EUROPEAN CENTRAL BANK



OCCASIONAL PAPER SERIES
NO. 53 / OCTOBER 2006

# LABOUR PRODUCTIVITY DEVELOPMENTS IN THE EURO AREA

by Ramon Gomez-Salvador, Alberto Musso, Marc Stocker and Jarkko Turunen

EUROPEAN CENTRAL BANK

OCCASIONAL PAPER SERIES

NO. 53 / OCTOBER 2006

# LABOUR PRODUCTIVITY DEVELOPMENTS IN THE EURO AREA[1]

by Ramon Gomez-Salvador, Alberto Musso, Marc Stocker and Jarkko Turunen


In 2006 all ECB publications feature a motif taken from the €5 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=923369.

1 *Prepared by R. Gomez-Salvador (ECB), A. Musso (ECB), M. Stocker (UNICE) and J. Turunen (ECB). Most of the work for this paper was done while all authors were working in the Euro Area Macroeconomic Developments Division of the ECB's Directorate General Economics. The excellent research assistance of Mary Santoianni and several comments by, and discussions with, Neale Kennedy, Gerard Korteweg and Hans-Joachim Klöckers are gratefully acknowledged. The authors thank the Groningen Growth and Development Centre for having provided them with much of the data used in this paper.*

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

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

**Telephone**
+49 69 1344 0

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

**Fax**
+49 69 1344 6000

**Telex**
411 144 ecb d



ISSN 1607-1484 (print)
ISSN 1725-6534 (online)

# CONTENTS

## ABSTRACT

This paper provides a description and a discussion of some important aspects relating to recent productivity developments in the euro area. Following decades of stronger gains in the euro area than in the US, labour productivity growth has fallen behind that in the US in recent years. This reflects a decline in average labour productivity growth observed in the euro area since the mid-1990s, which stands in sharp contrast with opposite developments in the US. The decline in labour productivity growth experienced in the euro area since the mid-1990s resulted from both lower capital deepening and lower total factor productivity growth.

From a sectoral perspective, industries not producing or using intensively information and communication technology (ICT) would appear mostly responsible for the decline in average labour productivity growth since the mid-1990s. These developments were broadly experienced by most euro area countries. A comparison with developments in the US suggests that the euro area economy seems to have benefited much less from increased production and use of ICT technologies, in particular in the services sector. Diverging trends in labour productivity growth between the euro area and the US in recent years mainly reflect developments in a number of specific ICT-using services such as retail, wholesale and some financial services where strong gains were registered in the US.

The evidence presented in this paper suggests that, in order to support economic growth in the euro area, emphasis should be given to both policy measures that directly address the determinants of productivity and, given the interactions among the various factors of growth, to policies that raise labour utilisation.

## EXECUTIVE SUMMARY

Productivity gains are a key factor driving long-term economic growth and increases in living standards. In the short to medium term, productivity also affects business cycle developments, inflation, exchange rates and other key macroeconomic variables, such as consumption, investment and employment. In this respect, the productivity growth performance of the euro area raises questions regarding the sources of economic growth in the euro area and directly impacts the environment for monetary policy.

Developments in euro area productivity growth since the second half of the 1990s have been disappointing. Euro area labour productivity growth (as measured by real GDP per hour worked) declined from an average of 2.1% in the period 1990-1995 to only 1.2% in the period 1996-2005. At the same time, productivity growth in the United States increased strongly, from 1.3% in 1990-1995 to 2.1% in 1996-2005. As a result, following decades of stronger gains in the euro area than in the US, productivity growth in the euro area has fallen behind that in the US in recent years. More recently, in the first half of 2006, productivity growth in the euro area has gained some momentum. However, these more recent positive signs may be to a large extent a cyclical phenomenon and only developments over the course of the next few years will allow for a proper assessment of whether these recent improvements are sustainable.

In this Occasional Paper, the main issues relating to the assessment of recent productivity developments in the euro area are summarised. While it is important to note that many aspects of productivity developments are still not well-understood, a number of rather robust conclusions emerge from the available evidence.

First, the overall assessment that there has been a decline in euro area labour productivity growth is independent of whether labour productivity is measured per person employed or per hour worked. Furthermore, the decline was experienced by most euro area countries. Second, the decline in labour productivity growth resulted from both lower capital deepening and lower total factor productivity (TFP) growth. The former can partly be associated with the robust pace of job creation since the mid-1990s, while the latter might be partly explained by higher utilisation of lower-skilled workers. The slowdown in both capital deepening and TFP growth appears to be widespread across euro area countries. Third, from a sectoral perspective, industries not producing or using intensively information and communication technology (ICT) would appear mostly responsible for the decline in average labour productivity growth in the euro area since the mid-1990s.

Moreover, the comparison of recent euro area developments with those of the US shows that, while the slowdown in labour productivity growth would appear to be related to strong employment growth, particularly in low-skilled jobs, there has been a lack of productivity-enhancing use of new technologies in the euro area. The acceleration of US productivity in recent years is generally associated for a significant part with the production and use of ICT, which spurred output per hour worked through significant capital deepening and higher TFP growth. The euro area economy seems to have benefited much less from these factors, reflecting both lower investment in ICT compared with the US and barriers to the diffusion or appropriate use of new technologies, in particular in the services sector. Diverging trends in labour productivity growth between the euro area and the US in recent years mainly reflect developments in a number of specific ICT-using services such as retail, wholesale and some financial services where strong gains were registered in the US.

The slowdown in euro area productivity growth and the divergent developments with respect to the US pose a challenge for economic policy. A number of specific policy proposals have been

made recently by expert groups (in for example the Kok and Sapir reports). Given the evidence presented in this Occasional Paper, it seems that particular emphasis should be given both to policy measures that raise labour utilisation, even though some of them may temporarily reduce productivity growth, and to policies that directly address the determinants of productivity.

## I INTRODUCTION

Productivity growth is a key macroeconomic driving force in the long run and an important determinant of macroeconomic dynamics in the short to medium run. In the long run, according to standard economic theory, productivity growth is the primary source of growth in real output per capita, a measure of economic welfare. In the medium run, growth in labour productivity, together with growth in total hours worked, determines developments in real output growth. Furthermore, the assessment of the role of productivity shocks and the interpretation of the pro-cyclicality of productivity are key issues in the analysis of business cycle fluctuations. The evolution of productivity may also be important for the interpretation of developments in other macroeconomic variables, including inflation and exchange rates, in the short to medium run.[1] Productivity growth thus influences in potentially important ways the macroeconomic environment in which monetary policy is conducted. For example, possible changes in trend productivity growth affect the derivation of the optimal monetary policy. At the same time, not only is this analysis particularly difficult in real time, but also the medium-term implications of a change in trend labour productivity growth for monetary policy may vary greatly and depend on several factors such as the strength of the initial response of demand.[2]

The recent evolution of euro area productivity growth has been disappointing, both compared with past developments and with recent productivity performance in the United States. In particular, euro area labour productivity growth (as measured by real GDP per hour worked) declined from an average annual growth rate of 2.1% in the period 1990-1995 to only 1.2% in the period 1996-2005. At the same time, productivity growth in the US increased strongly, from 1.3% in 1990-1995 to 2.1% in 1996-2005. As a result, euro area productivity growth has fallen behind that of the US after having shown stronger gains for several decades. These developments raise important questions about the sources of economic growth in the euro area.

In this paper, we analyse the main issues related to the recent productivity performance in the euro area. We focus on describing and explaining developments in productivity in the euro area in terms of their immediate determinants. In this respect, one important contribution of this paper is that we update and extend the analysis of euro area productivity presented in Vijselaar and Albers (2004) and ECB (2004). In particular, we include in our sample more recent data for both the total economy analysis (covering the period up to 2005, compared with 2001 in the former study and 2003 in the latter) and the sectoral analysis (using data updated to 2002, compared with 1999 in the former study and 2000 in the latter). Moreover, we provide a more detailed analysis on a number of issues,

1 As regards inflation, mechanisms have recently been suggested that imply that, under certain conditions, shifts in labour productivity growth can affect inflation temporarily. For example, whereas in traditional models inflation is independent of productivity growth because the direct effect of productivity growth on inflation is fully offset by its impact on wage inflation, Ball and Moffitt (2001) suggest that because workers adjust their wage aspirations slowly, changes in productivity growth affect inflation. Differences in productivity growth developments across sectors may also have implications for real exchange rate dynamics. According to the Harrod-Balassa-Samuelson hypothesis, real exchange rate developments depend, among other factors, on the productivity growth performance of the domestic tradable sector relative to the non-tradable sector as well as on how this sectoral productivity gap compares across countries.

2 In particular, evidence of lower productivity growth may lead to lower expectations as regards profits and real wages, thus possibly lowering investment and consumption also in the short term. The speed at which expectations are adjusted is important. If expectations are rapidly adjusted, spending may react quickly, thereby tempering the impact on inflation of changes in labour productivity (see Bernanke, 2005).

including a more detailed disaggregated analysis, and include a discussion of some important issues not covered in the above-mentioned studies, such as productivity developments from a longer-term perspective (since 1950) and the impact of alternative measures of total factor productivity (TFP). We mainly use data from the Groningen Growth and Development Centre (GGDC). Previous versions of these data have been used to analyse determinants of productivity growth in European countries, with a special focus on the production and use of information and communication technology (ICT), in various studies (see for example Van Ark et al., 2003, and O'Mahony and van Ark, 2003). However, previous studies discuss evidence for euro area countries (or the EU aggregate) rather than the aggregate euro area, as in the current study.[3] We also incorporate recent estimates of labour quality growth in the euro area derived in Schwerdt and Turunen (2006), allowing for the first time a more complete decomposition of euro area labour productivity growth.

We find that the decline in euro area labour productivity growth is independent of whether labour productivity is measured per person employed or per hour worked and that it was experienced by most euro area countries. The decline in euro area labour productivity growth resulted from both lower capital deepening and TFP growth. From a sectoral perspective, industries not producing or using intensively ICT would appear mostly responsible for the decline in average labour productivity growth since the mid-1990s. While the slowdown in labour productivity growth appears to be related to strong employment growth, a comparison with developments in the US also suggests that the euro area economy seems to have benefited much less from increased production and use of ICT technologies, in particular in the services sector. Diverging trends in labour productivity growth between the euro area and the US in recent years mainly reflect developments in a number of specific ICT-using services such as retail, wholesale and some financial services where strong gains were registered in the US.

The rest of the paper is organised as follows. In Section 2 we provide an overview of the conceptual framework used in the analysis of productivity developments. In Section 3 we analyse productivity developments in the euro area in detail. This includes an analysis of the immediate causes of the slowdown in euro area productivity growth, as well as of the divergent developments in the euro area vis-à-vis the US. We provide evidence of structural breaks in euro area labour productivity growth and assess the possible implications of adjusting productivity measures for changes in input quality and utilisation. We also analyse developments at the sectoral level. In Section 4 we relate the decline in productivity growth to growth in euro area real GDP per capita. We summarise our findings and provide concluding remarks about economic policies in Section 5.

