welfare. Although in rare cases these two alternative standards may conflict, they are normally compatible. For example, anti-cartel actions and prohibitions of mergers typically occur in cases where there is clearly an increase of market power with no countervailing gains in productive or transactional efficiency. In such circumstances, the loss of consumer welfare always exceeds the increase in producer surplus, so that intervention by a competition authority to protect consumer welfare also increases total welfare. Being based on a "rule of reason" approach rather than a list of per se prohibitions, EU competition policy also allows efficiency gains to be taken into account. If the parties involved in an agreement between firms or a merger can show that, because of efficiency gains, the net effect on consumers is positive, the transaction will normally be allowed ([136]).

Empirical research finds a strong link between the stance of competition policy and productivity. The seminal analysis conducted by Nickell (1996), considered the link between market structure and both the level and growth rate in TFP. By using a Lerner index as proxy for the market power of UK manufacturing firms, he demonstrated a sizeable impact of rents on TFP. Dutz and Vagliasindi (2000) and Vagliasindi (2001) find a significant effect of competition policy in transition economies, as gauged by the impact of concentration and foreign competitors, on the mobility of enterprises. Dutz and Hayri (1999) established a strong positive correlation between the perceived effectiveness of competition policy (by business executives) and long-run growth. According to Nicoletti and Scarpetta (2003), lower entry barriers and less state control are positively correlated with catch-up productivity growth in manufacturing industries. Griffith and Harrison (2004), when analysing the determinants of profit mark-ups, found that entry barriers play a sizeable role. Alesina, Ardagna, Nicoletti and Schiantarelli (2003) found that barriers to entry had a significant negative effect on investment in OECD countries over the 1975-1998, but that public ownership has no significant effect due to incentives in public firms to over-invest. Cincera and Galgau (2005) yielded a significant direct relationship between market entry/exit and labour productivity. Taking their estimates at face value, a 1% increase in entry rates would raise labour productivity in an industry by 0.6% per year.

The impact of product market reforms at large

Research that estimates the combined impact of composite measures of market reform also find a positive impact. A number of empirical studies make use of some aggregate indicators of product market reforms, which have been developed by the OECD, the Frazer institute or the World Bank ([137]). They document that tighter product market regulation has a weakening effect on different economic activities that are directly or indirectly linked with productivity growth.

- IMF (2004) estimated that a one-standard deviation increase in the OECD indicators of

([135]) There is a large degree of complementarity and interaction between the Community and national level in the area of enforcement of EC competition rules. Most countries are strengthening their competition enforcement regimes in line with the modernised Community competition rules. While enforcement procedures have not been formally harmonised by EC law, there is, in many instances, convergence of national laws beyond legal obligations towards the Community standard. Such convergence entails considerable benefits for undertakings in the EU in terms greater predictability.

([136]) Similarly, the other branch of EU competition policy, state aid control, applies the principle that state aid can be tolerated if it is a suitable and proportionate instrument for remedying a market failure. State aid in support of research, for example, permits the exploitation of the positive externalities and may contribute to increased innovation. On the other hand, there remains serious doubt about the effectiveness of State aid as a tool to attract investment.

([137]) For a description of these indictors, see Chapter VI in the EU Economy 2006 Review, or Crafts (2006).

product market reforms would lift per capita GDP after 4 years by 7%.

- Using a panel of 20 OECD countries for the period 1985-1995, Salgado (2002) estimated the potential impact of product market reforms (i.e. reductions in tariff rates as well as the deregulation and liberalisation of product markets) on total factor productivity growth to be between 0.2 and 0.3 percentage points a year in the long run.

- Nicoletti and Scarpetta (2005) relate a large number of reforms to TFP growth across OECD countries (see Table 4.3.3). Their estimates suggest that the impact of reforms is larger for countries further behind the technology frontier. Those countries and industries experiencing the greatest reform temporarily grew faster. In a follow up study, they quantify that TFP in continental European economies could increase by between 0.4 and 1.1% after 10 years, if these would align their industry-specific regulation with that of the most liberal OECD countries ([138]).

- A number of studies found that regulation has a negative impact on market entry (Klapper et al. (2004), Brandt (2005), Cincera and Galgau (2005)). Market entry is positively correlated with productivity growth (see above).

- Bassanini and Ernst (2002) use various OECD indicators of product market regulation and investigate their effect on industry R&D intensity. Their cross country evidence seems to suggest that product market reforms would have positive effects on innovation in manufacturing industries, especially non-tariff barriers and inward deregulation (state-control and barriers to entrepreneurship).

- Alesina et al., 2005 came up with evidence that the impact of deregulation on investment is greater when the policy reform is large and when changes occur in highly regulated economies.

- Conway et al. (2006) studied the effect of product market regulation on the international diffusion of new technologies, finding that product market regulation has a negative impact on the adoption of information and communications technology and on the location decisions of multi-national enterprises.

- The Bassanini and Brunello (2007) paper suggests that an increase in product market deregulation generates a sizeable increase in training incidence.

Table 4.3.3

Change in TFP growth over 10 years from adopting regulatory best practices

	overall regulatory reform	industry-specific reform	total effect
AT	0,10	0,32	0,42
BE	0,15	0,45	0,60
DK	0,10	0,27	0,37
FI	0,04	0,55	0,59
FR	0,19	0,43	0,62
DE	0,08	0,62	0,70
EL	0,29	0,83	1,12
IT	0,22	0,48	0,70
NL	0,11	0,34	0,44
PT	0,23	0,42	0,65
ES	0,12	0,28	0,41
SE	0,01	0,50	0,51
UK	0,00	0,11	0,11

Source: Nicoletti and Scarpetta (2005).

3.4. The effects of higher competition in the QUEST II model

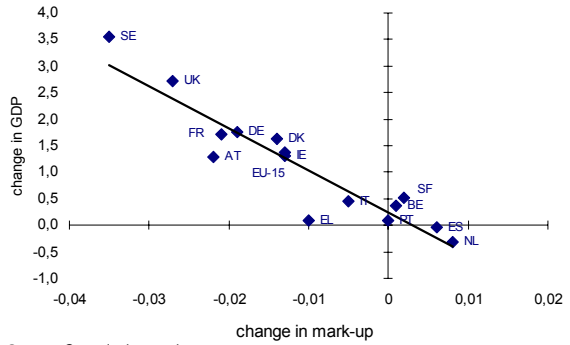
Chapter 4 presented simulations with the QUEST II model of changes in labour market and product market regulations. The objective of this exercise consisted in translating the observed changes in institutional indicators between 1995 and 2003 into shocks to variables in the QUEST model. Since the simulations are already shown in Chapter 4, it should suffice here to give a brief summary of the simulation that concerned a reduction in mark-ups.

For this exercise, changes in the Frazer indicator of product market reforms were translated into changes in mark-ups using the estimates from Griffith and Harrison (2004). These mark-up shocks can be relatively easily introduced in the QUEST II model since it assumes competition to be imperfect. That is, firms do not take prices as given, but they set prices by varying the mark-up according to demand conditions. In the model, the smaller mark-up shifts up the demand for capital and labour because firms are willing to engage in projects which earn a lower marginal product. Table 4.3.4 reiterates the assumed

([138]) See Nicoletti and Scarpetta (2005).

change in the mark-ups derived from the changes in the Frazer indicators and the resulting GDP effect in QUEST II. Overall, Graph 4.3.3 suggests that the magnitude of the GDP effect is broadly proportional to the change in the mark-up, with the variation around the regression line mostly explained by differences in terms-of-trade effects. The largest impact on GDP can be observed for Sweden and the UK, consistent with a sizeable reduction of mark-ups.

Graph 4.3.3: **Simulation results: changes in mark-ups**



Source: Commission services.

Making use of a rather close correlation between changes in unemployment rates and employment rates in most EU-15 countries, the change in labour productivity can be deducted from the simulation results ([139]). Accordingly, the final column in Table 4.3.4 can be read as the impact of changes in profit margins on labour productivity in the various Member States. At the EU level, the results suggest that a decline in profit mark-ups of 1.3 percentage points would yield an increase of GDP of 1.4%, which is composed of a 1% increase in employment and 0.3% higher level of labour productivity.

Table 4.3.4
The impact of changes in mark ups on labour productivity in the QUEST model

	Change in mark-up [(1)]	GDP effect	Unemploy-ment	Employ-ment	Labour produ-ctivity
BE	0,001	0,37	-0,20	0,18	0,19
DK	-0,014	1,63	-0,95	0,83	0,80
DE	-0,019	1,75	-1,13	1,30	0,45
IE	-0,013	1,31	-0,54	0,89	0,42
EL	-0,010	0,10	0,03	*0,01*	0,09
ES	0,006	-0,03	0,11	-0,10	0,07
FR	-0,021	1,72	-0,72	0,91	0,81
IT	-0,005	0,45	-0,09	0,12	0,33
NL	0,008	-0,31	0,17	-0,27	-0,04
AT	-0,022	1,29	-0,47	0,91	0,38
PT	0,000	0,08	0,00	*0,00*	0,08
SF	0,002	0,51	-0,16	0,17	0,34
SE	-0,035	3,55	-1,38	1,64	1,91
UK	-0,027	2,71	-1,45	1,15	1,56
EU-15	-0,013	1,38	-0,71	1,02	0,36

[(1)] estimated change 1995-2003 used as shock to the Quest model.

Model-based analysis in Bayoumi et al. (2004) showed that competition friendly product market reforms, reducing the price-mark-up in the euro area by 10 percentage point, would lead to a GDP level increase in the euro area of 4.3% in the long run. Following a similar modelling strategy, Bayoumi et al. (2004) computed that if product market reforms were leading to a price mark-up in the euro area similar to the US level, i.e. around 12% lower according to their estimates, the GDP level would increase in the Euro-area by 8.6% (relative to its baseline level) in the long run. Thus, these simulations obtained a smaller, but nevertheless sizeable, impact of changes in mark-ups on GDP than the QUEST simulations above.

3.5. Policy conclusions

Competition is crucial for both the level and growth rate of productivity. Market contestability puts pressure on firms to innovate and favours the turnover of firms by prompting competitive firms to enter the market and less competitive ones to exit the market. Although economic theory conjectured that intense competition would detract firms from innovating because they would not be able to collect the required funds, the empirical evidence suggests that these concerns appear to be overblown, even if it is true that the most innovative firm in a market is usually the dominant one.

Empirical research to estimate the impact of each of these policy areas, either in isolation or combined,

([139]) The empirical link between employment and unemployment rates was relatively loose in Greece and Portugal. However, since unemployment in these two countries hardly responded to changes in mark-ups, the expansion in GDP is almost entirely driven by higher labour productivity in these two countries.

confirm the expected positive effects on productivity and growth. Simulations with QUEST to compute the macroeconomic impact of the increase in competitive pressure on product markets that has taken place in the 1995-2003 period, suggest a positive effect on GDP amounting to almost 1.5%, consisting of a 1% increase in employment and a 0.5% increase in labour productivity. Again this confirms that policies targeted on raising productivity also can have a positive impact on employment, i.e. the sometimes presumed employment-productivity trade-off is a fallacy.

EU policies in the pursuit of stronger competition are three-pronged and while their primary objective may not be to raise productivity, they are clearly helpful in this regard. Specifically, the internal market initiative stimulates productivity by increasing the exposure of firms to foreign competition, economies of scale (including in R&D activities) and the easier cross-border transfer of technology and managerial skills. As noted, moreover, the liberalisation and regulation of network industries such as telecommunication, electricity, gas postal services, rail, road and air transport have contributed to productivity. Finally, competition policy proper has contributed to lower entry barriers and less state control.

Warranted are nevertheless further steps to complete the internal market initiative and to actively improve the contestability of markets, notably the liberalisation of services where the scope for productivity growth appears most pertinent. More flexible regulatory and institutional frameworks are able to deliver a dynamic and competitive business environment in the services industry, notably in retail trade.

4. Policies to foster reallocation

4.1. Introduction

To the extent that economic growth is driven by an expansion of the technology frontier, the economy will be exposed to structural change. New high technology sectors may gain market shares at the expense of shrinking sectors. New firms may become important players and well-established firms may be forced to exit the market. Economic institutions and policy interests in the EU may have been too much focused on preserving economic structures. Big firms have repeatedly been bailed out when they were under financial stress. Similarly, efforts to reduce social tensions in declining industries might have left fewer financial means available to spur structural change.

Modern economic theory considers structural change an inevitable consequence of innovation and economic growth. The reallocation of production factors from economic activity in low-productivity enterprises towards innovative firms assumes a main role in the paradigm of creative destruction. Competition between market entrants and incumbents then ensures the survival of the most profitable and productive firms. The reallocation effect has gained in prominence over the recent years. The rising interest in this channel has been motivated in particular by the observation that market entry of new firms and rapid growth of young firms made an important contribution to the diffusion of ICT and thereby enhanced productivity in the USA. Some economists attributed the rising productivity gap towards the USA to a better adaptability of the US economy to the "technological revolution" of ICT ([140]). Many EU Member States were blamed for having institutional structures that were not sufficiently conducive to the take up of new technologies, meaning fewer entrants, less competitive pressure on incumbents and higher survival of low-productivity firms ([141]). The Nordic countries are seen as the exception. Market regulation, human capital, R&D investments and venture capital have been highlighted as reasons why they were better positioned to accrue the benefits of ICT than other EU Member States ([142]).