## 2 CONCEPTUAL FRAMEWORK

In this section we present the key concepts, as well as the basic growth accounting relationship that provides a conceptual framework for the analysis. The two concepts of productivity most often used in economic analysis are represented by labour productivity and TFP. Labour productivity is defined as real output per unit of labour input. Typically, the labour input is measured in terms of hours worked. Alternatively, especially when data for hours worked are not available or are of low quality, labour input is measured in terms of the number of persons employed. The relationship between

3 The focus on immediate determinants of labour productivity growth in the euro area adopted in this study leaves out other important related issues. In particular, issues related to labour utilisation as the other component of real GDP per capita growth are dealt with only to the extent that they result in interactions with developments in productivity. For a discussion of developments in labour utilisation in the euro area, see Musso and Westermann (2005). Also, productivity developments in euro area countries and in other European countries are not discussed in detail. See Annenkov and Madaschi (2005) for an analysis of productivity developments in Nordic EU countries. Finally, it is important to note that many of the theoretical and empirical issues presented in this paper are still under discussion in the literature. Therefore, this paper should be seen only as a first step towards a more complete understanding of euro area productivity developments.

labour productivity per hour worked ($LP^H$) and labour productivity per employed person ($LP^E$) can be summarised by a simple accounting equation, in which $H^{AV}$ stands for average hours worked per person employed:

$$LP^H \equiv \frac{real\ \ output}{hours\ \ worked} = \frac{\left(\frac{real\ \ output}{employment}\right)}{\left(\frac{hours\ \ worked}{employment}\right)} \equiv \frac{LP^E}{H^{AV}} \quad (1)$$

The evolution of $LP^H$ and $LP^E$ deviate if $H^{AV}$ changes over time. This is a relevant factor as average hours worked tend to change continuously and sometimes irregularly, for example as a result of the increased importance of part-time jobs.

Theoretical analyses often refer to a more specific measure of productivity, that is, TFP, which is defined as real output per unit of all (combined) inputs. This is sometimes also called multi-factor productivity or the Solow residual. It is often assumed that TFP is a measure that corresponds to the theoretical concept of technological progress. However, in practice TFP captures the impact of several factors (such as improvements in organisation and in the quality of labour and capital), such that its evolution cannot automatically be associated with purely technological advances.

The relationship between labour productivity and TFP, as well as other determinants of real output per capita growth, can be illustrated using the standard growth accounting framework.[4] In this context, real output per capita ($Y^{PC}$) can be decomposed into two main factors: labour productivity and labour utilisation (defined here as hours worked per head of total population). Both main factors can be decomposed further into a number of components. Labour productivity is a function of *TFP*, capital intensity (i.e. capital per unit of labour input *K/H*) and labour quality (*LQ*). Labour utilisation can be decomposed into four components: average hours worked; the unemployment rate (*UR*); the participation rate (*PR*); and the share of the working age population in the total population ($P^{WA}/P^{TOT}$). Using the basic Cobb-Douglas production function, this decomposition of real output per capita can be presented formally as follows, in which α represents the labour income share:

$$Y^{PC} = \underbrace{TFP \cdot \left(\frac{K}{H}\right)^{(1-\alpha)} \cdot (LQ)^{\alpha}}_{LP^H} \cdot \underbrace{H^{AV} \cdot (1-UR) \cdot PR \cdot \frac{P^{WA}}{P^{TOT}}}_{labour\ \ utilisation} \quad (2)$$

The decomposition presented in equation 2 forms the basis of the empirical analysis in this paper. We mainly focus on decomposing labour productivity growth (the first part) into its immediate determinants: TFP growth, capital deepening and increases in labour quality. However, in order to put developments in euro area labour productivity growth into a broader perspective we show results of the full decomposition of real GDP per capita in Section 4.

In addition to the direct impact of each component on output, the relationships between the components may be characterised by important interactions. For example, the reintegration of low-skilled workers into employment to reduce the unemployment rate may imply a decrease in productivity growth, at least temporarily. Other interactions may be characterised by reinforcing effects, as might be the case between technological progress and capital accumulation: not only does capital accumulation support technological progress, as stressed in the new growth theory literature, but also the reverse can take place.[5] Finally, other relationships, such as the relationship between labour productivity and demographic developments, may be quite complex and therefore uncertain. As a result, policy measures undertaken to influence individual components on the right-hand side of equation (2), such as

4 See for example Barro (1999) for more details.

5 For example, capital-using technological progress, which has the effect of increasing the marginal productivity of capital compared with that of labour, implies increasing demand for capital relative to labour and therefore tends to raise the growth rate of capital intensity.

TFP or the other components of labour productivity, are likely to influence also other components, making the net effect on real output per capita uncertain.

To fully understand the sources of labour productivity growth, it is useful to differentiate between immediate and more fundamental sources of labour productivity growth. The immediate sources of labour productivity growth consist of TFP growth, capital deepening and growth in labour quality. Growth accounting methodologies presented in this paper allow for the identification of these immediate sources. However, each of the immediate sources is the result of more fundamental factors that in turn depend on institutions and preferences. For example, TFP growth may depend on innovation, R&D spending and technology diffusion, which in turn are influenced by institutional factors, such as regulation, and preferences.[6] However, research on these more fundamental sources of labour productivity growth has not yet allowed clear conclusions to be reached and more empirical work needs to be carried out in order to obtain a better understanding about their role.[7]

## 3 KEY FEATURES OF EURO AREA PRODUCTIVITY DEVELOPMENTS

International comparisons of labour productivity have received increased interest in recent years. This has been partly due to the impressive productivity performance of the US economy since the second half of the 1990s and the view that the introduction and diffusion of ICT may have led to sustained higher productivity growth there. The euro area economy seems to have benefited much less from this factor. Instead, euro area productivity growth slowed down and fell behind that in the US over this time period. In this section we look at recent developments in labour productivity (measured per hour worked and per person employed) both in the euro area and the US. The main sources of these developments are analysed, first by looking at the estimated contributions of TFP and capital deepening from a total economy perspective, then covering country and sectoral dimensions. We also provide evidence of structural breaks in euro area labour productivity growth and assess the possible implications of adjusting productivity measures for changes in input quality and utilisation.

### 3.1 OVERALL LABOUR PRODUCTIVITY GROWTH

The main developments in euro area productivity growth are summarised as follows (see Table 1). While productivity growth was broadly unchanged between the 1980s and the first half of the 1990s, both in the euro area and the US, a substantial change can be observed in the second half of the 1990s. In the euro area, average productivity growth (per hour worked) declined to 1.7% in the period 1996-2000 and further to 0.7% on average in the period 2001-2005. This is clearly lower than the 2.5% and 2.3% recorded respectively in the 1980s and in the first half of the 1990s. By contrast, in the US, growth in productivity per hour worked rose to an average of 2.1% in the period 1996-2000 and to 2.6% over the period 2001-2005, a level of growth clearly above that experienced in the past. This rise in the US may partly reflect cyclical factors, but the apparent resilience of productivity growth during the past downturn and the significant further pick-up over the last two years tends to support the widespread view that the mid-1990s marked a structural improvement in US productivity growth. As a consequence, euro area labour productivity growth per hour worked fell in recent years clearly behind that in the US – for the first time in several decades. Clearly the assessment that productivity growth in the euro area has fallen behind that in the US since the mid-1990s is independent of the way labour productivity growth is measured. In particular, downward trends in productivity growth are observed for the euro area irrespective of whether productivity

6 See for example the contributions by Hall and Jones (1999), Acemoglu, Robinson and Johnson (2000) and Alcalá and Ciccone (2004).

7 See for example the discussion in Griliches (2001).

**Table 1 Labour productivity growth in the euro area and the US**

(whole economy, annual average percentage changes)

| | GDP per employed person | | | | GDP per hour worked | | | |
|---|---|---|---|---|---|---|---|---|
| | 1981-90 | 1991-95 | 1996-00 | 2001-05 | 1981-90 | 1991-95 | 1996-00 | 2001-05 |
| US | 1.4 | 1.3 | 2.3 | 1.9 | 1.5 | 1.1 | 2.1 | 2.6 |
| Euro area | 1.8 | 1.9 | 1.3 | 0.5 | 2.5 | 2.3 | 1.7 | 0.7 |
| BE | 1.7 | 1.6 | 1.4 | 1.0 | 1.9 | 2.3 | 1.6 | 1.3 |
| DE | 1.8 | 2.6 | 1.8 | 0.9 | 2.7 | 2.9 | 2.5 | 1.2 |
| GR | 0.6 | 0.7 | 2.0 | 2.8 | 1.1 | 0.6 | 2.1 | 2.9 |
| ES | 2.3 | 2.2 | -0.2 | -0.8 | 3.3 | 2.3 | -0.2 | -0.6 |
| FR | 2.1 | 1.5 | 1.5 | 1.1 | 2.9 | 1.7 | 2.1 | 1.9 |
| IE | 3.6 | 2.6 | 3.9 | 2.5 | 3.8 | 3.5 | 5.6 | 3.0 |
| IT | 1.7 | 1.8 | 0.9 | -0.6 | 2.0 | 2.3 | 0.9 | -0.2 |
| LU | 2.7 | 1.2 | 2.8 | 0.0 | 3.3 | 2.1 | 2.9 | 1.1 |
| NL | 0.9 | 0.6 | 0.4 | 0.6 | 2.0 | 1.4 | 0.4 | 0.8 |
| AT | 1.9 | 1.1 | 2.9 | 1.5 | 2.4 | 2.7 | 3.3 | 1.9 |
| PT | 1.5 | 2.2 | 2.1 | 0.3 | 1.8 | 2.8 | 3.4 | 0.2 |
| FI | 2.6 | 2.9 | 2.3 | 1.4 | 3.1 | 2.8 | 2.6 | 1.5 |

Sources: ECB calculations based on data from the Groningen Growth and Development Centre and the Conference Board (Total Economy Database, May 2006, http://www.ggdc.net).

is measured per person employed or per hour worked.

While for the US several empirical studies have found clear evidence of a break in labour productivity growth in the mid-1990s, for the euro area it may be questioned whether it makes sense to analyse labour productivity growth developments by considering sub-periods covering the years before and after the mid-1990s, as opposed for example to sub-periods covering full economic cycles. These issues are discussed in more detail in Box 1 entitled "Long-run trend developments in euro area labour productivity growth". This box also provides an analysis of structural breaks, which includes evidence pointing to a break in trend labour productivity growth in the mid-1990s in both the US and the euro area. Thus, the subsequent analysis focuses on different sub-periods which take 1995 as one of the main delimiting years.[8]

Underlying developments in aggregate euro area productivity, there are important differences across euro area countries.[9] The decline in labour productivity growth (per hour worked) since the mid-1990s was observed in a number of euro area countries, in particular Germany, Italy, Spain, the Netherlands and Belgium. However, labour productivity growth increased in other countries such as Greece and Ireland. In some countries, such as France and Ireland, the gap between labour productivity per employed person and per hour worked increased significantly, reflecting significant changes in the annual hours worked.