4.2. How important is the reallocation effect?

Though theory and policy implications of the reallocation effect are largely undisputed, the empirical evidence is still scarce. On the one hand, business demography statistics reveal that there is substantial turnover of firms. About 9% of all firms in 2004 were founded each year 7.5% of the firms exit the market on average each year in those of the old EU Member States for which data is available. About 20% of newly founded firms have been found to exit the market after 2 years, implying that around 80% of new firms survive. In the new Member States, both birth and death rates were a third to a fourth higher. Survival rates were also around 5 percentage point higher than in the old Member States. The observation that reallocation effects play a more important role in the new compared to the old Member States is also confirmed by a higher pace of inter-sectoral job switching ([143]).

Statistical analysis suggests that aggregate productivity growth appears to be still dominated by intra-firm or intra-sectoral productivity growth in most economies. Only a small contribution to productivity growth stems from new market entrants. One obvious reason is that by their nature most new firms are small relative to incumbents. Only 0.5% of new firms start with more than 20 employees and more than 50% without any employee, compared to almost 5% of the existing firms which are staffed with more than 20 employees. Moreover, several studies that analyse the productivity performance of new firms suggest that their productivity level is often lower than that of incumbents in the first years of operation ([144]). They experience high productivity

([140]) David (1990) compared the economic effects of ICT to those of the spread of electricity. Brynjolfsson and Hitt (2000) describe ICT as a general purpose technology that leads to return in excess of those emerging from pure capital-deepening because ICT fosters innovation and restructuring of organisations.

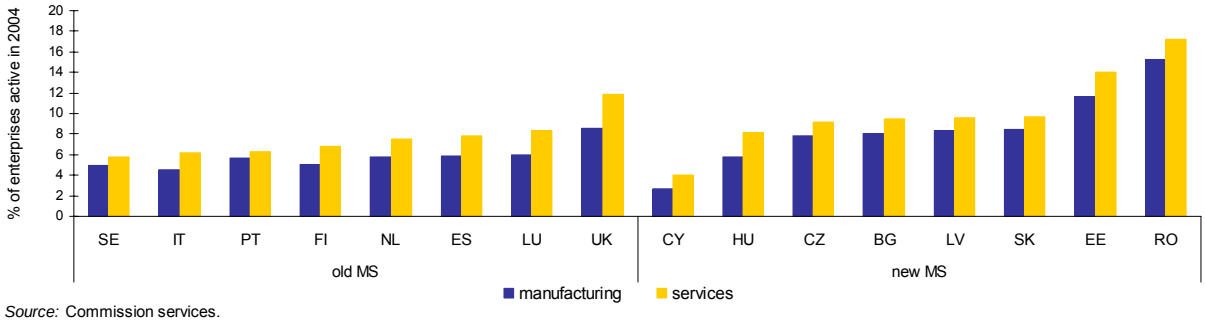
([141]) See, for example, Greenspan (2000), Gust and Marquez (2002). Linked to this literature is also the so-called "Solow paradox", which motivated studies on the length of adjustment to technical progress. In the late 1980s, it was found paradoxical that investment in IT did not show up in productivity statistics for a long time.

([142]) See Annenkov and Madaschi (2005).

([143]) According to Browne and Earle (2006), reforms and liberalisation were instrumental in this and yielded that reallocation effects boosted productivity.

([144]) See Bartelsmann et al. (20004) for a panel of 24 countries, Wagner (2007) with German and Farinas and Ruano (2005).

Graph 4.4.1: **Birth rate of new enterprises 2003-2004**



Source: Commission services.

growth only later in their life cycles and then tend to accomplish a higher productivity level than incumbent firms.

Consequently, productivity developments in existing firms accounts for the bulk of aggregate productivity growth. Previous analysis by OECD researchers and the European Commission with cross-country data confirmed that reallocation across firms or across sectors contributed positively to aggregate productivity growth, but by a relatively small amount ([145]). In contrast to these results, Bartelsman et al. (2004) calculated that the reallocation effect could be sizeable. Using a novel comprehensive dataset of 24 countries, they quantified the size of the reallocation effect at 20 to 50% of aggregate productivity growth. Other studies with US, Canadian or German data support the notion that the reallocation may be more important than earlier studies obtained ([146]). An exact magnitude seems, however, to be difficult to establish. There is the suspicion that different methods lead to contradicting results and that the way how real output is computed may lead to an underestimation of the productivity contribution from newcomers ([147]). One possible reason is that firms are more interested in nominal profits than in real productivity. As young firm may charge lower prices than incumbents, their true productivity would be underestimates once their output or value added is deflated with sector-wide prices. Less controversial than the size of the reallocation effect are some more specific results:

- There is huge heterogeneity of productivity in firms engaged in the same sector. Bartelsman and Doon (2000) report that the most productive firm in a sector could be twice as productive as the least productive one. The market share of low-productivity firms seems to be more important for cross-country productivity differences than that of star performers.

- Market exit of low-productivity enterprises matters more for aggregate productivity performance than market entry of new firms. For example, in Bartelsman et al. (2004) the contribution to productivity growth of market entry was negative in most OECD countries. Fogel et al. (2006) document that the more stable the size of big firms in an economy, the lower aggregate productivity growth.

- There is a pronounced difference between the US and Western European economies with respect to firm growth. Newly established US firms seem to expand much faster. Since firms that survive the first years of their existence also tend to experience fast productivity growth, structural limitations to firm expansion may be at least as important for the productivity difference between the US and the EU as entry conditions. ([148])

with Spanish data. The opposite result was found for French firms by Bellone et al. (2006).

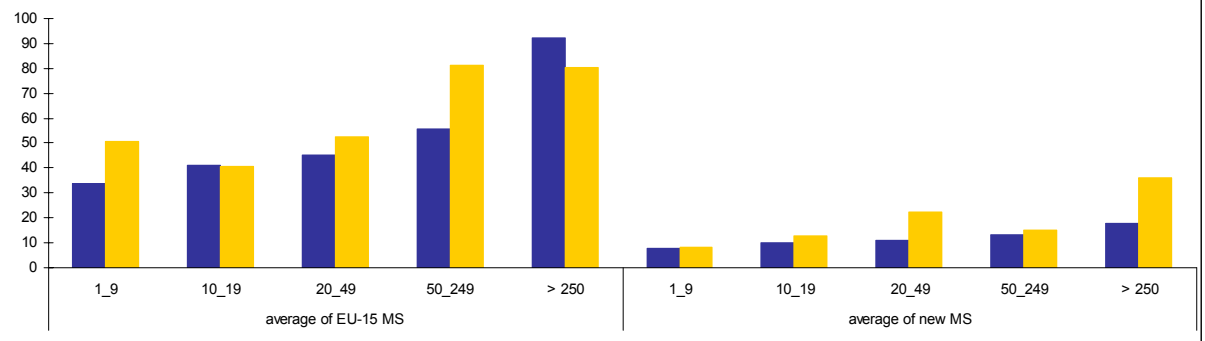
([145]) See OECD (2003, Sources of growth), ECFIN Review (2003), Foster et al. (2005).

([146]) Foster et al. (1998), Baldwin and Gu (2006) and Cantner and Krueger (2005).

([147]) See Metcalfe and Miles (2007) and Foster et al. (2005).

([148]) This has implications for the optimal design of policies in support of SMEs. Generally, the policy measures that aim at better reallocation capacity reported in Chapter 4.4.3 are relevant for both market entry and firm growth.

Graph 4.4.2: **Labour productivity by firm size**



Source: Commission services.

- Some important insights also emerged with respect to the composition of productivity growth within existing firms.

- Productivity growth within existing firms is often associated with declining market shares, implying that productivity improvements may be due to downscaling rather than expansion. In Nordhaus (2006), a 1% higher productivity growth is associated with 0.25% smaller employment in the total economy. The effect is different in manufacturing. There, productivity gains lead higher employment, which is likely due to the positive impact of productivity on international cost competitiveness and export performance.

- Higher market entry is also associated with higher productivity growth accomplished by incumbents. Bartelsman et al. (2004) demonstrate a positive correlation between productivity growth in incumbents and the contribution to productivity growth from new entrants as well as with firm turnover rates. Thus, contestable markets seem to force incumbents to improve productivity, leading to aggregate productivity gains even if actual market entry is small.

- Recently, Crespi et al. (2007) detected in a panel of UK firms that firms, which lost market shares, are more likely to introduce organisational change. At the same time, their estimates reveal a strong interaction effect of ICT and organisational change, suggesting that only firms that complement ICT investment with organisational change record a strong improvement in productivity.

- Studies for the retailing services, where a large productivity growth difference between the US and the EU has been observed, suggest that a high share of productivity improvements in existing firms is due to new establishments, mainly the replacement of old stores through new formats. Research also showed that many existing US manufacturing companies change their product mix over time and this behaviour is estimated to contribute more to aggregate productivity growth than firm entry and exit ([149]).

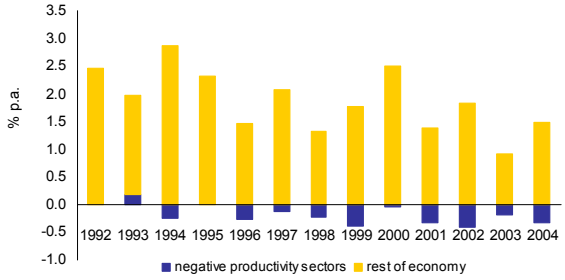
The positive image of reallocation effects in the microeconomic literature contrasts with a more sceptical view voiced by some macroeconomists. The so-called Baumol's disease claims that reallocation means that more resources become employed in low productivity sectors, usually illustrated as services or more-specifically personal services. Thus, the flow of labour is not necessarily from low to high-productivity sectors, but from high to low productivity sectors. Graph 4.4.3 shows that in the EU-15, indeed, some sectors with negative productivity growth experienced an expansion of employment and output relative to the total economy.

Due to the impact of two effects, namely that labour costs tend to equate over sectors and demand for these low-productivity services is often price-inelastic, the rising share of resources in low-productivity sectors over time may translate into lower aggregate productivity growth. The impact of the shift of resources towards lower productivity sectors can be calculated by means of fixed-share analysis. For the

([149]) Foster et al. (2002), Bernard et al. (2006a).

USA, Nordhaus (2006) computed that reallocation reduced productivity growth by half a percentage point on average 1948-1961. EU-KLEMS data for the EU-15 reveals that a number of sectors recorded negative productivity growth in 1996-2004. Adding up their contribution to aggregate productivity growth yields that sector-specific negative productivity growth deducted about 0.25 percentage point over this period. This is not a marginal amount, but clearly dominated by productivity developments in sectors with positive albeit decelerating productivity growth ([150]).

Graph 4.4.3: **Contribution of negative productivity sectors to aggregate productivity growth, EU-15**



Note: Sectors with negative productivity are hotels and restaurants, R&D, other business services, education, other community services, private households. *Source:* EU KLEMS, Commission services.

Though the Baumol effect captures primarily a measurement problem rather than a welfare issue, it has some relevant policy implications. An important issue is that productivity improvement may lead to the same output produced with less input, freeing resources for use in other sectors rather than to more output produced in a sector with an unchanged amount of resources. According to some scholars, the cost reduction effects are the dominant consequence of productivity growth. For example, the above mentioned paper by Nordhaus (2006) estimated with US data that in the long term consumers accrue 95% of the benefits of innovation in the form of lower prices. Only a tiny share accrues in the form of higher wages and capital income in the sectors concerned. Wages and profits are largely determined by aggregate economic developments and not by productivity developments in individual sectors. Thus, downward price stickiness and wage bargaining may have an important impact of the transmission of the productivity advances via lower prices towards real income gains.

Moreover, if productivity gains lead to a more efficient production of the same amount of output, the overall welfare gains will depend on the deployment of freed resources. To some extent, the real income gains through lower prices will spur a re-direction of demand. It is a central piece of the Baumol disease that demand for some services is little price elastic, implying that it depends mainly on income developments. In line with this notion, Table 4.4.1 shows that low-productivity services witnessed an increase in both value added and employment shares relative to the total economy despite strong increases in relative prices.

Table 4.4.1

Economic performance in sectors with low productivity growth 1995-2004

	Relative productivity performance	Increase in share in value added	Increase in share in hours worked	Increase in relative price
Hotels and restaurants	-15.0	0.3	0.5	27.4
Insurance and pension funds	-33.1	0.1	-0.1	73.4
Other business activities	-28.6	0.3	0.8	24.0
Education	-18.7	0.4	0.4	18.5
Sewage and refuse disposal	-24.2	0.1	0.1	16.7
Private households with employed persons	-16.8	0.1	0.2	15.2

Note: Relative performance is expressed in comparison to total industry value added
Source: EU KLEMS.