8 Note that not all sets of sub-periods used in the following sections coincide. The main reason is that three alternative datasets from the GGDC are used to discuss alternative aspects of labour productivity growth, and these datasets have different starting and end years: the *Total Economy Database* (May 2006 update) covers the period 1950-2005, the *Total Economy Growth Accounting Database* (June 2005 update) covers the period 1980-2004, and the *60-Industry Database* (February 2005 update) covers the period 1979-2002.

9 Country estimates can vary significantly according to data sources, in particular for hours and employment data. Statistical improvements and/or revisions could partly explain some of these differences. For instance, the way a recent change in employment levels in Spain is treated has important implications for productivity developments in recent years in this country. However, different data sources do not affect to a significant extent the picture at the aggregate euro area level.

Box 1

## LONG-RUN TREND DEVELOPMENTS IN EURO AREA LABOUR PRODUCTIVITY GROWTH

Labour productivity growth is subject to both long-run as well as short-run changes. The former are typically captured by trend patterns, which reflect ongoing structural changes. The latter are often associated with business cycle dynamics, but can also reflect specific irregular episodes. The analysis of recent and projected labour productivity developments needs to take into account both long-run trend changes and short-run dynamics, among other purposes to assess the degree to which changes in productivity growth may be sustainable.

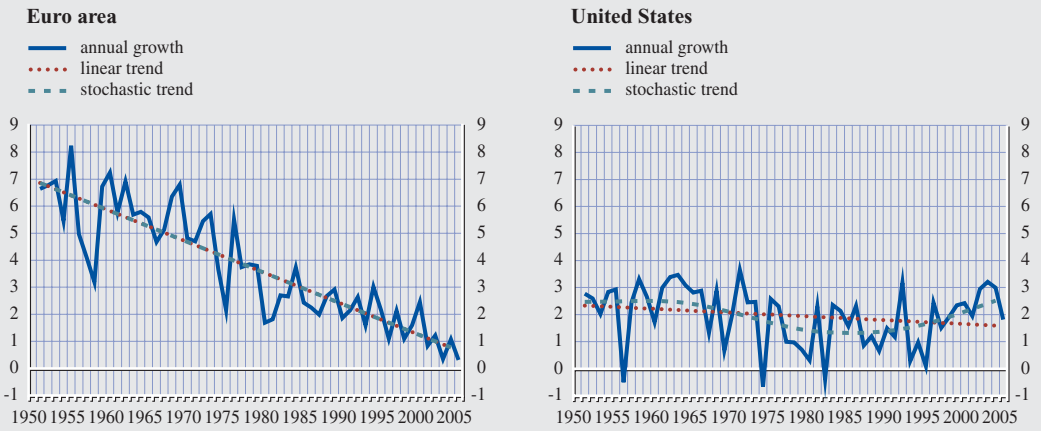
Against this background, this box examines long-term labour productivity growth in the euro area from 1950 to 2005 relative to the US. This analysis can also provide useful indications as regards the relevant sub-periods on which a discussion of structural developments should be based.

### Trend developments in labour productivity since 1950

Euro area long-run labour productivity growth (measured in terms of real GDP per hour worked) has been subject to a gradual declining trend since at least 1950 (see left-hand panel of Chart 1). This decline appears to be observable during all of the past five and a half decades, with broadly similar intensity, as signalled by the fact that the stochastic trend almost coincides with the linear trend. In part these developments can be associated first with the boom of the reconstruction period following World War II, and subsequently with the productivity slowdown which affected all advanced economies from the early 1970s onwards. Thus, from levels close to 6% in the 1950s and 1960s, labour productivity growth in the euro area decreased on average

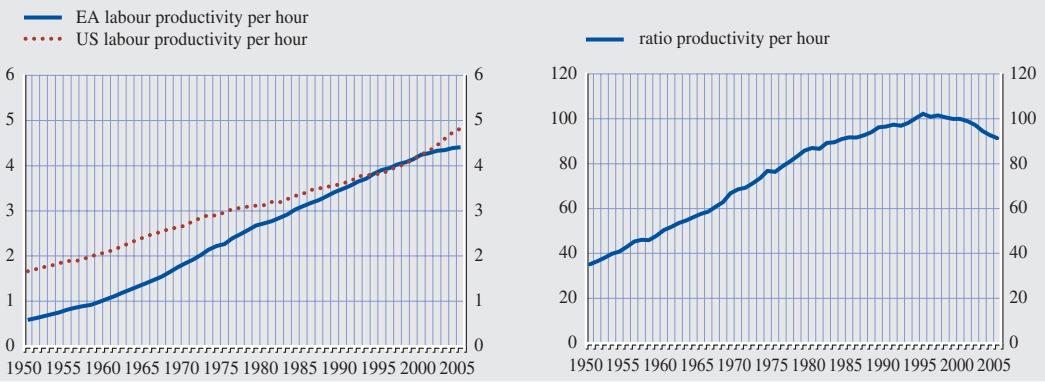
Chart 1 Labour productivity (per hour) growth in the euro area and the US

(percentage points)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre and the Conference Board, Total Economy Database, May 2006, http://www.ggdc.net, and the US Bureau of Labor Statistics.
Note: Data for the euro area are based on GGDC data for output (total GDP, in millions of 2005 USD, converted at "EKS" purchasing power parities) and total hours worked for all member countries from 1968 onwards, while from 1960 to 1967 the data are for all member countries excluding Austria, from 1956 to 1959 the data are for Germany, the Netherlands, Belgium, Portugal and Ireland, and from 1950 to 1955 the data are for Germany and the Netherlands. For the US, data from the GGDC has been complemented with total hours worked data from the US Bureau of Labor Statistics from 1950 to 1959. Stochastic trends have been estimated within a basic unobserved components model via STAMP 6.01 (see Koopman et al., 2000) and Ox 3.00 (see Doornik, 2001).

**Chart 2 Labour productivity (per hour) levels in the euro area and the US**




Sources: ECB calculations based on data from the Groningen Growth and Development Centre and the Conference Board, Total Economy Database, May 2006, http://www.ggdc.net, and the US Bureau of Labor Statistics.

to levels around 4% in the 1970s, 2.5% in the 1980s and 2% in the 1990s. From 2001 to 2005 it was on average just below 1%. By contrast, labour productivity growth in the US seems to have been subject to less marked long-term changes (see right-hand panel of Chart 1). Over the whole sample period, US labour productivity growth has fluctuated around an average of 2%. At the same time, some structural changes can also be observed for the North American economy. First, to some extent the US economy also experienced a productivity slowdown from the mid-1970s to the mid-1990s. Second, reflecting the impact of recent advances in information and communication technology associated with the "new economy", from the mid-1990s labour productivity growth in the US rebounded and started to follow an upward trend.

The different long-run developments in labour productivity growth in the two economic areas can in part be explained once the levels of productivity are taken into account. Euro area labour productivity (per hour) started in the early 1950s from levels which were about 40% of those recorded for the US (see Chart 2). Subsequently, the euro area underwent a process of gradual catch-up, which led to levels of labour productivity similar to those in the US by the mid-1990s. However, after the mid-1990s the different labour productivity dynamics induced a reversal in the trend labour productivity ratio.

Thus, a full understanding of long-run trends in labour productivity growth in the two areas needs to take into account various phenomena which characterised the post-War period, including inter alia the gradual catch-up process of Europe, the productivity slowdown in both areas from the early 1970s onwards, and "new economy" developments in the US economy. While the stylised facts characterising these phenomena are well-documented, their full explanation is still an open question. For example, the causes of the productivity slowdown are still debated.[2] Nevertheless, taking into account these phenomena suggests that long-run developments can be fruitfully discussed by comparing developments over different sub-periods, during which a specific force inducing a structural change prevailed. The identification of such sub-periods is examined next.

1 See Koopman et al. (2000) and Doornik (2001).
2 Various possible explanations have been proposed, ranging from sectoral shifts to the impact of the oil shocks of the 1970s to increasing measurement problems. However, none seems to provide a fully satisfactory interpretation. Recent empirical studies include Hornstein and Krusell (1996), Sichel (1997) and Nordhaus (2004).

**Table 1 Basic properties of labour productivity (per hour) growth in the euro area and the US over different sub-periods**

(average growth rates, percentage points)

| | | Breaks[1] | Mean growth rate | Trend |
|---|---|---|---|---|
| Euro area | | 1973, 1979, 1995 | | |
| overall | (1951-2005) | | 3.8 | decreasing |
| | (1951-1973) | | 5.8 | broadly constant |
| | (1974-1979) | | 3.8 | decreasing |
| | (1980-1995) | | 2.4 | broadly constant |
| | (1996-2005) | | 1.2 | decreasing |
| United States | | 1973, 1995 | | |
| overall | (1951-2005) | | 2.0 | broadly constant |
| | (1951-1973) | | 2.5 | broadly constant |
| | (1974-1995) | | 1.2 | broadly constant |
| | (1996-2005) | | 2.4 | increasing |

Sources: ECB calculations based on data from the Groningen Growth and Development Centre and the Conference Board, Total Economy Database, May 2006, http://www.ggdc.net, and the US Bureau of Labor Statistics.
1) Break tests are carried out using the multiple breaks test of Bai and Perron (1998) on the growth rate of the series specified. Dates for the breaks are based on the results of several tests carried out on various sample sizes (for example, in addition to the whole sample size, starting from 1961 instead of 1951 to assess the impact of the data for the 1950s, which may be of lower quality; or ending in 2002, 2003 or 2004 instead of 2005 to assess the impact of the most recent data, which may be subject to further revisions) as well as various variants of the tests (namely, tests for abrupt changes and tests for gradual changes). The break dates reported were found in most variants of the tests.

## Structural change and shifts in trend labour productivity growth

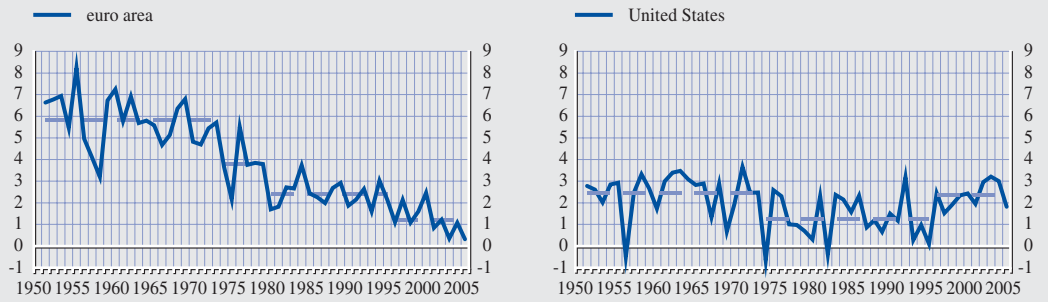
In order to assess developments over time, it is useful to examine different sub-periods. Various approaches can be adopted to delimit sub-periods, but all are to some extent arbitrary. An assessment of developments by decade is not only arbitrary but also potentially misleading, as labour productivity growth varies over the business cycle, and fluctuations (from one turning point to the next) do not necessarily coincide with decades. Ideally, average developments covering one full business cycle could be examined, but the identification of turning points is also open to debate, and business cycles may vary significantly in terms of duration. Assessing developments in trend labour productivity (say, by decade, or five-year periods) is an alternative solution, but the trend-cycle separation is a rather controversial issue and different approaches can lead to rather different results. Thus, we adopt a statistical perspective and apply structural break tests to annual growth rates in labour productivity.[3] Although it should be recognised that the latter approach is not immune from criticism, at least it exploits the latest advances in econometric techniques, which can provide a statistical foundation to the analysis of the data.

Overall, statistical tests point to various common structural breaks in the euro area and the US. Notably, in both areas a break is found around 1973 and another is found around 1995 (see Table 1 above). The former is consistent with previous studies which located the start of the productivity slowdown in the early 1970s, while the latter is consistent with the emergence of a "new economy" effect for the US but is more difficult to interpret for the euro area. In addition, for the euro area another break is found around 1979.[4] With the exception of the more recent break, all structural changes identified give rise to a period of lower average labour

3 Tests for multiple structural breaks have been conducted using the method of Bai and Perron (1998).
4 Despite the pronounced slowdown in productivity growth that can be observed in the data for the US during the second half of the 1970s, the econometric methods applied do not lead to the conclusion that this period can be highlighted as a separate period.

**Chart 3 Labour productivity (per hour) growth in the euro area and the US**

(percentage points)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre and the Conference Board, Total Economy Database, May 2006, http://www.ggdc.net, and the US Bureau of Labor Statistics.

productivity growth. A sharp contrast emerges from 1995 onwards. While in the US labour productivity growth rebounded sharply and started an upward trend, in the euro area after the mid-1990s productivity growth fell further (see also Chart 3). These more recent developments are discussed more in detail in the main text of this Occasional Paper.

### 3.2 TFP GROWTH AND CAPITAL DEEPENING

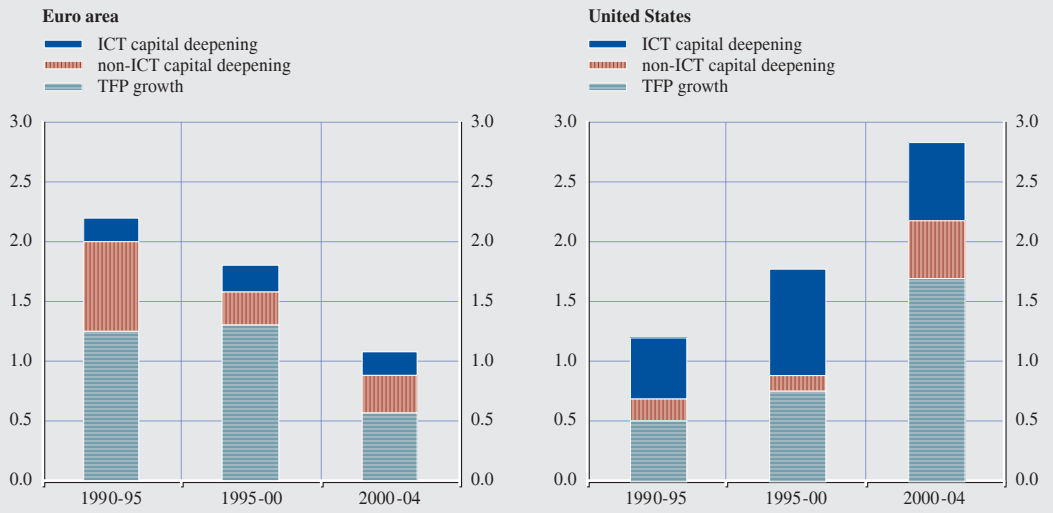
In this sub-section we investigate the decline in euro area labour productivity growth by looking at its main immediate sources, i.e. TFP growth and capital deepening. As discussed in Section 2 above, the standard growth accounting equations attribute the main source of increases in labour productivity per hour worked to TFP growth and to capital deepening. The decomposition of labour productivity is subject to significant measurement uncertainty owing to largely omitted factors such as factor quality and utilisation (see Box 2 entitled "TFP growth and the measurement of factor inputs"). Despite measurement uncertainty, there seems to be robust evidence that slower labour productivity growth in the euro area since the mid-1990s reflects both less capital deepening and lower growth in TFP (see left-hand side of Figure 1). During the period 1995-2000, capital deepening was only half of that observed over the period 1990-1995, hence accounting for the slowdown in aggregate labour productivity growth. This deceleration was entirely due to lower non-ICT capital deepening, while increases in ICT investment are estimated to have had a positive, albeit limited, effect on the contribution of ICT capital deepening since the mid-1990s.

The main factor driving lower capital deepening in the euro area appears to have been strong employment growth, as estimates of capital services growth only show signs of a minor deterioration during the 1990s (see Figure 2). Sustained wage moderation and continued progress with labour market reforms is likely to have contributed to these developments, leading firms to shift to more labour intensive production following earlier substitution policies in favour of capital during the 1980s and early 1990s. Lower labour productivity growth resulting from stronger employment growth is likely to be maintained as long as the underlying adjustment to more labour intensive production continues. If this adjustment were to come to an end, labour productivity growth would be expected to recover some of the momentum lost since the mid-1990s.

In addition to the transitory impact on productivity via lower capital deepening, policies designed to increase the employment of low-skilled workers may have depressed

**Figure 1 Contributions to growth in labour productivity per hour worked**

(annual percentage point contributions)

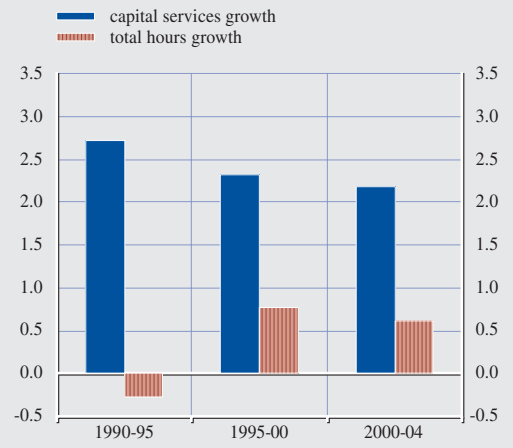



Sources: ECB calculations based on data from the Groningen Growth and Development Centre (Total Economy Growth Accounting Database, June 2005, http://www.ggdc.net).

average labour quality growth. Available evidence provides some support to the view that labour quality increased more moderately in recent years than in the first half of the 1990s (see Schwerdt and Turunen, 2006). As the TFP measure that is used here is not adjusted for changes in labour quality, this decline may have contributed to the more moderate pace of measured TFP growth. However, the evolution of labour quality is unlikely to be able to fully account for the deceleration in measured TFP. Indeed, the analysis presented in Box 2 discussing issues related to the appropriate measurement of TFP shows relatively robust evidence of a gradual deterioration in TFP growth. The nature and the origins of lower TFP growth in the euro area are debatable. On the one hand, the slowdown over recent years may expose the lack of competitiveness and adaptability of the euro area in an ever more globalised and technology-driven environment. A more optimistic interpretation could be that it captures the costs of industrial restructuring and the implementation of structural reforms over recent years, while these are expected to raise productivity in the future. The negative impact of these changes might have been emphasised by the persistence of relatively inflexible labour markets where more significant progress in product and financial market reforms was achieved.

**Figure 2 Capital and labour input growth in the euro area**

(annual growth rates)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre (Total Economy Growth Accounting Database, June 2005, http://www.ggdc.net).

Comparing the factors driving US labour productivity growth shows striking differences. The increasing contributions from ICT capital deepening and total factor productivity (see right-hand side of Figure 1) show the role of accelerating investment in ICT and higher growth in measured TFP in the US. In fact, the shares of ICT investment in GDP and the pace of ICT capital deepening were both higher in the US, thus contributing to the labour productivity growth gap between the two economic areas.

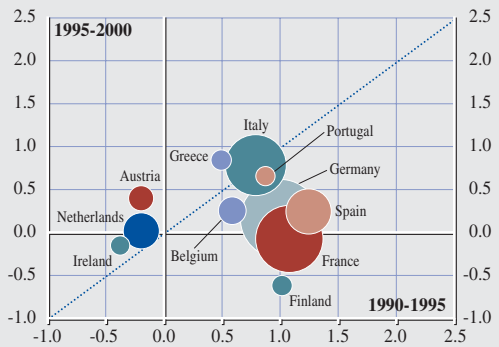
Diverging trends in TFP growth are also remarkable, with the US showing significant improvements in recent years. The lack of a comparable increase in the euro area since the mid-1990s is sometimes considered to reflect structural impediments limiting the diffusion of technological progress, which spurred US productivity since the mid-1990s. The analysis presented in Sub-section 3.3 may corroborate this assessment, showing that the ICT-using sectors in the euro area failed to experience the strong acceleration in labour productivity observed in the US in recent years.

An analysis of TFP growth and capital deepening contributions across euro area countries may help to understand whether aggregate developments are widely shared at the country level, or whether they reflect idiosyncratic features. It is useful to recall here that measurement issues are pervasive in cross-country comparisons. As a result, the country results should be interpreted with caution. Although tentative, available evidence indicates that lower capital deepening in the second half of the 1990s was a key factor behind the decline in labour productivity growth in most euro area countries with the exception of the Netherlands, Ireland, Greece and Austria (see Figure 3). The slowdown in capital deepening has been particularly marked in Finland, Spain, Germany and France.