With respect to potential demand for services, Pissarides (2006) argued that prices in low-productivity services need to be sufficiently high in order to provide incentives for labour to move into them. He reasoned that both job creation and compensation in low-productivity jobs was high in the USA because rising income allowed consumers to afford higher prices for services. In addition, Pissaridies identified several reasons of why market production was more attractive in the USA than home production, ranging from labour market regulation via availability of child care services and household aids to entry regulation and taxation. For these reasons, employment in low productivity sectors expanded in the USA much more than in the EU.

([150]) A recent study by Inklaar et al. (2003) analysed the growth differential between the periods 1979-1995 and 1995-2000 in the US and EU-4 and did not find large reallocation effects. According to their study, sectoral employment reallocation has increased growth in the US by 0.05% points (p. a.) and reduced growth by -.06% points (p. a.) in EU-4.

4.3. Economic policy measures that impact on reallocation

The expansion of the technology frontier is not a costless operation to the extent that it will expose the economy to structural change. The adjustment capacity of the economy is thus crucial in ensuring that a maximum benefit is drawn from technological change. However, the EU Member States are susceptible to have limited capacity to adjust due to limited flexibility allowed for by labour market institutions and rule books.

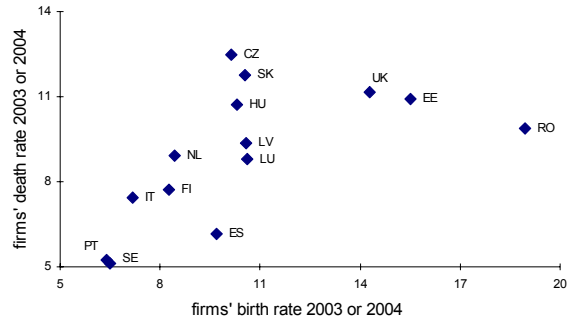
4.3.1. Facilitating market entry ([151])

A number of measures have been undertaken in the various EU Member States over recent years to facilitate market entry. One of the most prominent measures concerned the reduction of administrative costs for entrants through the creation of one-stop shops, replacing contacts with a multitude of administrations before a firm can be opened, and the reduction of time and costs required for registering a new company. In several countries, accounting rules have been simplified, statistical reporting burdens reduced and business support measures reformed.

Other measures targeted framework conditions relevant for new firms. Some of those aimed at improving access to finance for SMEs by introducing venture capital instruments, loan guarantee schemes or rising risk financing by public banks. A further strand of policies intends to provide practical help to firm founders through the creation of business incubators, networks of business angels and technology parks. Measures in the area of education were also seen as potentially important. For example, initiatives to teach entrepreneurship in higher education were launched in a few countries.

The observation that entry and exit rates are closely correlated across countries was interpreted by academics as indicating that net market entry is not an accumulation process, but follows the characteristics of a search process. Thus, an institutional framework that is conducive to experimentation would encourage higher firm entry. Therefore, it is useful to note that several Member States reviewed their bankruptcy legislation. One strategy was to promote the continuity of viable enterprises rather than their liquidation. Another one was to accelerate bankruptcy proceedings and facilitate fresh-starts. Although improved mechanism for business transfer have not yet played a prominent role in reform plans, the rise of private equity in many Member States, suggests that business transfers have an important role in practice for structural change. However, mergers and acquisitions, especially when a cross-border dimension is involved, have often been regarded controversial by political actors.

Graph 4.4.4: **Correlation between firm entry and exit**



Source: Commission services.

It still appears premature to estimate the impact of the undertaken measures on market entry, reallocation and productivity performance. One reason is that official data on firm entry and exit is lagging by several years. Currently, the most recent observation available in Eurostat concerns the year 2004 and is only available for half of the EU Member States. Moreover, these figures tend to vary strongly over the business cycle, which makes it difficult to disentangle the effect of policy measures for cyclical effects.

There has been up to now little empirical research on product market determinants of reallocation. Overall, it appears as if ensuring a high degree of competition and deregulation could foster reallocation effects. A recent study by Fogel et al. (2006) suggests that changes in the market position of large enterprises are more pronounced in countries with higher income and small governments. They also found common law, smaller banking systems, stronger shareholder rights, contestable markets and openness to be conducive to stronger "creative destruction". As regards the

([151]) For more information on the measures listed below, see the European Commission's Annual Progress Report and the 2007 Competitiveness Report, European Commission (2006, 2007).

determinants of market entry, empirical studies identified a wealth of firm and industry-specific factors ([152]). Capital intensity and high R&D intensity seem to deter market entry whereas past profits in a sector appear not to be a main driving force of market entry. According to the results in Cincera and Galgau (2005), product market deregulation improves entry in manufacturing and in few services sectors. They did not detect evidence that a reduction in the time spent with government bureaucracy or of the restrictions on FDI had a significant impact on entry and exit rates. A slightly different picture emerges from the cross-country study undertaken by Klapper et al. (2004). This study found that entry rates in "naturally high entry industries" are lower in countries with more cumbersome entry regulation. However, this study also sees a potentially beneficial impact of regulation on market entry provided it contributes to the enforcement of intellectual property rights and a well-developed financial system.

Policy-relevant factors concern adjustment costs and entry-deterring strategies of incumbents. This means that access to finance and a competition policy that ensures contestable markets are important triggers in any reform strategy that aims at fostering reallocation. However, some observers expressed concerns that policies that privilege SMEs may have the adverse side affect of preventing the growth of SMEs. These cautions are motivated by the observations that firm growth rates differ more between the EU Member States and the USA than entry rates in combination with the insight that new firms' productivity performance improves markedly when they grow. Cincera and Galgau (2005) note that it takes new firms 5 to 10 years before they are able to fully compete with incumbents.

4.3.2. Reduction of administrative burden ([153])

Reducing the administrative burden faced by companies is often regarded as an important policy to stimulate market entry and new firm's growth potential. Administrative costs are the costs incurred by enterprises and others in meeting legal obligations to provide information on their activities or their production to public authorities or private parties. It appears to be useful to distinguish between administrative costs, which include information that would be collected by businesses even in the absence of the legislation and administrative burden, which is information that would not be collected without the legal provisions. ([154])

While big and small firms may face administrative costs alike, the burden may be much greater for smaller firms, given their smaller size. The reduction of administrative burden consequently is one of the five most important goals on the EU's Lisbon agenda. In a recently presented Action programme the EU Commission intents to work with Member States to cut the administrative burden by about 25%. The programme focuses on information obligations implied both by EC legislation and by national law. In their National Reform Programmes, all EU Member States announced measures that aim at improving the business environment in their National Reform Programmes. Progress in measuring and reducing administrative burden is underway in many Member States, with some having announced concrete reduction targets. However, the reduction of administrative burden is only one element of better regulation. Systematic simplification programmes have been implemented in around half of the EU Member States and while the importance of impact assessments for designing legislative proposals is well understood, only few countries systematically assess all relevant impacts of legislative proposals.