Over the more recent years, the slowdown in TFP growth observed at the euro area level also seems to have been experienced by most euro area countries (see Figure 4). All countries but Greece experienced significantly lower TFP growth in the period 2000-2004 than in the second half of the 1990s. While this may reflect the synchronisation of business cycles across euro area countries, a similar picture emerges when comparing the period 2000-2004 with the first half of the 1990s, a period also marked by relatively weak average growth. In fact, since the first half of the 1990s, a deterioration in

**Figure 3 Capital deepening in euro area countries from 1990-1995 to 1995-2000**

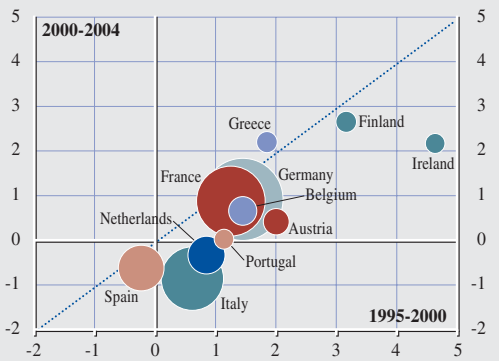
(annual percentage point contributions to growth in labour productivity per hour worked)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre (Total Economy Growth Accounting Database, June 2005, http://www.ggdc.net).
Note: The size of the bubbles reflects the average GDP weights in the euro area aggregate at actual exchange rates from 1990 to 2000.

**Figure 4 Total factor productivity in euro area countries from 1995-2000 to 2000-2004**

(annual percentage point contributions)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre (Total Economy Growth Accounting Database, June 2005, http://www.ggdc.net).
Note: The size of the bubbles reflects the average GDP weights in the euro area aggregate at actual exchange rates from 1990 to 2000.

TFP growth is observed in all euro area countries except for Finland, Greece and France where it increased somewhat. While caution is required in the interpretation of these results, the country evidence seems to indicate that the slowdown in capital deepening in the second half of the 1990s and the subsequent deceleration in TFP growth were widespread across euro area countries.

Box 2

## TFP GROWTH AND THE MEASUREMENT OF FACTOR INPUTS

The standard measure of TFP growth is the Solow residual, sometimes also called multi-factor productivity. It is computed as the share of output growth which cannot be accounted for by increases in primary factors of production such as labour and capital. It is generally interpreted to capture the effect of disembodied technological progress, improved utilisation and reallocation of resources, but also shifts in the sectoral composition of output. As a measure of overall economic efficiency, TFP is a key factor determining the evolution of labour productivity and in the longer term of overall activity and income per capita. While conceptually clear, the measurement of TFP is highly uncertain due to a number of data limitations, which concern all factors of production but are particularly severe for the capital input. This box concentrates on the uncertainty linked to the correct estimation of factors of production, thus leaving aside issues relating to the appropriate measurement of output (services output, hedonic deflators, etc.).

The most rudimentary estimate of TFP growth is calculated from aggregate national accounts data, where capital input is the capital stock and labour input is the total number of hours worked in the economy. Two important issues arise when such a crude measure is used. First, appropriate estimates of capital and labour should reflect the flow of productive services rather than simply considering the number of units in production. In particular, account should be taken of changes in the average quality of both labour and capital, which are otherwise implicitly included in measured TFP (generally leading to an overestimation of TFP growth). Second, the basic Solow residual assumes that the factors of production are flexible and fully employed. This is a valid working assumption over the very long run, but in the medium run there are adjustment costs in changing the quantity of both labour and capital, implying that firms often respond to short-term fluctuations in demand by changing the intensity of utilisation of inputs rather than their quantity. Varying degrees of factor utilisation may explain a significant part of the high cyclicality of measured TFP growth (its correlation with real GDP growth is 0.8 since 1980, compared with 0.4 for labour productivity growth). One should therefore also take into account changes in factor utilisation when assessing underlying TFP developments. The impact of factors' quality and varying degrees of utilisation are discussed successively.

### TFP and quality-adjusted measures of labour and capital

Often, no explicit account is taken of the evolution of capital and labour quality, due to the lack of reliable and timely data. As a result, quality improvements in the factors of production are therefore implicitly captured in measured TFP. In order to illustrate the implied potential bias, capital quality for the euro area is derived from the work of the Groningen Growth and Development Centre (GGDC) on capital services, while labour quality estimates are based on

**Table 1 Factor quality and TFP estimates**

(annual percentage changes)

| | | By decade | | By cycle | | Recent periods | | |
|---|---|---|---|---|---|---|---|---|
| | | 1980-1990 | 1990-2000 | 1982-1993 | 1993-2003 | 1990-1995 | 1995-2000 | 2000-2004 |
| TFP based on capital stock and total hours worked | (1) | 1.6 | 1.3 | 1.5 | 1.0 | 1.3 | 1.4 | 0.6 |
| Capital quality | | 0.3 | 0.2 | 0.3 | 0.2 | 0.1 | 0.3 | 0.2 |
| Impact on measured TFP | (2) | -0.1 | -0.1 | -0.1 | -0.1 | 0.0 | -0.1 | -0.1 |
| Labour quality | | 0.5 | 0.7 | 0.6 | 0.6 | 0.9 | 0.5 | 0.6 |
| Impact on measured TFP | (3) | -0.3 | -0.5 | -0.4 | -0.4 | -0.6 | -0.3 | -0.4 |
| Quality adjusted TFP | (1)+(2)+(3) | 1.1 | 0.8 | 1.0 | 0.6 | 0.7 | 1.0 | 0.2 |

Sources: ECB calculations based on data from the Groningen Growth and Development Centre (Total Economy Growth Accounting Database, June 2005, http://www.ggdc.net) and Schwerdt and Turunen (2006).
Note: Capital quality estimate from the Groningen Growth and Development Centre (2005) available up to 2004. Capital quality is understood here as the difference between capital services and capital stock. Labour quality estimates are from Schwerdt and Turunen (2006) and for pre-1984 aggregation are based on country data published in Jorgenson (2004).

Schwerdt and Turunen (2006). Table 1 presents average developments in labour and capital quality over different time periods and their corresponding impact on TFP growth estimates.

Starting with capital, removing the impact of quality changes on measured TFP implies a downward shift in estimates by around 0.1ppt throughout the sample period. While the increasing share of ICT capital has implied some acceleration in capital quality since the mid-1990s, this would seem to affect only marginally the profile of TFP growth over the most recent periods.

Turning to labour quality, available data suggest that a significant acceleration in labour quality growth in the earlier part of the 1990s was followed by a gradual slowing down since the mid-1990s. This points to a more significant deceleration in actual TFP during the first half of the 1990s. Since the mid-1990s, growth in labour quality showed signs of moderation, possibly reflecting the impact of continued robust growth in employment resulting in entry of workers with lower human capital into the labour market. This moderation could have contributed to some of the apparent decline in TFP growth estimates.

Altogether, developments in capital and labour quality point to a more significant deceleration in TFP estimates during the first half of the 1990s, followed by a further decline in recent years. Beyond its impact on the pattern of TFP growth, the most significant contribution of appropriately accounting for factor quality is to reduce the average growth rate of TFP significantly, thus implying a much lower contribution to labour productivity than suggested by more standard measures.

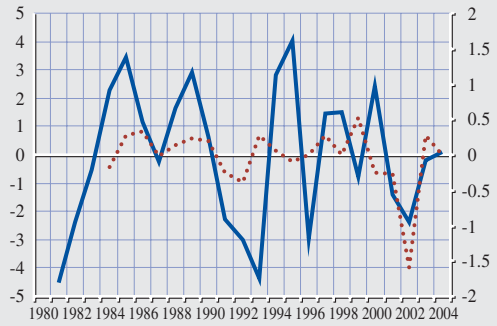
## TFP and varying degrees of factor utilisation

While there is consistent evidence of a slowdown in TFP growth during the 1990s, its timing appears difficult to establish due to its significant correlation with the business cycle. This correlation is mainly attributed to variable rates of utilisation of labour and capital across different phases of the cycle, i.e. labour and capital hoarding.

While the degree of factor hoarding is unobservable, survey data can provide some provisional indications. In particular, the rate of capacity utilisation in industry is generally found to be a good proxy for capital hoarding, while cyclical variations in hours are considered both

**Chart 1 Survey indication of factor utilisation**

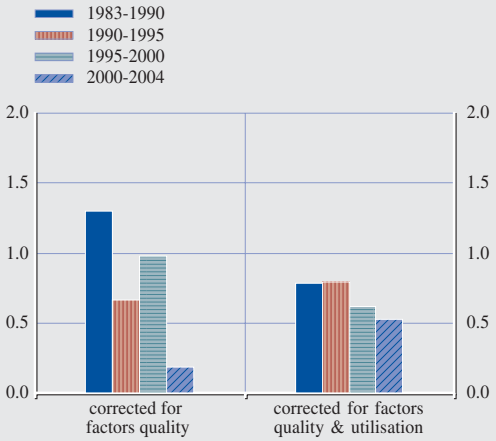
(annual percentage changes)




Sources: European Commission Business Surveys and Labour Force Surveys.

**Chart 2 TFP growth adjusted for variable rates of factor utilisation**

(annual percentage changes)




Sources: GGDC, EC, Eurostat and ECB calculations.

theoretically and empirically to be related to labour effort. Chart 1 presents the evolution of capacity utilisation from European Commission Business Surveys and the deviation of actual hours worked from "normal" working time according to Eurostat Labour Force Surveys (both in annual growth rates). According to this evidence, capital utilisation was reduced significantly less over the recent period of slower growth than during the period surrounding the 1993 recession. On the other hand, hours worked per person would seem to have been reduced more significantly, possibly indicating the use of more flexible working time arrangements to accommodate cyclical fluctuations in demand.

When accounting for factor hoarding, the timing of the TFP growth slowdown in the course of the 1990s is significantly affected (see Chart 2). In fact, the slowdown becomes detectable in the second half of the 1990s, while non-adjusted TFP growth shows a downward movement occurring mainly over the most recent years. However, significant caution is required in interpreting these results. First, capacity utilisation is only surveyed in manufacturing and might therefore not adequately represent economy-wide developments. Second, although mainly referring to capital use, capacity utilisation may also capture changes in the utilisation of other factors of production (such as labour). Third, there is some uncertainty regarding the recent trends in hours, with a larger downward adjustment according to Labour Force Surveys than according to GGDC/OECD data.

Despite the limitations, adjusting for factor utilisation suggests a gradual decline in TFP growth throughout the last two decades. In addition, the most recent deterioration would seem to have occurred around the mid-1990s rather than during the last few years of subdued economic growth as indicated by most standard measures.

Overall, TFP estimates are subject to significant measurement uncertainty but there is relatively robust evidence of a deceleration during the 1990s, reinforcing the view that labour productivity growth was structurally weaker than in earlier periods.

### 3.3 SECTORAL ANALYSIS

The decomposition of labour productivity growth per hour worked at the sectoral level sheds more light on the different developments in labour productivity growth in the euro area and the US. In particular, it helps to identify those sectors in the euro area where the short-run link between strong employment and low productivity growth was particularly marked. It also helps to understand the degree to which the gap in total factor productivity growth may reflect technical progress in some specific sectors. Linked to the idea that ICT has played an important role in diverse productivity developments in the euro area and the US, a distinction is made between industries according to their intensity in the use of ICT. A typical breakdown is between ICT-producing, ICT-using and remaining industries which are labelled as "non-ICT".[10]

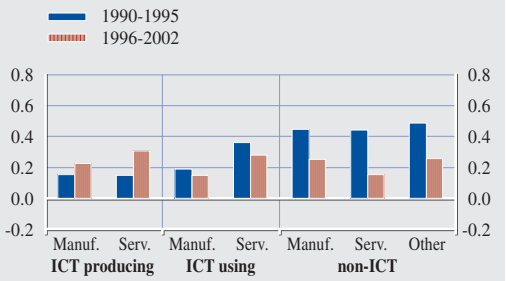
Following this ICT taxonomy, the main features of sectoral productivity contributions can be summarised as follows. First, a significant deceleration in hourly labour productivity in non-ICT sectors from the first half of the 1990s explains most of the decline in euro area aggregate labour productivity growth over the late 1990s (see right-hand side of Figure 5, and Annex 1 for a more detailed breakdown by individual industries). This deceleration in labour productivity in the non-ICT sectors seems primarily related to strong employment growth, which reduced the pace of capital deepening. Figure 6 shows that a negative correlation between employment and labour productivity growth developments exists within non-ICT industries. No such relationship exists for the ICT-producing and ICT-using industries (not shown).

Second, productivity developments in the ICT-producing sectors were in recent years relatively strong in the euro area, and even outperformed slightly the US in the segment of ICT-producing services (software, computer and communication services). Overall, developments in the ICT-producing sectors contributed to higher aggregate labour productivity growth in the second half of the 1990s, by around 0.3ppt per year compared with the first half of the 1990s. This is consistent with a positive technological shock also occurring in the euro area ICT-producing sector, which led to stronger labour productivity and higher employment growth (see left-hand side of Figure 7 for the link between employment and productivity growth across ICT-producing industries). However, this sector represents a smaller share of the economy in the euro area than in the US, which implies that positive developments had a more limited impact on aggregate productivity in the euro area (see left-hand side of Figure 7).[11]

Third, the ICT-using sectors in the euro area failed to experience the strong acceleration in labour productivity observed in the US in recent years. In particular, key ICT-using services such as retail, wholesale and financial services saw broadly stable, or slightly lower, productivity growth in recent years in the euro area. At the

**Figure 5 Sectoral decomposition of euro area labour productivity growth in 1990-1995 and in 1996-2002**

(percentage point contribution from different sectors)



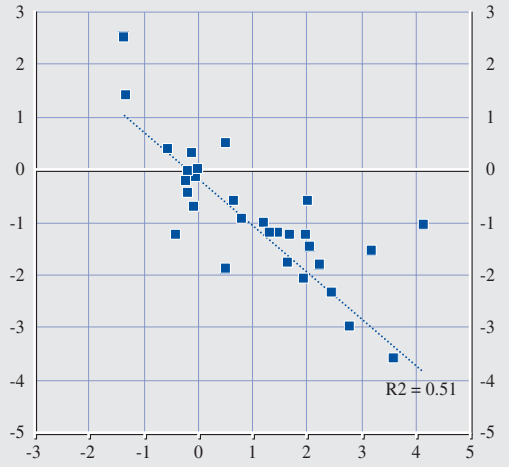

Sources: ECB calculations based on data from the Groningen Growth and Development Centre (60-Industry Database, February 2005, http://www.ggdc.net).

10 A table with the employment and output shares of the different sectors is presented in Annex 1.

11 Beyond ICT-producing manufacturing, differences in sectoral compositions between the US and the euro area appear to have limited implications for aggregate productivity developments. Computing aggregate labour productivity in the euro area with US sector weights implies that labour productivity growth would have been 2.1% in 1990-1995, instead of 2.2%, and 1.7% in 1996-2002, instead of 1.6%. Overall, the deceleration would have been slightly milder between the two periods, but the general picture of a slowdown in labour productivity growth does not appear related to a different sectoral composition in the euro area.

**Figure 6 Changes in euro area labour productivity and employment growth between 1990-1995 and 1996-2002 in non-ICT industries**

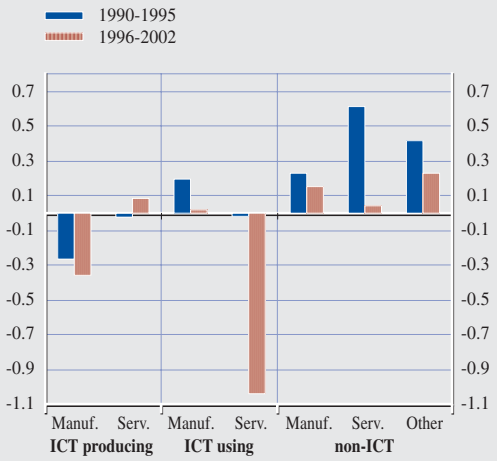
(percentage points)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre (60-Industry Database, February 2005, http://www.ggdc.net).
Note: The vertical axis shows the difference between average productivity growth over the periods 1996-2002 and 1990-1995. The horizontal axis shows the difference between average employment growth over the periods 1996-2002 and 1990-1995.

**Figure 7 Sectoral decomposition of the gap between euro area and US labour productivity growth in 1990-1995 and in 1996-2002**

(percentage point contribution from different sectors)[1)]



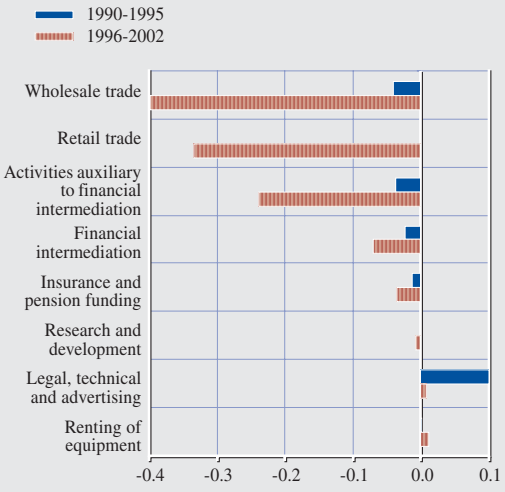

Sources: ECB calculations based on data from the Groningen Growth and Development Centre (60-Industry Database, February 2005, http://www.ggdc.net).
1) The end period varies across data sources. The 60-Industry Database of the GGDC includes data up to 2002, while the data used for Figures 1 to 4 end in 2004.

same time, productivity growth in these sectors surged in the US. This accounts for a large part of the difference in aggregate productivity growth between the euro area and the US of around 1ppt over the period 1996-2002 (see Figures 7 and 8, and Annex 1 for the contribution of other individual industries). The apparent lack of spillover effects of ICT beyond the ICT-producing sector could suggest a slow diffusion of new technologies in the euro area, possibly related to barriers to competition and innovation, as well as stringent labour and product market regulations. These regulations are expected to affect negatively productivity trends by reducing competition, by limiting the efficiency in production and by lowering the incentive to innovate, all of which appear particularly pertinent in the euro area services sector.

Overall, the main reason for diverging trends in labour productivity growth between the euro area and the US in recent years seems to primarily reflect developments in a limited number of ICT-using services such as retail, wholesale and financial services, where strong gains were registered (only) in the US. Regarding the labour productivity growth slowdown in the euro area since the mid-1990s,

**Figure 8 Contributions of ICT-using services to the labour productivity growth gap between the euro area and the US**

(percentage points)




Sources: ECB calculations based on data from the Groningen Growth and Development Centre (60-Industry Database, February 2005, http://www.ggdc.net).

strong employment growth in traditional non-ICT sectors would appear to have significantly contributed to slower capital deepening at economy-wide level. While one could assume that the slowdown in aggregate TFP growth might also have been most visible in non-ICT industries, this remains mostly speculative in the absence of more timely data spanning over recent years when the deceleration became more clearly visible.

## 4 THE CONTRIBUTION OF LABOUR PRODUCTIVITY TO GROWTH

In the previous sections we have documented a sustained decline in euro area labour productivity growth and identified its main determinants. A further accounting exercise for the factors underlying the evolution of real GDP per capita is useful to demonstrate the key features of recent developments in the euro area compared with the US, in terms of the relative contributions of labour productivity and labour utilisation. For example, a significant acceleration in labour utilisation in the euro area has led to higher real GDP per capita growth since the mid-1990s (see Table 2). In particular, in the second half of the 1990s, a significant increase in the participation rate and a decline in the unemployment rate more than offset the continued decline in hours worked per person and the slight negative working age population developments. This emphasises the positive role played by policies promoting higher labour utilisation, even if the same policies have contributed to reducing the pace of labour productivity in recent years. However, the positive impact of higher labour utilisation in the euro area was smaller than that of rising productivity growth in the US. As a result, the gap in per capita GDP growth between the two economies was maintained in recent years.

As regards labour utilisation, and despite the recent positive contribution to per capita GDP

**Table 2 Decomposition of annual growth in GDP per capita**

(average percentage changes and percentage points per annum)

| | GDP per capita | GDP per hour worked | Labour utilisation | Hours worked per person employed | Unemployment rate | Labour force participation | Share of working age population in total population |
|---|---|---|---|---|---|---|---|
| | a = b + c | b | c = sum d to g | d | e | f | g |
| **1981-1990** | | | | | | | |
| Euro area | 2.0 | 2.5 | -0.5 | -0.7 | -0.2 | -0.1 | 0.5 |
| United States | 2.2 | 1.4 | 0.8 | -0.1 | 0.2 | 0.7 | 0.0 |
| Gap US – EA | 0.2 | -1.1 | 1.3 | 0.6 | 0.4 | 0.8 | -0.5 |
| **1991-1995** | | | | | | | |
| Euro area | 1.1 | 2.3 | -1.2 | -0.4 | -0.6 | -0.2 | 0.0 |
| United States | 1.2 | 1.1 | 0.0 | 0.2 | 0.0 | 0.0 | -0.1 |
| Gap US – EA | 0.1 | -1.2 | 1.2 | 0.6 | 0.6 | 0.2 | -0.1 |
| **1996-2000** | | | | | | | |
| Euro area | 2.5 | 1.7 | 0.9 | -0.4 | 0.5 | 0.8 | -0.1 |
| United States | 2.9 | 2.1 | 0.8 | 0.2 | 0.3 | 0.0 | 0.2 |
| Gap US – EA | 0.4 | 0.5 | -0.1 | 0.6 | -0.2 | -0.8 | 0.3 |
| **2001-2005** | | | | | | | |
| Euro area | 1.2 | 0.7 | 0.5 | -0.2 | -0.1 | 0.9 | -0.1 |
| United States | 1.6 | 2.6 | -1.0 | -0.6 | -0.2 | -0.3 | 0.2 |
| Gap US – EA | 0.4 | 1.8 | -1.4 | -0.4 | -0.2 | -1.1 | 0.3 |

Sources: ECB calculations based on data from the European Commission, the OECD and the Groningen Growth and Development Centre (Total Economy Database, May 2006, http://www.ggdc.net).
Note: Positive contributions from unemployment reflect a decline in the unemployment rate.

growth, its level in the euro area is still much lower than in the US. In particular, in the euro area unemployment rates are currently more than 3 percentage points higher, labour force participation rates about 5 percentage points lower and annual hours worked per employed person about 15% lower. While the gap vis-à-vis the US has somewhat narrowed with regard to unemployment and participation, it widened further with regard to annual hours worked per person employed in the second half of the 1990s. A downward trend in annual hours worked per worker can be observed in the euro area over the 1990s, while it remained broadly unchanged in the US. Statutory or collectively agreed working hours, public holidays and annual leave all affect the level of annual hours worked per worker. The negative trend in working time per worker in the euro area can also be related to institutional factors (other than working time regulation) that hamper the supply of labour, such as taxes and social benefits. Finally, it is worth mentioning that demographic factors will continue to exert downward pressure on per capita income, via their negative effect on the labour force.