In practice, the reduction of regulation and administrative costs has been difficult, also because most of the measures were introduced for specific reasons. They serve to correct market failures, to protect market participants or to provide policy makers with information. Even without legal obligations, enterprises may find it useful to collect information and reveal them to business partners or financial institutions. Moreover, the administrative costs of collecting and providing information need to be weighted against the value of information for policy makers. The demand for more transparency in financial markets, for example, implies the incurrence of higher administrative costs to financial firms.

([152]) For a review and further estimates, see Cincera and Galgau (2005).

([153]) See also Chapter 2 in the 2007 Competitiveness Report (European Commission (2007)).

([154]) See European Commission (2006).

Nevertheless, the cumulative impact of such regulations may impose substantial economic costs. The UK-based Better Regulation Task Force reckoned that costs to comply, keeping records and providing information to authorities could be 3-4 % of GDP. A similar estimate was obtained and by the Dutch Central Planning Bureau (CPB), which suggested that administrative costs imposed on European companies are in the order of magnitude of 3.4% of GDP. An additional important insight supplied by the Dutch study is that the administrative costs are to a large extent size independent overhead costs, which make the burden especially hard to bear for small and medium sized enterprises and for business start ups. A sceptical view on the economic benefits of reducing the regulatory burden is expressed by Helm (2006). He argues that regulation is a public good that often addresses market failures. The estimation of the true costs of reducing regulatory burden would therefore require a disaggregated approach.

Using data for 11 European countries, Koedijk and Kremers (1996) observed a negative correlation between regulation (as measured by restrictions on business establishment, public ownership, industry-specific support and shop-opening hours) and growth. Tang and Verweij (2004) focus specifically on the administrative costs of complying with rules and regulations. They assume that these costs are largely made up of wages for workers that firms need to hire to comply with government regulations and to provide information to the government. Under the assumption that the administrative costs on business for the whole of the EU is equivalent to the value estimated for the Dutch economy, Tang and Verweij come to the conclusion that a 25% reduction in the administrative costs in the EU would initially result in a 1% increase in real GDP. The long run effects would be even larger. The impact of a reduction of administrative costs is also subject to the macro-econometric simulations in Section 3.4, which reveal that the impact of a given reduction in administrative costs can be multiplied if it is associated with increased market entry.

4.3.3. Labour market regulation

A consensus has evolved among economists that labour market structures have an important impact on reallocation effects. This view has been supported by a number of empirical studies that show that the impact of product market reforms on productivity or on employment tends to be stronger when labour markets are deregulated ([155]). In formal studies, indicators of employment protection and labour market regulation have often been identified as significant determinants of labour turnover, innovation and productivity ([156]). High minimum wages may also act as a deterrent for labour mobility. Chapter 3 reviews the impact of labour market policy on productivity ([157]).

The theoretical reasoning is based on the reasoning that if an incumbent firm is faced with strict employment protection legislation, it is likely to defend its market position fiercely, which could discourage new entrants. Moreover, employment protection may lead to fewer incentives of firms to expand largely because small and medium sized firms are often either exempted from employment protection legislation or governed by less tighter rules than big firms. This effect could lead to smaller average firm sizes and, since firm size correlates positively with productivity, to lower productivity. Apparently this line of reasoning is in line with the stylised facts in the EU and the USA with respect to employment protection, firm growth and productivity developments.

The strong stance in the empirical research that employment protection reduces reallocation effects contrasts with the absence of strong evidence that looser employment protection could improve aggregate rates of employment or unemployment. Whereas employment protection legislation is one of the most controversial items in EU reform discussions, there has been a tendency in the EU to liberalise protection of temporary contracts. The spread of part-time jobs, fixed-term contracts and other forms of contractual flexibility are widely understood to have contributed to the favourable employment performance witnessed over the past decade in the EU.

([155]) See Griffith et al. (2007), Nicoletti and Scarpetta (2005b), Berger and Danninger (2006).

([156]) See Haltiwanger et al. (2006) on job turnover, OECD (2003) and Autor et al. (2007) on productivity, Bassanini and Ernst (2002, OECD), Caballero et al. (2004), Griffith et al. (2006) and Alesina and Zeira (2006) on innovation and creative destruction.

([157]) See especially Section 3.3.1 and Box 3.1.

Apart from allowing for more flexible labour contracts, labour market policies have tried to increase flexibility through ([158]):

- active labour market policies in order to help people to cope with rapid change, unemployment spells and transitions to new jobs,
- fostering life-long learning in order to ensure the continual adaptability and employability of workers,
- modernising social security systems in order to combine incentives to participate in the labour market with the provision of adequate income support and facilitate labour market mobility.

Economists also stressed the role of wage differentiation. Alesina and Zeira (2006) argue that labour market regulations that encompass minimum wages, unemployment subsidies and firing costs reduced wage flexibility and wage inequality in Europe, leading to the adoption of labour-saving technologies at the low end of the skill distribution.

4.3.4. Financial market integration

The completing of the single market in financial services has been recognised as one of the key areas for EU's future growth. The economic function of the financial sector is traditionally seen as improving the efficiency of capital through the reduction of transaction costs in the channelling of savings to investment and facilitating risk management by pooling, diversifying and reallocating risks among economic agents with different risk-taking characteristics and possibilities. Both the selection of investment projects and the reallocation of risks can also have a strong impact on structural change and TFP growth because it facilitates embedding technical advances in the capital stock. Especially in periods of rapid technological change, this allows countries to convert technical development into higher rates of economic growth ([159]). The role of an efficient financial system for structural change is particular evident for young firms that intend to enter new markets since they often face financial constraints. For them, asymmetric information and agency costs set hurdles for obtaining the necessary finance to enter the market or to introduce new technologies. Financial intermediaries can play a crucial role in overcoming these obstacles ([160]).

As regards the question of whether banks or markets are better equipped to channel savings into risky investment, the economic literature is somewhat inconclusive. On the one hand, by pooling and diversifying risks banks and other financial institutions may afford to finance riskier and more specialised investment projects. In addition to their specialisation in the selection of investment projects, they may also have a comparative advantage in monitoring investment projects, for example through the provision of staged finance. On the other hand, the opportunity to share risks via the capital market may also induce investors to invest a higher fraction in riskier projects. The possibility to hedge against project-specific shocks may stimulate agents to undertake specialised investment. Since both banks and markets may have their advantages, completeness, size and efficiency have emerged as crucial determinants of a financial system that is conducive to structural change and growth.

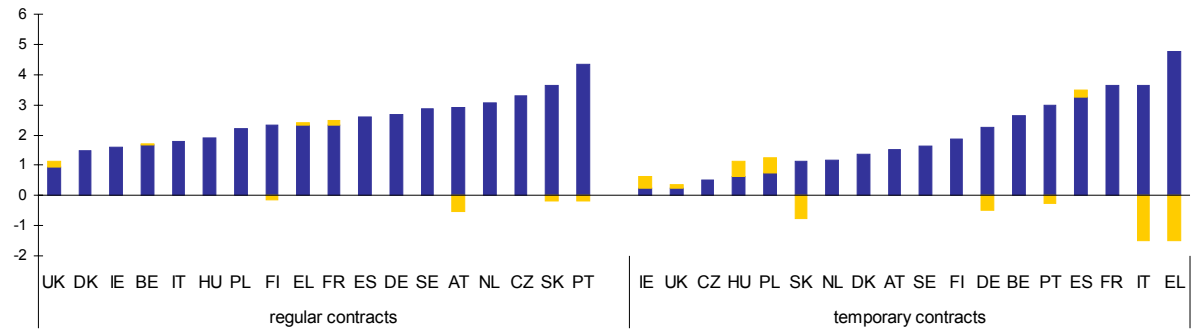
Within the EU, cross-border financial integration is seen as a means to promote the efficiency of the financial system. The efficiency of the EU financial system has long been constrained by national segmentation. The financial sectors of the Member States evolved to reflect specific national conditions and preferences. While these systems were generally efficient from a national perspective, they were much less so when viewed from the perspective of a progressively integrating EU economy. A significant divergence had emerged between the real sector, which has increasingly operated on a cross-border basis, and a still highly fragmented financial sector. The degree of fragmentation was such that the EU financial sector could not function efficiently and so acted as a drag on the overall performance of the EU economy. Aghion (2005) noted that foreign banks tend to spur competition and spur national banking

([158]) This set of policies has also been called "flexicurity" as it aims to combine a flexible labour market with income security for the workers concerned. The latter is to be accomplished through more security in the market in contrast to security in the job.

([159]) See Pelgrin et al. (2002).

([160]) For a review on the impact of financial integration on economic activity, see Chapter 4 in EU Economy 2001 Review.

Graph 4.4.5: **Employment protection legislation index**



Source: OECD.

markets more efficient. Increased foreign entry forces domestic banks to eliminate excessive overhead and accept lower profits. Levine (2000) pointed out that in larger more liquid markets it is easier to profit from new information. Kose et al. (2006) stress that the impact of financial openness on the domestic financial sector is not limited to enhanced access to the financing of domestic investment. The effects of financial integration via imposing discipline on macroeconomic policies, exposing domestic firms to competition of foreign entrants, and unleashing forces that result in better government and corporate governance are also important. Generally, since financial activity is characterised by economies of scale, well functioning pan-European market for banks together with liquid, and also pan-European, stock market should have a strong impact on total factor productivity in financial intermediation industry and large impact on economic growth.

4.4. The effect of lower administrative costs and entry in the QUEST model

This section explores the possible macroeconomic effects using the QUEST model ([161]). In the simulations reported below, it is assumed that the administrative costs in EU15 are reduced by 25% (or 0.85% of GDP) over the period 2006 to 2010.

The reduction in administrative costs is assumed to be beneficial for firms since it reduces average production costs, i. e. less overhead labour is required for producing the same level of output. Modelling this impact in a macro-econometric model has the advantage that general equilibrium effects can also be shown. In a partial analysis, the benefits from a reduction of administrative costs would be limited to one-off efficiency gains because some of the workers that were employed in order to comply with administrative obligations are no longer needed, i.e. the same output can be generated with less workers. Additional effects may be important in this context because if goods markets are sufficiently flexible, additional benefits for consumers and workers can arise in the form of lower prices and more employment induced by increased competition due to lower (administrative) entry barriers. The competition effects are however less certain than the cost effects therefore it is useful to distinguish both effects and report them separately.

The results show (see Table 4.4.2), that a reduction in administrative costs is beneficial in terms of output, investment and consumption. However, it has negative employment effects. Over a period of five years GDP growth could rise by about 0.1% if such measures were implemented successively. In the long run GDP could rise by about 1%. Notice, however, employment effects from such measures are likely to be small and can even be negative if as assumed here a cut in administrative costs is mainly associated with a reduction of overhead labour. In this case there would be little incentive for firms to expand employment.

([161]) This exercise is carried out for the EU15 aggregate. For the simulation a new variant of the QUEST model is used which incorporates improvements on the production side. In particular a clear distinction is made between variable costs and fixed costs (especially in the form of overhead labour).

Table 4.4.2
Reducing administrative costs (% deviations from baseline)

	A: Without entry					
	2006	2007	2010	2015	2025	2055
GDP	0.2	0.1	0.6	0.9	0.9	1.0
Private consumption	0.1	0.3	0.5	0.8	0.9	0.9
Investment	-0.0	-0.4	0.3	0.4	0.5	0.5
Capital	-0.0	-0.0	-0.0	0.1	0.3	0.5
Real wages	0.1	0.3	-0.1	-0.2	-0.2	-0.1
Employment	0.0	-0.2	-0.4	-0.4	-0.4	-0.4
	B: With entry					
	2006	2007	2010	2015	2025	2055
GDP	0.2	0.4	1.3	1.6	1.8	2.0
Private consumption	0.1	0.3	0.7	1.1	1.2	1.4
Investment	0.5	0.9	2.1	2.4	2.5	2.7
Capital	0.0	0.1	0.3	1.0	1.7	2.5
Real wages	0.1	0.5	1.2	1.5	1.7	1.9
Employment	0.1	0.1	0.1	0.1	0.1	0.1

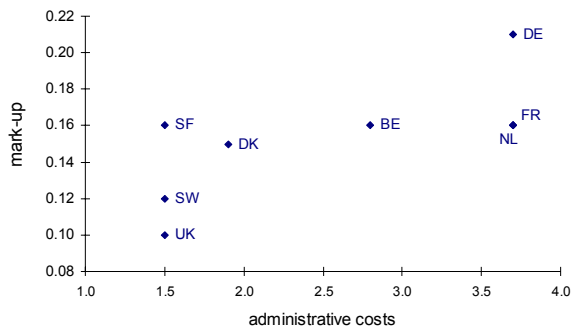
Source: QUEST model.