## 5 CONCLUDING REMARKS

This paper has documented the recent sustained decline in euro area labour productivity growth and identified its main immediate sources, i.e. declines in capital deepening and TFP growth. Lower capital deepening can partly be associated with the robust pace of job creation since the mid-1990s, while lower TFP growth might be partly explained by higher utilisation of lower-skilled workers. The slowdown in both capital deepening and TFP growth can be observed in most euro area countries. From a sectoral perspective, industries not producing or intensively using ICT appear mostly responsible for the decline in average labour productivity growth since the mid-1990s. Moreover, the comparison of recent euro area developments with those of the US shows that, while the slowdown in labour productivity growth appears to be related to strong employment growth, there has been a lack of productivity-enhancing use of new technologies in the euro area. The acceleration of US productivity in recent years is generally associated for a significant part with the production and use of ICT, which spurred output per hour worked through significant capital deepening and higher TFP growth. The euro area economy seems to have benefited much less from these factors, reflecting both lower investment in ICT compared with the US and barriers to the diffusion or appropriate use of new technologies, in particular in the services sector. Diverging trends in labour productivity growth between the euro area and the US in recent years mainly reflect developments in a number of specific ICT-using services such as retail, wholesale and some financial services where strong gains were registered in the US.

The immediate sources of productivity growth identified in this paper are the result of more fundamental factors that increase the pace of technological progress, such as research and development (R&D) and innovation activity, greater diffusion of new technologies, such as ICT, and advances in human capital (see Barro and Sala-i-Martin, 2004). These fundamental factors in turn depend on economic policies, the institutional framework and preferences. Our understanding of the interactions between fundamental factors and economic policies remains incomplete. As a result, identifying specific policy recommendations is not an easy task and more empirical research is clearly needed.

Nevertheless, a number of broad policy recommendations to address fundamental factors of lower productivity growth have already been made by expert groups (such as those in the Sapir report of July 2003 and the Kok report of November 2004) and were reflected also in the recent mid-term review of the Lisbon agenda. One of the three key areas of the mid-term review is "knowledge and innovation for growth" and the policy recommendations within this area, together with other recommendations concerning human

capital, are likely to go a long way towards addressing the main fundamental determinants of lower TFP growth in the euro area documented in this paper. For example, the programme calls for an increase in expenditure on R&D as a share of GDP. For the euro area as a whole and for most euro area countries, the share of R&D spending remains well below the 3% target (for a detailed discussion see ECB, 2005). This suggests that further efforts are needed to increase the share of R&D spending in a number of euro area countries. Our results also suggest that policies directed at improving productivity growth in the services sector are likely to be particularly important (see also ECB, 2006). Overall, in addition to further progress with reforms directed towards higher rates of labour utilisation, our results support the call for economic policies that aim at stimulating innovation and promoting the use of productivity-enhancing technologies. Policies that contribute to increasing product market competition, facilitating restructuring and increasing human capital are likely to speed up productivity gains from the use of new technologies. In this regard, emphasis on strengthening the implementation of the renewed Lisbon agenda objectives is very welcome.

## ANNEX – ICT TAXONOMY

### Employment and nominal output shares of different industry groups

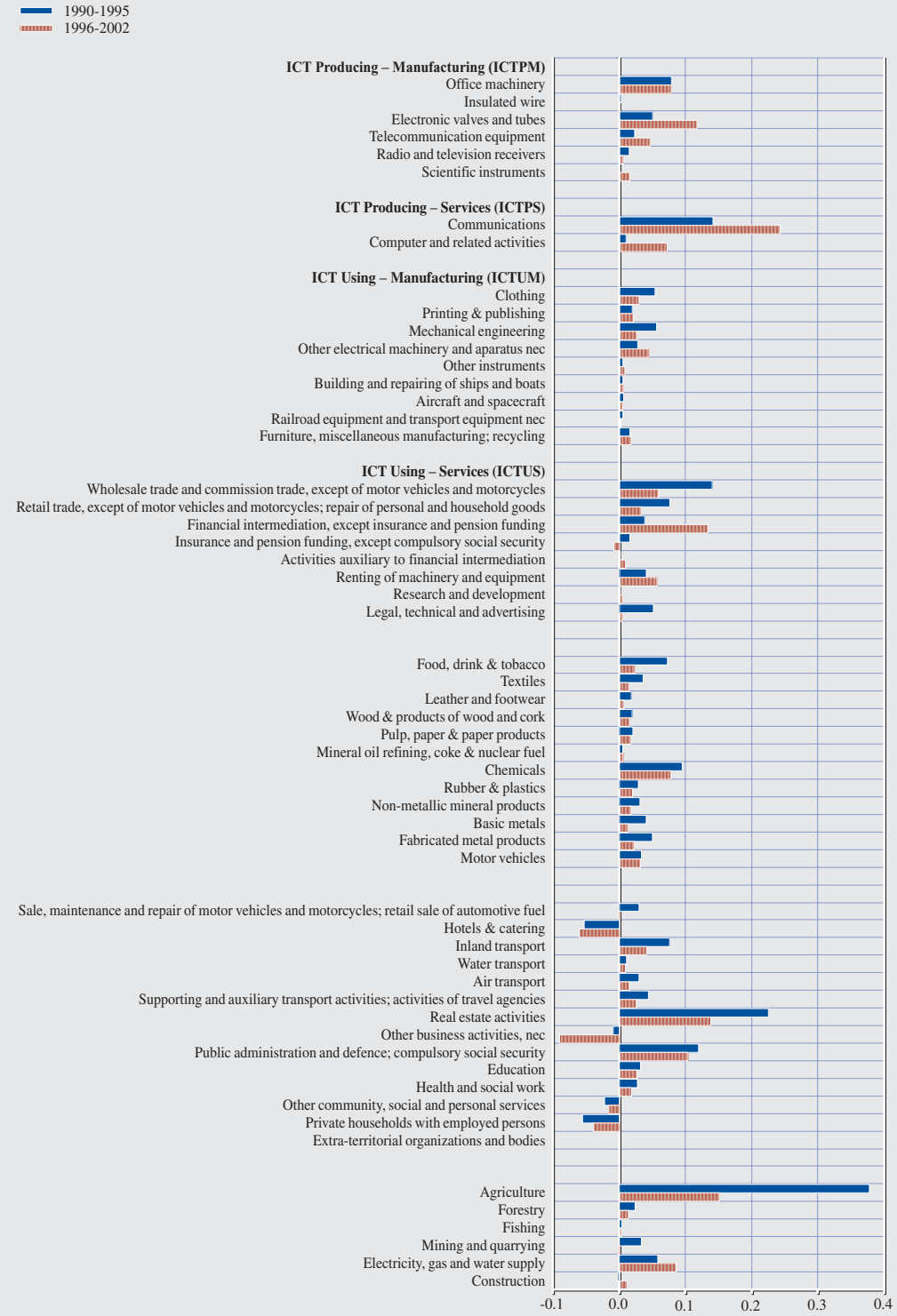
(average for 1996-2002)

| | Euro area | | US | |
|---|---|---|---|---|
| | Employment | Output | Employment | Output |
| **ICT-producing** | **3.6** | **5.3** | **4.3** | **7.0** |
| Manufacturing | 1.1 | 1.2 | 1.2 | 2.1 |
| Services | 2.4 | 4.1 | 3.0 | 4.9 |
| **ICT-using** | **26.2** | **27.3** | **27.6** | **29.4** |
| Manufacturing | 6.3 | 6.0 | 4.7 | 4.7 |
| Services | 19.9 | 21.3 | 23.0 | 24.7 |
| **Non-ICT** | **70.2** | **67.4** | **68.1** | **63.5** |
| Manufacturing | 11.7 | 13.0 | 6.9 | 9.2 |
| Services | 45.1 | 43.8 | 52.2 | 44.7 |
| Other | 13.4 | 10.6 | 9.0 | 9.6 |

Sources: ECB calculations based on data from the Groningen Growth and Development Centre (60-Industry Database, February 2005, http://www.ggdc.net).
Note: ICT-using industries are distinguished from non-ICT industries based on the share of ICT capital in total capital services in the US (see Stiroh, 2002, for a discussion). Van Ark et al. (2003) show that the ranking of ICT intensity across industries is reasonably similar in the US and in Europe.

## Contributions of individual industries to growth in labour productivity per hour worked in the euro area

(percentage points)




Sources: ECB and the Groningen Growth and Development Centre (60-Industry Database, February 2005).

## Contributions of individual industries to the labour productivity growth gap between the euro area and the US

(percentage points)


Sources: ECB and the Groningen Growth and Development Centre (60-Industry Database, February 2005).

## REFERENCES


Acemoglu, D., J. A. Robinson and S. Johnson (2000), "The Colonial Origins of Comparative Development: An Empirical Investigation", *American Economic Review,* Vol. 91, December 2001, pp. 1369-1401.

Alcalá, F. and A. Ciccone (2004), "Trade and Productivity", *Quarterly Journal of Economics,* Vol. 119 (2004), No 2, pp. 613-46.

Annenkov, A. and C. Madaschi (2005), "Labour productivity in the Nordic EU countries: a comparative overview and explanatory factors 1980-2004", ECB Occasional Paper No 39, October.

Bai, J. and P. Perron (1998), "Estimating and testing linear models with multiple structural changes", *Econometrica,* Vol. 66 (1).

Ball, L. and R. Moffitt (2001), "Productivity Growth and the Phillips Curve", in *The Roaring Nineties: Can Full Employment Be Sustained?,* in Krueger and Solow (eds), Russell Sage Foundation and Century Foundation, 2001.