For employment to increase it must in addition be the case that reducing administrative costs facilitates entry of new firms and therefore increases competition. As shown in panel B of 4.4.2, if increased competition would force firms to reduce mark-ups and pass on the reduced costs to consumers fully in the form of lower product prices, the output effects could about double and there would likely to be a positive impact on employment.

It must be stressed that the results reported in panel A and B are supposed to span the minimum and the maximum possible effects. The actual size of the effect will depend on various factors, first of all on the degree of competition in the goods market. It is also likely to depend on the nature of the reduction of fixed costs. Some fixed costs, in particular start up costs, may constitute larger entry barriers than fixed costs which have to be paid by both new and incumbent firms. Thus a reduction of administrative burden biased towards start up costs could potentially induce larger competition effects ([162]).

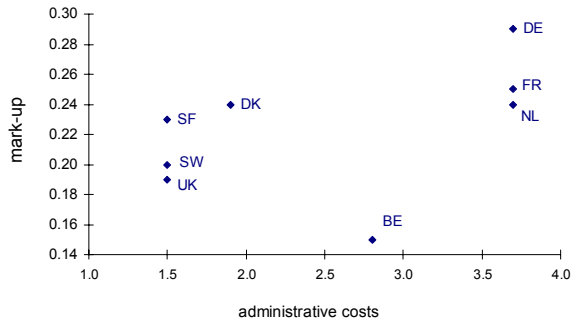
So far there, only a limited amount of research has been conducted on the link between administrative costs and competition. That there might be a link is suggested by the following graphs which show a scatterplot between mark-ups (see Oliveira Martins (1996)) and administrative costs for two homogeneous sets of industries, namely fragmented and segmented industries ([163]).

Graph 4.4.6: **Fragmented industries**



Source: Kox (2005) and Oliveira Martins et al. (1996).

Graph 4.4.7: **Segmented industries**



Source: Kox (2005) and Oliveira Martins et al. (1996).

Within both groups of industries, there seems to be a positive relationship between the level of administrative costs and mark-ups across countries. Though these graphs suggest that there might be a competition effect, the following caveats should be kept in mind. First, these graphs obviously do not control for other factors which could explain the cross-country variation of mark-ups. Second, the distribution of the administrative burden as calculated by Kox is based on the distribution of start up costs which are likely to have the strongest impact on competition. Recently, Griffith et al. (2006) provide

([162]) Kox (2005) estimated that - on the basis of the Djankov et al. (2002) study - start up costs amount to about 0.6% of GDP, ranging from 0.05% for the UK to 1.3% for Greece but with most EU15 countries concentrated at values around 0.6%.

([163]) It is important to look at relatively homogeneous groups of industries across countries because countries differ in the composition of industries. Sectors with a relatively small average establishment size are termed fragmented industries, while sectors characterised by the existence of large establishments (high fixed costs) are termed segmented industries.

some evidence that government bureaucracy has negative effect on mark-ups, however, the coefficient estimates are only weakly significant. Also, Ciccone et al. (2006) find that cutting government procedures to business start ups increases entry in industries which experience increasing (global) demand and technology. But there are also other studies which do not find a link. For example, Cincera and Galgau (2005) have looked at the relationship between time spent with government bureaucracy (obtained from the Fraser institute) and entry and exit rates. They did not find a significant impact. These conflicting pieces of evidence suggest that more empirical work is still needed in order to pin down the competition effects of a reduction in administrative costs.

Concluding remarks

The European Union has not yet succeeded in reaping the full benefits from the information technology revolution and the spurt in the global division of labour associated with international economic integration since the mid-1990s. Hence there is considerable scope to boost Europe's productivity. Accordingly, policies in pursuit of a 'knowledge society' figure prominently on the European Union's policy agendas exemplified by the Lisbon process. In this framework, Member States have included a host of policy measures aimed at strengthening TFP growth in their National Reform Programmes and associated Implementation Reports. These policies can be grouped under three main headings: *(i)* knowledge building; *(ii)* strengthening competition forces; and *(iii)* enhancing flexibility.

This chapter set out to clarify the economic foundations of these policy areas in order to lift the black box which surrounds the empirical concept of TFP by showing how they are related to the concept of endogenous growth. Moreover, by reviewing the numerous empirical studies, often with firm-level or sectoral data, that show that changes in policy-relevant structural variables can have a significant impact on productivity and growth performances, the chapter has tried to strengthen the empirical basis for microeconomic reforms along the Lisbon agenda. It has nevertheless become clear that in order to arrive at a full understanding of the impact of structural reforms on economic activity, there is still a missing link between actual policy reforms and their effect on economically meaningful structural variables. There have so far been few case studies that address this knowledge gap. Therefore, quantifying the likely economic effect of specific reforms remains difficult.

Despite this limitation, the analysis underpins the notion that policies such as the following can make an important contribution to stronger productivity growth in the European Union.

- *Higher levels of better targeted R&D investment, with more market-based financing systems*. Here, feasible fiscal incentives to R&D may be preferable to direct budgetary support if deadweight losses can be contained and the R&D induced is genuinely 'additional'. Strong linkages between public and private research are needed in combination with more effective protection of intellectual property rights.

- *Developing world-class educational establishments in the pursuit of top managerial and research skills to lead the economy to high rates of innovation and diffusion of new technologies.* More skilled researchers are needed if R&D activity is to expand, otherwise the increasing demand for these skills will merely raise wage costs and squeeze other investment activities.

- *Next steps to establish a fully functioning single market and to actively improve the contestability of markets.* In this respect, it is not only important to facilitate market entry, but also to ensure that policies in support of SMEs do not cause disincentives for firms to grow. More flexible regulatory and institutional frameworks are able to deliver a dynamic and competitive business environment, notably in the services industry. In this context, it has been often observed that the introduction of new technologies shifts the productivity frontier only if firms are able to simultaneously re-organise their activity.

- *Improving the quality of public finances.* The need to improve competitiveness, concerns about fiscal sustainability and growing demands by taxpayers to get more value for public money have prompted efforts to gear the tax mix and the allocation of resources within the public sector towards better efficiency and effectiveness. This includes, inter alia, the modernisation of public administration which can be a key element to ensure control over expenditure and budgetary consolidation.

Whilst many aspects of this approach have been announced in recent years in individual EU countries' reform programmes, and in several cases introduced, the "mindset" shift needed to make an overall success of the process has further to go at both the national and European levels.

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