Barro, R. (1999), "Notes on Growth Accounting", *Journal of Economic Growth,* Vol. 4 (2), pp. 119-37.

Barro, R. and X. Sala-i-Martin (2004), *Economic Growth,* second edition, MIT Boston.

Bernanke, B. (2005), "Productivity", speech given on 19 January 2005, available at www.frb.gov.

Doornik, J. A. (2001), *Ox: An Object-Oriented Matrix Language,* Timberlake Consultants Press.

ECB (2004), "Labour productivity developments in the euro area: Aggregate trends and sectoral patterns", ECB Monthly Bulletin, July.

ECB (2005), "The Lisbon Strategy – five years on", ECB Monthly Bulletin, July.

ECB (2006), "Competition, productivity and prices in the euro area services sector", by the Task Force of the Monetary Policy Committee of the European System of Central Banks, ECB Occasional Paper No 44.

Griliches, Z. (2001), "A Perspective on What We Know about the Sources of Productivity Growth", in *New Developments in Productivity Analysis,* Hulten et al. (eds), Chicago University Press.

Hall, R. E. and C. I. Jones (1999), "Why Do Some Countries Produce So Much More Output per Worker than Others?", *Quarterly Journal of Economics,* Vol. 114, pp. 83-116.

Hornstein, A. and P. Krusell (1996), "Can Technology Improvements Cause Productivity Slowdowns?", *NBER Macroeconomics Annual* 1996, pp. 209-59.

Jorgenson, D. (2004), "Information Technology and the G7 Economies", *World Economics* 4(4), pp. 139-69.

Koopman, S., A. Harvey, J. Doornik and N. Shephard (2000), *STAMP: Structural Time Series Analyser Modeller and Predictor,* Timberlake Consultants Press.

Musso, A. and T. Westermann (2005), "Assessing potential output growth in the euro area – a growth accounting perspective", ECB Occasional Paper No 22, January.

Nordhaus, W. (2004), "Retrospective on the 1970s Productivity Slowdown", NBER Working Paper No W10950, December.

O'Mahony, M. and B. van Ark (2003), "EU Productivity and Competitiveness: An Industry Perspective", European Commission.

Schwerdt, G. and J. Turunen (2006), "Growth in euro area labour quality", ECB Working Paper No 575.

Sichel, D. (1997), "The Productivity Slowdown: Is a Growing Unmeasurable Sector the Culprit?", *Review of Economics and Statistics,* Vol. 79, No 3, pp. 367-70.

Stiroh, K. J. (2002), "Information Technology and the US Productivity Revival: What Do the Industry Data Say?", *American Economic Review* 92(5), pp. 1559-76.

Van Ark, B., R. Inklaar and R. McGuckin (2003), "ICT and Productivity in Europe and the United States. Where Do the Differences Come From?", *CESifo Economic Studies,* Vol. 49(3), pp. 295-318.

Vijselaar, F. and R. Albers (2004), "New Technologies and Productivity Growth in the Euro Area", *Empirical Economics,* 29(3), pp. 621-46.

## EUROPEAN CENTRAL BANK
## OCCASIONAL PAPER SERIES

1 "The impact of the euro on money and bond markets" by J. Santillán, M. Bayle and C. Thygesen, July 2000.

2 "The effective exchange rates of the euro" by L. Buldorini, S. Makrydakis and C. Thimann, February 2002.

3 "Estimating the trend of M3 income velocity underlying the reference value for monetary growth" by C. Brand, D. Gerdesmeier and B. Roffia, May 2002.

4 "Labour force developments in the euro area since the 1980s" by V. Genre and R. Gómez-Salvador, July 2002.

5 "The evolution of clearing and central counterparty services for exchange-traded derivatives in the United States and Europe: a comparison" by D. Russo, T. L. Hart and A. Schönenberger, September 2002.

6 "Banking integration in the euro area" by I. Cabral, F. Dierick and J. Vesala, December 2002.

7 "Economic relations with regions neighbouring the euro area in the 'Euro Time Zone'" by F. Mazzaferro, A. Mehl, M. Sturm, C. Thimann and A. Winkler, December 2002.

8 "An introduction to the ECB's survey of professional forecasters" by J. A. Garcia, September 2003.

9 "Fiscal adjustment in 1991-2002: stylised facts and policy implications" by M. G. Briotti, February 2004.

10 "The acceding countries' strategies towards ERM II and the adoption of the euro: an analytical review" by a staff team led by P. Backé and C. Thimann and including O. Arratibel, O. Calvo-Gonzalez, A. Mehl and C. Nerlich, February 2004.

11 "Official dollarisation/euroisation: motives, features and policy implications of current cases" by A. Winkler, F. Mazzaferro, C. Nerlich and C. Thimann, February 2004.

12 "Understanding the impact of the external dimension on the euro area: trade, capital flows and other international macroeconomic linkages" by R. Anderton, F. di Mauro and F. Moneta, March 2004.

13 "Fair value accounting and financial stability" by a staff team led by A. Enria and including L. Cappiello, F. Dierick, S. Grittini, A. Maddaloni, P. Molitor, F. Pires and P. Poloni, April 2004.

14 "Measuring financial integration in the euro area" by L. Baele, A. Ferrando, P. Hördahl, E. Krylova, C. Monnet, April 2004.

15 "Quality adjustment of European price statistics and the role for hedonics" by H. Ahnert and G. Kenny, May 2004.

16 "Market dynamics associated with credit ratings: a literature review" by F. Gonzalez, F. Haas, R. Johannes, M. Persson, L. Toledo, R. Violi, M. Wieland and C. Zins, June 2004.

17 "Corporate 'excesses' and financial market dynamics" by A. Maddaloni and D. Pain, July 2004.

18 "The international role of the euro: evidence from bonds issued by non-euro area residents" by A. Geis, A. Mehl and S. Wredenborg, July 2004.

19 "Sectoral specialisation in the EU: a macroeconomic perspective" by MPC task force of the ESCB, July 2004.

20 "The supervision of mixed financial services groups in Europe" by F. Dierick, August 2004.

21 "Governance of securities clearing and settlement systems" by D. Russo, T. Hart, M. C. Malaguti and C. Papathanassiou, October 2004.

22 "Assessing potential output growth in the euro area: a growth accounting perspective" by A. Musso and T. Westermann, January 2005.

23 "The bank lending survey for the euro area" by J. Berg, A. van Rixtel, A. Ferrando, G. de Bondt and S. Scopel, February 2005.

24 "Wage diversity in the euro area: an overview of labour cost differentials across industries" by V. Genre, D. Momferatou and G. Mourre, February 2005.

25 "Government debt management in the euro area: recent theoretical developments and changes in practices" by G. Wolswijk and J. de Haan, March 2005.

26 "The analysis of banking sector health using macro-prudential indicators" by L. Mörttinen, P. Poloni, P. Sandars and J. Vesala, March 2005.

27 "The EU budget – how much scope for institutional reform?" by H. Enderlein, J. Lindner, O. Calvo-Gonzalez, R. Ritter, April 2005.

28 "Reforms in selected EU network industries" by R. Martin, M. Roma, I. Vansteenkiste, April 2005.

29 "Wealth and asset price effects on economic activity", by F. Altissimo, E. Georgiou, T. Sastre, M. T. Valderrama, G. Sterne, M. Stocker, M. Weth, K. Whelan, A. Willman, June 2005.

30 "Competitiveness and the export performance of the euro area", by a Task Force of the Monetary Policy Committee of the European System of Central Banks, June 2005.

31 "Regional monetary integration in the member states of the Gulf Cooperation Council (GCC)" by M. Sturm and N. Siegfried, June 2005.

32 “Managing financial crises in emerging market economies: experience with the involvement of private sector creditors” by an International Relations Committee task force, July 2005.

33 “Integration of securities market infrastructures in the euro area” by H. Schmiedel, A. Schönenberger, July 2005.

34 “Hedge funds and their implications for financial stability” by T. Garbaravicius and F. Dierick, August 2005.

35 “The institutional framework for financial market policy in the USA seen from an EU perspective” by R. Petschnigg, September 2005.

36 “Economic and monetary integration of the new Member States: helping to chart the route” by J. Angeloni, M. Flad and F. P. Mongelli, September 2005.

37 “Financing conditions in the euro area” by L. Bê Duc, G. de Bondt, A. Calza, D. Marqués Ibáñez, A. van Rixtel and S. Scopel, September 2005.

38 “Economic reactions to public finance consolidation: a survey of the literature” by M. G. Briotti, October 2005.

39 “Labour productivity in the Nordic EU countries: a comparative overview and explanatory factors – 1998-2004” by A. Annenkov and C. Madaschi, October 2005.

40 “What does European institutional integration tell us about trade integration?” by F. P. Mongelli, E. Dorrucci and I. Agur, December 2005.

41 “Trends and patterns in working time across euro area countries 1970-2004: causes and consequences” by N. Leiner-Killinger, C. Madaschi and M. Ward-Warmedinger, December 2005.

42 “The New Basel Capital Framework and its implementation in the European Union” by F. Dierick, F. Pires, M. Scheicher and K. G. Spitzer, December 2005.

43 “The accumulation of foreign reserves” by an International Relations Committee Task Force, February 2006.

44 “Competition, productivity and prices in the euro area services sector” by a Task Force of the Monetary Policy Committee of the European System of Central banks, April 2006.

45 “Output growth differentials across the euro area countries: Some stylised facts” by N. Benalal, J. L. Diaz del Hoyo, B. Pierluigi and N. Vidalis, May 2006.

46 “Inflation persistence and price-setting behaviour in the euro area – a summary of the IPN evidence”, by F. Altissimo, M. Ehrmann and F. Smets, June 2006.

47 “The reform and implementation of the stability and growth pact” by R. Morris, H. Ongena and L. Schuknecht, June 2006.

48 "Macroeconomic and financial stability challenges for acceding and candidate countries" by the International Relations Committee Task Force on Enlargement, July 2006.

49 "Credit risk mitigation in central bank operations and its effects on financial markets: the case of the Eurosystem" by U. Bindseil and F. Papadia, August 2006.

50 "Implications for liquidity from innovation and transparency in the European corporate bond market" by M. Laganá, M. Peřina, I. von Köppen-Mertes and A. Persaud, August 2006.

51 "Macroeconomic implications of demographic developments in the euro area" by A. Maddaloni, A. Musso, P. Rother, M. Ward-Warmedinger and T. Westermann, August 2006.

52 "Cross-border labour mobility within an enlarged EU" by F. F. Heinz and M. Ward-Warmedinger, October 2006.

53 "Labour productivity developments in the euro area" by R. Gomez-Salvador, A. Musso, M. Stocker and J. Turunen, October 2006.

ISSN 1607148-4